ISSN: 1122-5548

CAPSICUM & EGGPLANT NEWSLETTER

UNIVERSITY OF TURIN (DI.VA.P.R.A. - AGRICULTURAL GENETICS

EUCARPIA

No. 19

2000

CAPSICUM & EGGPLANT NEWSLETTER

NUMBER 19

2000

PAUL W. BOSLAND
AGRONOMY & HORTICULTURE
NEW MEXICO STATE UNIVERSITY
LAS CRUCES, NM 88003
(505) 646-5171

University of Turin
DI.VA.P.R.A.
Agricultural Genetics
Via Leonardo da Vinci, 44 - 10095 Grugliasco - Italy
http://www.agraria.unito.it/dip/divapr/geneti/cenl

The Editorial Staff of "Capsicum and Eggplant Newsletter" gratefully acknowledges the contribution of the Food and Agriculture Organisation of the United Nations towards improving the content and the diffusion of the Newsletter.

Printed by the University of Turin

June 2000

EDITOR

P.Belletti
DI.VA.P.R.A. - Agricultural Genetics
University of Turin
Via Leonardo da Vinci, 44 - 10095 Grugliasco - Italy
Fax +39 011 6708826- Email: capsicum@agraria.unito.it

SCIENTIFIC COMMITTEE

SUBSCRIPTION

Annual subscription: 30 EURO (normal) and 150 EURO (supporter).
3-years subscription: 80 EURO (normal) and 400 EURO (supporter).
All rates include carriage charges.

Subscription to be sent to EUCARPIA Secretariat (P. O. Box 315, 6700 AH WAGENINGEN, The Netherlands). Payment can be done:

1. by credit card of Visa, Eurocard, American Express or Diners Club;
2. by bank transfer , postal giro or cheque. In this case an extra amount of 10 EURO is requested to cover the bank costs;

EUCARPIA bank relation is: Postbank N.V., Eucarpia postal giro No. 2330521, P.O.Box 315, 6700 AH Wageningen, The Netherlands.

Please, always specify your name and the cause of the payment.

JUNE 2000

The picture in the cover is derived from the
"Herbario nuovo di Castore Durante", Venetia, MDCXXXVI

Printed in Italy

CONTENTS

FOREWORD

Next autumn, our Department will complete its move to its new location at Grugliasco. Starting in September 2000, our new fax number will be **+39 011 6708826**.

We remind our readers that *Capsicum and Eggplant Newsletter* has its own Email address: **capsicum@agraria.unito.it**. One can send messages as well as **submit contributions for publication** to this address. In addition, the Website Home Page, **http://www.agraria.unito.it/dip/divapr/geneti/cenl** has all the information about the Newsletter.

The nineteenth issue of *Capsicum and Eggplant Newsletter* includes a very interesting invited paper. It was written by Marie-Christine Daunay, Richard Lester, Jean Hennart and Claude Duranton and deals with present status and perspectives of eggplant breeding. We thank these Authors very much for their efforts and for their kind willingness to increase the scientific value of our publication. In addition, we would like to remind you that any suggestions on the topics and/or authors to be considered for invited papers in future issues of *Capsicum and Eggplant Newsletter* are welcomed.

Continuing the tradition of not modifying the accepted contributions, the papers have been printed as received. The Authors, not CENL, are responsible for both the scientific content and the form of their reports.

Please, remember that this Newsletter is highly dependent on the financial support of the recipients. Therefore, a subscription fee is appreciated. The subscription fee is the same as last years, although the requested currency has changed: 30 EURO for normal and 150 EURO for supporter subscribers. Remember that to make the payment less time-consuming and to reduce bank costs, we have introduced the option of a 3-year subscription. It is possible (and encouraged!) to book your own copy to quicken its delivery. Just fill in the order form on page 143 and send it to us, together with a copy of the payment order, which must always be made out to Eucarpia. In case you decide to pay by credit card, please use the voucher on page 145. Because of the lower banking costs, credit card payment is preferred.

The deadline for submission of articles to be included in the next issue of the Newsletter (No. 20, 2001) is **February 28, 2001**. Please note that it is also possible (**and encouraged**) to submit the paper through Email.

We regret to report that many papers had to be rejected because of inadequate scientific rigor or lack of attention paid to the instructions for submission. Most of the accepted articles had poor English grammar and syntax. Please, before submitting a manuscript, have it proofed by someone capable of editing in the English language. **It is imperative that you follow the submission instructions very carefully. Otherwise your contribution will not be accepted.** Starting with issue No. 20, a stricter policy will be in force!

Piero Belletti and Luciana Quagliotti

Turin, 30th June 2000

LIST OF THE CONTRIBUTIONS

LIST OF THE AUTHORS

Capsicum and Eggplant Newsletter, 19 (2000): 11-18. Invited paper.

EGGPLANTS : PRESENT AND FUTURE

M.C. Daunay (1), R.N. Lester (2), J.W. Hennart (3), C. Duranton (4)

(1) Station de Génétique et Amélioration des Fruits et Légumes, INRA. Domaine St Maurice, B.P.94, 84143 Montfavet-cedex, France.
(2) School of Biosciences, University of Birmingham, P.O.Box 363, Birmingham B15 2TT, U.K.
(3) Vilmorin Recherches, Centre de la Costière, Ledenon 30210, France.
(4)Technisem, ZAC des Gâtines, 7, av du Garigliano, 91601 Savigny/O, France.

Many cultivated, half cultivated and even wild eggplants used as food

Eggplants and cultivated or wild relatives, cover a wide range of *Solanum* species (genus *Solanum,* mainly subgenus *Leptostemonum)*, the geographical origin of which is mainly Asia and Africa. The best known species, and the economically most important in terms of production volume, is *S. melongena* L., domesticated in the Indo-Burma region, and cultivated nowadays all over the world. Two African eggplants, the scarlet eggplant (*S. aethiopicum* L.) and the gboma eggplant (*S. macrocarpon* L.), are extensively cultivated there, and to a much smaller extent, in some other parts of the world. The scarlet eggplant is very morphologically variable, and it has been splitted into 4 cultigroups defined on the basis of the plant morphology and use by man (Lester, 1986). For instance, *S. aethiopicum* Kumba Group is used as leaf vegetable in south Senegal (Diouf *et al.*, 1998) ; *S. aethiopicum* Gilo Group is largely used as fruit vegetable in western Africa (Lester *et al.*, 1981).

But many other eggplant species, having a much lesser importance in economical terms, are consumed in Africa, Asia or Austral Asia. They are sometimes cultivated, e.g. *S. scabrum* Mill. (= *S. guineense* L., subg. *Solanum*). They are often half cultivated, i.e. the spontaneous plants are looked after and harvested. This is the case of *S. nigrum* L. (= *S. nodiflorum* Jacq., subg. *Solanum*) and of several species belonging to subg. *Leptostemonum* such as S. *Gilo-anguivi*, *S. violaceum* Ort. and *S. kurzii* (= *S. sanitwongsei* Craib.). The eggplant species can also be truly wild such as *S. torvum* Sw. and tens of other species. Depending on the species, the fruits, and/or the leaves, are used as vegetables, condiments or ingredients of condimental preparations.

Even more species used as medicine

S. melongena is used as medicine, in particular in India, for the treatment of diabete, bronchitis, asthma, dysuria, dysenteria etc. It is also known for decreasing the rate of blood cholesterol. *S. aethiopicum* group Gilo is used in some African countries as a

remedy against fevers, dizziness, convulsions, hypertension. *S. anguivi* Lam. in Africa increases the lactation, prevents malaria, stimulate appetite, treat hypertension. *S. macrocarpon* and its wild close relative *S. dasyphyllum* Schum. & Thonn. is used against fever, abdominal worms, diarrhea, stomacal aches etc. *S. violaceum* and related species are used in Asia against bronchitis and asthma, tooth ache, worms, diabete. *S. virginianum* L. (= *S. surratense* Burm. f. = *S. xanthocarpum* Schrad. & Wendl.) is used in India for cough, ear and tooth aches, rhumatisms, snake bites etc. Many other *Solanum* species, related or not to eggplants are also used for medicinal purpose, a good sample of which can be found in Bukenya & Carasco (1999) and Hanelt (2000).

The wide set of ailments treated by eggplants in the broad sense is linked to the presence in the plant parts of steroid alkaloids, in particular glycoalcaloids (such as Solasonine). These substances are known for having tensio-active properties, as well as actions on the cell membrane's permeability. Depending on the dose/proportion, their effect can be beneficial or toxic for human health. The doses associated to toxicity are associated to strong bitterness, not palatable.

Eggplants genetic resources

The genetic resources of the three main eggplant species comprise of course, as first gene pool (for each of them), the whole set of varieties cultivated all over the world (traditional varieties, landraces, modern cultivars, mutants etc.). The evaluation of those primary gene pools is far from complete, in particular in the field of disease and pests resistances.

The secondary gene pools of the main eggplant species comprise *Solanum* species which can be crossed (with some difficulties) with each of them. These secondary gene pools present 3 original characteristics. (1) as *S. melongena*, *S. aethiopicum* and *S. macrocarpon* are crossable to each-other, each of them can be used as a source of agronomic characteristics for improving the next one. (2) the second characteristic of the secondary gene pools is that they are mostly common to the 3 species. (3) this pool comprises over 100 species, only partially known by breeders (Daunay *et al.*, 1998) and the taxonomic aspects of which has been reviewed by Daunay *et al.* (1999). Yet the use of the secondary genepool for eggplants breeding is very limited, for many reasons. The main reason is that it is not well known by breeders. The second reason is a consequence of the former one : the evaluation of this secondary genepool for agronomic characteristics as well as for crossability is very poorly done. Therefore, examples of its use for breeding purposes are rare. Ano *et al.* (1991) introduced the resistance of *S. aethiopicum* Aculeatum and Gilo groups towards *Ralstonia solanacearum* into *S. melongena*. Daunay *et al.* (1993), Sihachakr *et al.* (1994) and more recently Jarl *et.al.* (1999) use the protoplast fusion for introducing into *S. melongena* resistances to soil born pathogens from *S. aethiopicum*, *S. torvum* and some other species. The resistance of *S. macrocarpon* to several insects (in particular mites, fruits and shoots borers), unfortunately not well characterized in details, is potentially of high interest for the breeding of *S. melongena* as well as for that of *S . aethiopicum*.

Genetic erosion has struck *S. melongena* germplasm for some tens of years, due to the reduction of the cultivation of traditional cultivars, pregressively replaced by more performant and less morphologically variable F1 hybrids. International Plant Genetic Resources Institute, (formerly called International Board for Plant Genetic Resources, IPBGR) has supported several collecting mission in different areas (in particular Asia and Africa) and one can reasonnably assume that most part of the genetic diversity of *S. melongena* has been saved. Important germplasm (around 1000 accessions) is preserved in genebanks (or equivalent) located in India, China, Taiwan, USA, Russia and Europe. The African eggplants are not, or to a small extent, submitted to genetic erosion, since the breeding activity on these species is rare and therefore few new and performant varieties are released. Traditional cultivars are still largely grown everywhere in Africa. But thanks to IPGRI's support, collecting missions were developed in the eighties (Lester et al., 1981). These genetic resources are presently maintained mainly in Europe. The wild germplasm related to cultivated eggplants, mainly African, has been poorly prospected. Roughly half of it, collected for taxonomic purposes is held in some European collections.

The European Union is financing (2000-2004) a European project called « EGGNET » (for « EGGplant NETwork »), which connects together 7 European countries, in order to regenerate, store, describe and evaluate the whole set of eggplants genetics resources held in Europe. This project associates taxonomists, botanists, breeders, gene bank curators and breeders from the private and the public sectors. It is searchable at the address Internet: http://www-bgard.sci.kun.nl/bgard/.

Molecular diversity and mapping of eggplants

Most of the variability studies carried out on seed proteins, isoenzymes and allozymes of *S. melongena* and related species have been done for taxonomic purposes (Pearce & Lester, 1979; Lester & Niakan, 1986; Isshiki *et al.*, 1994 a & b; Karihaloo & Gottlieb, 1995; Isshiki, 1996). The polymorphism between *S. melongena* advanced cultivars is low. It is greater between *S. aethiopicum* cultivars.

DNA polymorphism based on RAPDs (Karihaloo *et al.*, 1995) is a little greater amongst weedy forms of *S. melongena* than in advanced cultivars, but in any case it is narrow. Mace *et al.* (1999), have shown that the polymorphism for AFLPs found in a set of *S. melongena* accessions and related species, used for calculating genetic distances between taxa, is an excellent tool for clarifying taxonomic classification (species relationships) within subgenus *Leptostemonum*. Several other authors use chloroplastic DNA for taxonomic purposes (Sakata & Lester, 1994, 1997; Sakata *et al.*, 1991; Ishhiki *et al.*, 1998; Bohs & Olmstead, 1999).

A preliminary molecular linkage map for eggplant has been published recently (Nunome *et al.*, 1998), based on RAPDs and a F2 generation between a susceptible and a bacterial wilt resistant cultivar. Resistance as well as fruit shape were found to be linked with some linkage groups. Frary *et al.* (2000) are developing another map based on an interspecific F2 progeny (*S. linneanum* X *S. melongena*) with RFLPs

and cDNA tomato markers, which should allow a first mapping of traits such as anthocyanin presence in several organs, fruit shape, fruit stripes, leaf shape, prickliness and hairiness.

Eggplants Genetics and Breeding tomorrow

Eggplants genetics is largely unknown. Few characters are monogenically inherited, many are under polygenic control and many have not been phenotypically evaluated. However, this genetics could develop very fast, if molecular mapping of the main morphological and agronomic traits is done. This mapping must take advantage of the advanced mapping of pepper, potato and tomato which have in common a large portion of diversity (Table 1). Indeed, the use of markers, whatever they are (RFLPs, AFLPs, etc.), linked to morphological or agronomic traits common to eggplant and those other species, could accelerate the location of those traits in the eggplant genome.

Eggplants germplasm, cultivated and wild, is insufficiently evaluated for agronomic characteristics. Much research in the field of evaluation remains to be carried out, in order to bring to breeders knowledge of valuable agronomic characteristics. Several significant *S. melongena* germplasm centers exist round the world, and collaboration between them, scientists and breeders involved in eggplant, is necessary to achieve a good evaluation of the natural diversity, and to determine the genetic bases which control the agronomic characteristics. Molecular tools, if applied to eggplant germplasm, will bring a remarkable input both for evaluation (by using markers linked to agronomic characters mapped in other Solanaceae and common to eggplant) and for genome analysis (molecular map, genetic control of agronomic and morphological characters, synteny with other Solanaceae genomes). The results may allow the rapid development of Markers Assisted Selection for *S. melongena*, for introducing several agronomic characters difficult to screen on a phenotypical basis. The molecular tools are already bringing enlightenment to the genetic distances between eggplant and its related species, as well as between other Solanaceae taxa and will bring in the near future noticeable improvements of classification. Transgenesis is another molecular tool which could bring progress in eggplant breeding (Kumar *et al.*, 1998 ; Frijters *et al.*, 2000). If genetic resources centers, breeders and molecular biologists unify their efforts, one can say that *S. melongena* is at the eve of significant genetic improvement.

The breeding effort on the African eggplants, *S. aethiopicum* and *S. macrocarpon* , is generally speaking, limited since despite their importance for the African diete, their financial interest is quite limited for breeding companies. Nevertheless, isolated breeding efforts exist, in particular in Nigeria and Senegal, and one may predict that if the hybrid structure brings much better yield, it should develop fastly. For *S. macrocarpon*, there are even less breeding activities. However, as the breeding has not been very active and as the genetic diversity of these two African species (and their relatives) is high and very poorly evaluated yet, there are potentially hudge progresses to be made through the work of breeders.

As fundings are limited, the most efficient ways of achieving these goals should be (1) to develop collaboration between eggplant breeders, public research and germplasm centers of the different countries where research and breeding programmes are managed and (2) to define priority characters to work with (evaluation, genetic control). Two such programmes exist in Europe, one centered around eggplant genetic resources conservation and evaluation (see « EGGNET » project, quoted formerly), the other centered around the somatic hybridization between eggplant and *Solanum* species (information can be obtained at : dara.sihachakr@mve.u-psud.fr) , both projects being funded by the European Union. The recent creation (1998) of an bi-annual informal electronic leaflet, « Eggplant Info » (editor gerardw@sci.kun.nl), as a living link between scientists and breeders involved in eggplant, is a precious communication tool complementary to the Capsicum & Eggplant Newsletter.

Bibliographic references

Ano G., Hebert Y., Prior P., Messiaen C.M., 1991 : A new source of resistance to bacterial wilt of eggplants obtained from a cross *Solanum aethiopicum* L. X *Solanum melongena* L. Agronomie (11): 555-560.

Bohs L., Olmstead R.G., 1999 : *Solanum* phylogeny inferred from chloroplast DNA sequence data. pp 97-110 in Nee M., D.E. Symon, R.N. Lester & J.P. Jessop (eds). Solanaceae IV : advances in Biology and Utilization. Royal Botanic Gardens, Kew, U.K.

Bukenya Z.R., Carasco J.F., 1999 : Ethnobotanical aspects of *Solanum* L. (Solanaceae) in Uganda. pp 345-360 in M. Nee, D.E. Symon, R.N. Lester & J.P. Jessop (eds). Solanaceae IV. Advances in Biology and Utilization. Royal Botanic Gardens, Kew, U.K.

Daunay M.C., Chaput M.H., Sihachakr D., Allot M., Vedel F., Ducreux G., 1993 : Production and characterization of fertile somatic hybrids of eggplant (*Solanum melongena* L.) with *Solanum aethiopicum* L. Theor. Appl. Genet. (85) : 841-850.

Daunay M.C., Lester R.N., Dalmon A., Ferri M., Kapilima W., Poveda Aguilar M.M. and Jullian E., 1998 : The use of wild genetic resources for eggplant (*Solanum melongena*) breeding. II : Crossability and fertility of interspecific hybrids. Xth EUCARPIA Meeting on Genetics and Breeding of Capsicum & Eggplant, 1998 – Avignon, France.

Daunay M.C., Dalmon A., Lester R.N., 1999 : Management of a collection of *Solanum* species for eggplant (*Solanum melongena* L.) breeding purposes. pp 369-383 in M. Nee, D.E. Symon, R.N. Lester & J.P. Jessop (eds). Solanaceae IV. Advances in Biology and Utilization. Royal Botanic Gardens, Kew, U.K.

Diouf M., Diop M., Lô C., Dramé K.A., Séne E., Bâ C.O., Gueye M., Faye B., 1998 : Prospection de légumes traditionnels de type africain au Sénégal. Rapport final 1998, ISRA-CDH, Dakar, Sénégal.

Frary A., Doganlar S., Daunay M.C., Lester R.N., Tanksley S., 2000 : A genetic linkage map of eggplant. Plant & Animal VIII, San Diego (CA, USA), 01/9th-12th/2000, poster P319.

Hanelt P., 2000 : Rudolf Mansfelds Verzeichnis landwirtschaftlicher und gärtnerischer Kulturpflanzen (ohne Zierpflanzen). 3rd Edition, 4 volumes, Springer verlag, Berlin , 1998 pp. Under Press.

Isshiki S., Okubo H., Fujieda K., 1994a : Phylogeny of eggplant and related *Solanum* species constructed by allozyme variation. Sci. Hort. (59) : 171-176.

Isshiki S., Okubo H., Fujieda K., 1994b : Isozyme variation in eggplant (*Solanum melongena* L.). Journal of the Japanese Society for Horticultural Science (63) : 115-120.

Isshiki S., 1996 : Genetic variation of isozymes and its application to breeding in eggplant and its wild relatives . Bulletin of the Faculty of Agriculture, Saga Univ., Japan, (80) : 1-46.

Ishhiki S., Uchiyama T., Tashiro Y., Miyazaki S., 1998 : RFLP analysis of a PCR amplified region of chloroplast DNA in eggplant and related *Solanum* species. Euphytica (102) : 295-299.

Jarl C.I., Rietveld E.M., de Haas J.M., 1999 : Transfer of fungal tolerance through interspecific somatic hybridization between *Solanum melongena* and *S. torvum*. Plant Cell Reports (18) : 791-796.

Karihaloo J.L., Brauner S., Gottlieb L.D., 1995 : Random amplified polymorphic variation in the eggplant, *Solanum melongena* L. (Solanaceae). Theor. and Appl. Genetics (90) : 767-770.

Karihaloo J.L., Gottlieb L.D., 1995 : Allozyme variation in the eggplant, *Solanum melongena* L. (Solanaceae). Theor. and Appl. Genetics (90) : 578-583.

Kumar P.A., Mandaokar A., Sreenivasu K., Chakrabarti S.K., Sharma S.R., Bisaria S., Kaur S., Sharma R.P., 1998 : Insect resistant transgenic brinjal plants. Molecular Breeding (4) : 33-37.

Lester R.N., Jaeger P.M.L., Bleijendaal-Spierings B.H.M., Bleijendaal H.P.O., Holloway H.L.O., 1981 : African eggplants – a review of collecting in West Africa. FAO/IBPGR Plant Genetic Resources Newsletter 81/82 : 17-26.

Lester R.N., 1986 : Taxonomy of scarlet eggplants, *S. aethiopicum* L. Acta Horticulturae (182) : 125-132.

Lester R.N., Niakan L., 1986 : Origin and domestication of the scarlet eggplant, *Solanum aethiopicum*, from *S. anguivi* in Africa. pp 433-456 in Solanaceae II, Biology and Systematics, W.G. D'Arcy (ed.), Columbia Univ. press, New York (USA).

Mace E.S. Lester R.N., Gebhardt C.G., 1999 : AFLP analysis of genetic relationships among the cultivated eggplant, *Solanum melongena* ; and its wild relatives (Solanaceae). Theor. Appl. Genet. 99 : 626-633.

Nunome T., Yoshida T., Hirai M., 1998 : Genetic linkage map of eggplant (*Solanum melongena*) in Proceedings of Xth Meeting on Genetics and Breeding on Capsicum and Eggplant, Avignon (FRA) 09/7th-11th/1998 : 239-242.

Pearce K., Lester R.N., 1979 : Chemotaxonomy of *Solanum melongena*. pp 615-627 in J.G. Hawkes, R.N. Lester and A.D. Skelding (eds). Solanaceae I. The Biology and Taxonomy of the Solanaceae. Academic Press, pub. for the Linnean Society of London.

Sakata Y., Lester R.N., 1994 : Chloroplast DNA diversity in eggplant (*Solanum melongena*) and its related species *S. incanum* and *S. marginatum*. Euphytica (80): 1-4.

Sakata Y., Lester R.N., 1997 : Chloroplast DNA diversity in brinjal eggplant (*Solanum melongena* L.) and related species. Euphytica (97) : 295-301.

Sakata Y., Nishio T., Matthews P.J., 1991 : Chloroplast DNA analysis of eggplant (*Solanum melongena*) and related species for their taxonomic affinity. Euphytica (55) : 21-26.

Sihachakr D., Daunay M.C., Serraf I., Chaput M.H., Mussio I., Haicour R., Rossignol L., Ducreux G., 1994 : Somatic hybridization of eggplant (*Solanum melongena* L.) with its close and wild relatives. p.255-278. in Biotechnology in agriculture and forestry 27: somatic hybridization in crop improvement, Y.P.S. Bajaj (ed.), Berlin, Germany, Springer Verlag.

Table 1 : Examples of morphological and agronomical characteristics, common to eggplants an other Solanaceae.

- plant growth (erect to spreading): in eggplant, pepper, potato, tomato.
- glabrosity to hairiness: gradation is available in eggplant, pepper, potato and tomato.
- anthocyanins, distributed among different vegetative organs: hypocotyl and other vegetative parts (eggplant, pepper, potato, tomato).
- flowers and fruit number per inflorescence (clusters in potato, single fruits or clusters in eggplant, pepper and tomato).
- male sterility (recessive genes have been described in eggplant - but are difficult to obtain -, different genetic systems in pepper, potato and tomato).
- bitterness in the Solanaceous crops we are interested in, is due to saponins including steroid alkaloids. These glycoalkaloids are characterized by a steroidal nucleus containing nitrogen linked to triose or tetraose sugar moieties. The basic structures of these aglycones are chemically very similar, but the different forms of these aglycones, as well as the diverse sugar moieties, are different in various species of *Solanum* and *Lycopersicon*: eggplant (glycoalkaloid solasonine, aglycone solasodine), potato (glycoalkaloid solanine, aglycone solanidine) and tomato (glycoalkaloid tomatine, aglycone tomatidine).
- parthenocarpy : tendency in eggplant, pepper, potato, several monogenic systems in tomato.
- fruit furrowing: absent or more or less present in eggplant, pepper and tomato.
- fruit color: white epidermis in eggplant and tomato; presence of chlorophylls in the sub epidermal cells of eggplant, pepper, potato, tomato; anthocyanins in eggplant, pepper, tomato.
- resistance to diseases and pests: many eggplant diseases and pests are common to pepper, tomato and to a lesser extent to potato, such as *Verticillium dahliae*, *Meloidogyne* sp., *Fusarium oxysporum*, *Ralstonia solanacearum*, *Stemphylium* sp., *Oidium* sp., Tobacco Mosaic Virus, Tomato Mosaic Virus, Tomato Spotted Wilt Virus, Potato Virus Y, Cucumber Mosaic Virus. For several of them, monogenic or polygenic resistances are available in one or several of these four species.
- adaptation to abiotic stresses (cold, heat, drought, salinity), available in eggplant, pepper, potato, tomato.

Capsicum and Eggplant Newsletter, 19 (2000): 19-22.

THE CHEMISTRY OF PAPRIKA

A.ANU and K.V.PETER

Indian Institute of Spices Research, Marikkunnu, Calicut 673 012, India.

ABSTRACT

Paprika, Hungarian word for plants in the genus Capsicum, belongs to family Solanaceae. The present review deals with the chemical composition of paprika. *Capsicum annuum* is a rich source of vitamins. The pungency is caused by a group of vanillyl amides named capsaicinoids located in the placenta of the fruit. Carotenoids like capsanthin and capsorubin are responsible for the red colour of the fruit. One of the major components of the volatile oil, 2-methoxy-isobutyl pyrazine, possess an aroma characteristic of the fresh fruit. The fixed oil comprises mainly of triglycerides (about 60%) in which linoleic and other unsaturated acids predominate.

Introduction

Paprika is the Hungarian word for plants in the genus Capsicum. International spice traders use the term paprika for non-pungent, red *Capsicum* powder. Peppers, which have been found in pre historic remains in Peru, were widely grown in Central and South America in pre- Colombian times. Pepper seeds were carried to Spain in 1493 and from there spread rapidly throughout Europe. Capsicum in a fresh state is very rich in Vitamin C (ascorbic acid), as was shown by Dr Szent Gyorgyi, the Hungarian scientist, who was awarded the Nobel prize in1937 for isolating vitamin C from paprika fruits showing that they were one of the richest sources available of this vitamin. Capsanthin and capsorubin are the most important colouring pigments in Capsicum. The pungent principle is Capsaicin , which is present in the placenta, and is said to retain its pungency in a dilution of one part in one million. (Purseglove et al , 1981).

The genus Capsicum belongs to the family Solanaceae. Linnaeus recognized two species, *C.annuum* and *C.frutescens* in his *Species plantarum* of 1753 and later in 1767 added two more. .Five cultivated species are now recognized, namely *C.annuum* var. *annuum*, *C.frutescens*, *C. baccatum* var. *pendulum*, *C.chinense* and *C.pubescens* (Purseglove et al 1981). Smith et al made a horticultural classification of peppers grown in the United States confining to only two species viz. *Capsicum annuum* and *Capsicum frutescens*. This classification is exclusively based on fruit characteristics like colour, shape, pungency, size, uses etc. According to this classification, there are six major groups under *Capsicum annuum* and one group under *Capsicum frutescens*.

Kostoff (1962) was the first to report the chromosome number in *Capsicum* as n= 6 which was corrected by later workers. Raghavan & Venkatasubban (1940) also studied the chromosome numbers and cytology of *C.annuum* recording 24 as the somatic number in all the chilli varieties. Most Capsicum species studied, share a common basic chromosome number, n=12. Two exceptions are *C.ciliatum* from western South America and a Southern Brazilian wild species that has yet to be identified with certainity. These two species have n = 13 (Pickersgill 1991). *Capsicum lanceolatum*, a wild species reported by Stadley & Steyermark in 1940 was also found to have a chromosome number 2n=26 (Tong & Bosland, 1997).

Paprika of commerce comes from different producing areas and their major characteristics are as follows:

1. Hungarian paprika – Has a distinctive flavour and is in great demand in Europe, where it is used as a spice rather than a colouring agent. Hungarian paprika is produced in eight grades and three qualities, ranging in colour power and pungency.
2. Spanish paprika - Spain produces a sweet paprika in a wide range of colour values.
3. Moroccan paprika - Similar to Spanish paprika and produced as medium and high colour paprika.
4. Bulgarian paprika - Bulgaria is the one East European source that produces predominantly mild paprika. it is mainly used for food manufacturing purposes.
5. American paprika - This paprika is grown and produced in Southern California. California has become a larger supplier of paprika than any other individual country.
6. Yugoslavian paprika - This is quite similar to the Hungarian variety. It is normally ground fine and contains slight heat or pungency.
7. Czechoslovakian and Chilean – These are sweet to mildly pungent paprikas.
8. Romanian, Turkish and Greek – These are slightly pungent to pungent types.

9. Portuguese – This is a sweet paprika of medium to high colour strength.

CHEMICAL COMPOSITION OF FRUIT:

Capsicum fruit contains fixed (fatty oil), a little steam-volatile oil, pigments, pungent principles, resin, protein, cellulose, pentosans and mineral elements. Chillies and paprika may be regarded as taking up positions at opposite ends of a spectrum of common properties. On progressing from chillies through capsicums to paprika, there is steady decrease in pungency level and an increase in the pigment content. The fruits of most Capsicum species contain significant amounts of vitamins B, C, E and provitamin A (carotene) when in a fresh state. The large type of C.annuum is among the richest known sources of vitamin C, which may be present in up to 340mg/100g in some varieties (Purseglove et al 1981). The nutritional composition of paprika is given under Table 1.

TABLE1 NUTRITIONAL COMPOSITION OF PAPRIKA PER 100 GRAMS.

Composition	USDA Handbook 8-2[1]	ASTA[2]
Water (grams)	9.54	7.0
Food energy (K cal)	289	390
Protein (grams)	14.76	14.0
Fat (grams)	12.95	10.4
Carbohydrate (grams)	55.74	60.3
Ash (grams)	7.02	8.6
Calcium (grams)	0.177	0.2
Phosphorus (mg)	345	300
Sodium (mg)	34	20
Potasium (mg)	2,344	2,400
Iron (mg)	23.59	23.1
Thiamine (mg)	0.645	0.600
Riboflavine (mg)	1.743	1.360
Niacin (mg)	15.32	15.3
Ascorbic acid (mg)	71.12	59
Vitamin A activity (RE)	6,060	5,800

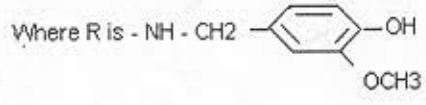
1 Composition of Foods: Spices and Herbs. USDA Agricultural Handbook 8-2. January 1977.
2 The Nutritional Composition of Spices, ASTA Research Committee, February, 1977.

Pungent Principle:

The primary pungent principle was first isolated in a crystalline state from the crude extract by Thresh (1846) who named the compound capsaicin (Purseglove et al). The heat of Capsicum powder is measured by scoville heat units (Scoville, 1912). One part per million concentration of capsaicinoids is measured as 15 scoville units. The nature of pungency has been established as a mixture of seven homologous-branched chain alkyl vanillyl amides, named capsaicinoids .

TABLE 2 CAPSAICINOIDS IDENTIFIED IN *CAPSICUM SPECIES*

Stuctural formula	Name
$(CH_3)_2$. CH.CH= CH.$(CH_2)_4$ - CO – R	Capsaicin
$(CH_3)_2$. CH.$(CH_2)_6$ – CO - R	Dihydrocapsaicin
(CH3) 2.CH.(CH2)5-CO-R	Nordihydrocapsaicin
(CH3)2. CH.(CH2)9 – CO- R	Homodihydrocapsaicin
(CH3)2.CH.CH= CH.(CH2)5-CO-R	Homocapsaicin
CH3. (CH2)7.CO – R	Nonanoic acid vanillylamide
CH3(CH2)8.CO – R	Decanoic acid vanillylamide



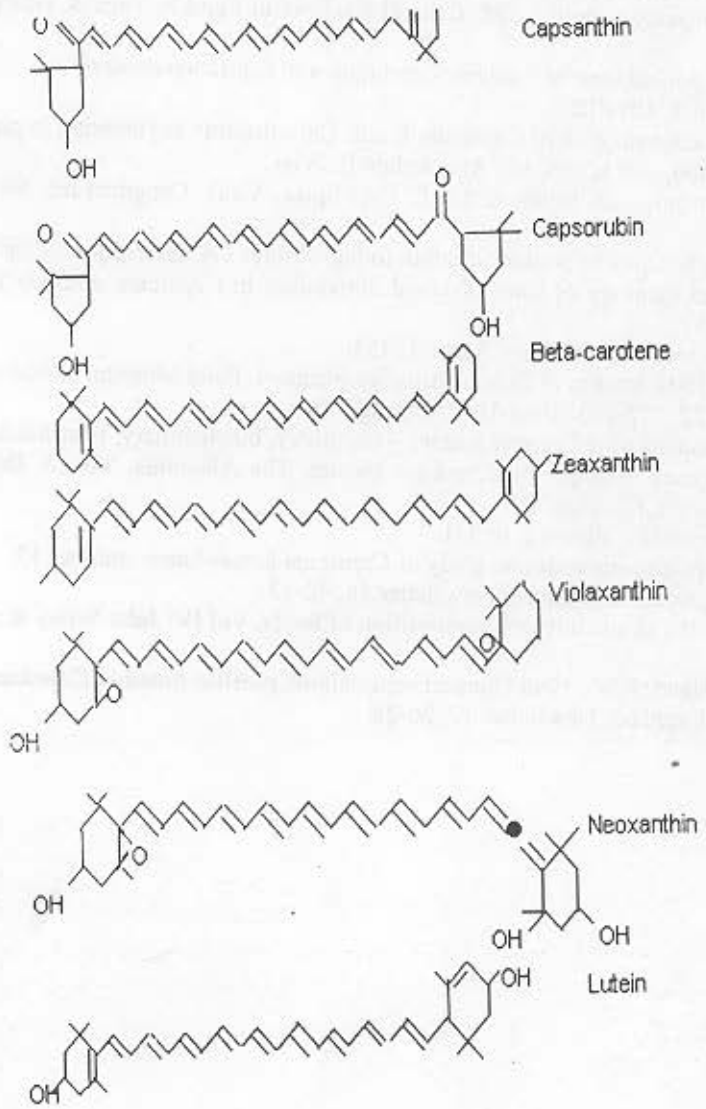
The distribution of the pungent principles in the fruit is uneven and is the greatest in the placenta. According to Govindarajan (1985), the group paprika contains less than 0.1% of capsaicinoids, the best grade of spanish paprika having 0 - 0.0003% and for the pungent grade a maximum of 0.5%. . Pungency level in chillies varies from 0.1 - 1.4%.

Tracer studies had shown L – Phenylalanine as the precursor of the aromatic residue of capsaicinoids. The enzyme involved in the conversion of L – Phenylalanine into capsaicinoids, trans – cinnamate – 4 monooxygenase and the capsaicinoids synthase were found in the vacoule fraction while the phenyl alanine – ammonia – lyase was found in the cytosol fraction (Govindarajan etal 1986). The vacoule of the protoplasts from the placenta of Capsicum fruit are unique in the synthetic activity of the membrane and the storage of the unique highly active capsaicinoids and different from other vacuoles which act as reservoirs of organic acids (Suzuki & Iwai 1984). The authors suggest the name capsisome for the *Capsicum* placenta vacuoles.

The pigments

The colour in paprika powder is the principal criterion for assessing its quality value. The pigment content of paprika powder can range from 0.1% to 0.8%. The colour value of paprika is usually expressed in terms of ASTA colour value (American Spice Trade Association). This is the extractable colour present in the paprika. Common paprika ASTA colours present in the industry are 85, 100, 120 &150 (Spices & Seasonings). The major colouring pigments in paprika are Capsanthin & Capsorubin comprising 60% of the total carotenoids. Other pigments are Betacarotene, Zeaxanthin, Violaxanthin, Neoxanthin & Lutein. Structures of the major pigments in paprika are given in figure 1.

FIGURE 1 STRUCTURE OF MAJOR PIGMENTS IN PAPRIKA



THE FIXED OIL

The fixed oil comprised mainly of triglycerides (about 60%)in which linoleic and other unsaturated acids predominate. The fat content and composition of paprika powder and its propensity to autooxidation are dependent upon whether the seeds are removed from the pod before grinding.

THE VOLATILE OIL

Fruits of Capsicum species have a relatively low volatile oil content, from about 0.1 to 2.6% in paprika (Winton &Winton, 1939). The characteristic aroma and flavour of the fresh fruit used as vegetable is imparted by the volatile oil. The composition of the volatile oil of fresh Californian green bell peppers has been examined by Buttery et al (1969) using gas chromatography. Twenty four components in this oil were positively identified. One of the major components, 2-methoxy-isobutyl pyrazine, was considered to posess an aroma characteristic of the fresh fruit and to dominate the organoleptic profile.

CONCLUSION

Paprika is ranked with the dominent vegetable crop tomato in production and consumption in foreign countries. The world trade in paprika oleoresin is showing a growing trend in recent years. In India , Bydagi,Warrangal chilli Arka Abir, Kt-pl-19 etc are a few achievements in this field. There is need to develop high yielding paprika like chillies with mild pungency and with high colour value as there is great demand for such varieties in the international market.

REFERENCES

Govindarajan, V.S., 1985 Capsicum – production,technology, chemistry and quality Part I : History, botany, cultivation and primary processing. CRC Critical Reviews in Food Science and Nutrition, 22 (2) : 109-176.

Govindarajan, V.S., 1986 Capsicum – production, technology,chemistry and quality Part III: Chemistry of the colour, aroma and pungency stimuli. CRC Critical Reviews in Food Science & Nutrition,24 (3): 245 – 355.

Kostoff, D., 1926 Die building der pollenkorne bei einigen varietation von *Capsicum annuum* . Ann.Univ.Sofia fac. Agron.4: 101-105.

Pickersgill, B., 1991 Cytogenetics and evolution of Capsicum L eds: Chromosome engineering in plants: genetics, breeding, evolution, part b, 139-160 Amsterdam Elsivier.

Purseglove, J.W., Brown, E.G., Green C.L. & Robbins, S.R.J., 1981 Spices Vol.1. Longman Inc. New York: 331-339.

Raghavan, T.S. & Venkatasubban, K.R., 1940 Studies in South Indian chillies I A description of varieties, chromosome numbers and cytology of some X-rayed derivatives in *Capsicum annuum* L. Proc. Ind.Acad.Sci. 2 (B): 29-46.

Scoville, W.L., 1912 Note on *Capsicum*. J.Am.Pharm.Assoc.1: 453.

Stadley, P.C. & Steyermark, J.A., 1940 Studies of Central America plants –I. Field Museum of Natural History. Bot. Series Vol. 22: 272-273. 1940-1942. Chicago. IL.

Suzuki, T & Iwai, K., 1984 Constituents of red pepper species – chemistry, biochemistry, pharmacology & food science of the pungency principle of *Capsicum species*, The Alkaloids, Vol.23, Brossi, A, Ed; Academic Press, Orlando, Fla, chap 4.

Thresh, L.T., 1846 Isolation of Capsaicin. Pharm.J. 6: 941.

Tong, N. & Bosland P.W., 1997 Meiotic chromosome study of *Capsicum lanceolatum* another 13 chromosome species, Capsicum & Eggplant Newsletter 16: 42-43.

Winton, A.L. & Winton, K.B., 1939 The stucture and composition of foods, Vol IV: John Wiley & Sons New York.

Yayeh Zewdie, Mueller, W & Bosland, P.W., 1998 Unusual capsaicinoid profiles found in *Capsicum pubescens*. Capsicum & Eggplant Newsletter 17: 26-28.

Capsicum and Eggplant Newsletter, 19 (2000): 23-26.

THE ACCUMULATION OF SELENIUM IN DIFFERENT ACCESSIONS OF SWEET PEPPER.

N.A. Golubkina*, A.N. Yuriev**, V.K. Gins **, P.F. Kononkov**, T.I. Hootsoparia ***, A.J. Sokolova ***, V.P. Pivovarov **, O.N. Pyshnaya **,
*Institute of Nutrition, Russian Academy of Medical Sciences, 109240 Moscow, Russia
** Russian Research Institute of vegetable breeding and seed production 143080 Lesnoy Gorodok, Moscow region, Russia
*** Moscow K.A.Timiriasev Academy of Agriculture, 127350 Moscow, Russia

INTRODUCTION

Selenium and vitamins play an important role of natural antioxidants that protect the organism against oxidative stress caused by environmental pollution, radiation and as a result of certain diseases' development. Unfortunately most of plants possess either high levels of vitamins and extremely low selenium concentrations or visa versa. Thus 5-14 mcg Se/kg are commonplace for sweet pepper (Varo P., 1980) that is known to be a leader among vegetables in the intensity of ascorbic acid and carotenoids biosynthesis. That is why Capsicum annuum. has never been considered as a source of selenium for human beings. Only toxic selenium concentrations in soils may coarse intensive selenium accumulation in fruit of sweet pepper (the value of 5 mg/kg is reported for endemic region of China (Combs G., 1986).
The aim of this work was to reveal the differences in selenium accumulation among 24 accessions of sweet pepper.

MATERIALS AND METHODS.

The experiment with 24 accessions of Capsicum annuum was conducted in a warm house at vegetable experimental farm of Russian institute of vegetable breeding and seed production during summer 1998. Seedlings were planted in 3x2,4 m plots of spacing 60x30 cm and healthy crops was raised. Fruit from 24 accessions were harvested separately, washed and used in triplicate for estimation of selenium and ascorbic acid content. The latter was determined using 2,6-dichlorophenol indophenol dye method (AOAC, 1996). Selenium concentration was assessed fluorimetrically after drying the samples at 40 C to constant weight (Alfthan G., 1984). Mean concentration of selenium in soils of the warm house was 310$\pm$36 mcg Se/kg.
Statistical analysis was performed by Fisher-Student criteria using Stattgraff programm.

RESULTS AND DISCUSSION

Data in table 1 show unexpected differences in levels of selenium accumulation by accessions of Capsicum annuum fruit. Thus they vary from 133 mcg/kg (dry weight) in 'Sirano' to more than 1 mg/kg in 'P-3'.

Table 1 Selenium and ascorbic acid content in friut of sweet pepper

Denomination	Mean mass, g	Width of pericarpy, mm	Se content, mcg/kg	AA*/ content mg%
'P-3'	110-120	7,5-8,5	1197±59	144±4
'Emerald'	65-75	5,5-6,0	768±25	138±3
'Paprica zeleninova'	40-45	5,0-5,5	739±27	114±5
'Yellow-fruit'	60-65	5,0-5,5	643±22	220±10
'F1 mavr+Chines'	55-60	4,5-5,0	534±20	170±8
Polaris	45-50	5,0-5,5	517±20	190±8
'Suptol'	60-65	5,0-5,5	507±21	134±4
'Vegetable'	95-105	6,0-6,5	503±18	147±6
'Mirto'	60-65	5,5-6	499±19	198±7
'F1 Mavr+Rodnic'	60-65	5-5,5	440±18	151±10
' 0-4'	55-60	4,0-4,5	439±17	232±9
'Citrino'	75-85	5,5-6,5	373±20	206±8
'Bendigo'	100-110	6,5-7,5	355±21	156±9
' 0-7'	45-55	4,5-5,0	350±18	152±7
'F1 Mavr+Bendigo'	65-75	5,5-6	331±17	179±11
'Nasay'	110-120	7,5-8	314±18	170±10
'Health'	65-75	5,0-5,5	283±17	168±8
'Galaxi'	60-65	5,0-5,5	255±20	172±10
'X -33-4'	85-95	6,0-6,5	243±19	159±11
'X 9/5'	45-50	4,5-5,0	234±16	224±13
'X -33-1'	50-60	4,5-5,0	209±17	197±12
'L-460-93'	95-100	6,0-6,5	205±16	200±12
'Ariana'	110-120	6,5-7,5	167±18	188±10
'Sirano'	60-65	5,0-5,5	147±16	214±13
'Medal'	75-95	5,5-6,0	133±19	195±12

*/ AA – ascorbic acid

Mean selenium concentration corresponds to 250 mcg/kg. Accessions with low selenium concentrations include 'Medal', 'Sirano' and 'Ariana' (about 130-170 mcg/kg of dry weight), while high levels of selenium accumulation are typical to 'P-3', 'Emerald', 'Paprica zelenova' and 'Yellow-fruit' (640 - 1200 mcg/kg of dry weight). The calculations show that the detected high concentrations of selenium in certain accessions can provide about 20 mcg Se/day via consuming 200 g of pepper per day. Taking into account that the recommended safe and adequate selenium

intake for healthy adults is 50-70 mcg/day (Levander O.1996) the value 20 mcg/day seems to be rather significant.

The value of selenium accumulation in fruit of sweet pepper does not correlate with fruit mass and the pericarpium width. Detected high selenium concentrations cannot as well be associated with the colour of fruit as both yellow and red accessions may possess elevated selenium content. At the same time presented data reveal the connection between selenium and ascorbic acid concentrations in Capsicum annuum. Taking into account that the intensity of ascorbic acid biosynthesis is greatly influenced by temperature, intensity of light and etc. the calculated negative correlation coefficient between the levels of selenium and ascorbic acid: -0,207 ($P<0,01$) - seems to be rather high. Thus high content of vitamin C was more typical for accessions with low level of selenium accumulation: 'Medal', 'Sirano', 'Ariana' - where as accessions with poor capacity of ascorbic acid biosynthesis usually possess unexpectedly high levels of selenium ('P-3', 'Emerald', 'Paprica zeleninova').

Up to the present time the degree of selenium accumulation by plants was considered to be a function of species' denomination, geochemical characteristic of soil and vegetation conditions (i.e. values of humidity, temperature, etc.). The above data shows that genetic control can also play a certain role in the process of selenium migration from soil to plants. The phenomenon seems to be typical not only for accessions of sweet pepper but probably can have a general meaning.Thus the value of selenium accumulation by four accessions of wheat grown in the same agrochemical conditions (experimental field with soil selenium concentration being 250±30 mcg/kg of dry weight, summer 1998) was found to vary from 93 to 181 mcg/kg (table 2). It should be emphasized that differences in selenium content between various accessions are more significant for grain than for leaves of Triticum L. so that the ratio between selenium levels in grain and leaves varies from 0,42 to 0,62.

Table 2. Accumulation of selenium in several accessions of wheat

Accession of wheat	Selenium content, mcg/kg*		Se grain/ Se leaves ratio
	cereal	leaves	
'Enita'	181	294	0,62
'Ivolga'	144,5	275	0,52
'Lada'	112	267	0.42
'Biora'	92,6	188	0,49

*/ of dry weight

Less distinct but also significant difference in selenium accumulation have 2 accessions of green onion: 'Danilovskiy' (221±3 mcg/kg of dry weight) and 'Odentsovskiy' (214±4 mcg/kg, $P<0,05$, warm house). Thus

the data reveal an opportunity to achieve direct plant selection with the aim of receiving accessions of high selenium accumulation capacity.
The connection between selenium and vitamin C content in Capsicum annuum is another phenomenon of great importance. A certain correlation between the concentration of antioxidants: ascorbic acid and vitamin E - in Chili pepper during cultivation has been revealed by Osuna-Garcia (Osuna-Garcia J.A., 1996). The present data show that natural antioxidants presented in plants should compose a unique system of compounds with similar biological effect and a strict correlation between the components which is typical for each species grown in the same agrochemical conditions.

LITERATURE CITED

ALFTHAN G., 1984. A micromethod for single-tube determination of selenium in biological material. Anal.Chim.Acta 165: 184.
A.O.A.C. 1996. Official Methods of Analysis. Association of Official Analytical chemists. Washington, D.C. 17th Ed.:
COMBS G., COMBS S., 1986. The Role of Selenium in Nutrition. N.Y. Acad.Press.
LEVANDER O., 1991. Scientific rationale for the 1989 recommended dietary allowance for selenium. J.Am.Diet.Ass. 91 (№12): 1572.
OSUNA-GARCIA J.A., WALL M.M., WADDELL C.A., 1996. Tocopherol and ascorbic acid content of new mexican-type chile during ripening. Proceedings of the National pepper conference. 8-11dec. Florida, ed. Maynard F.N.: 113.
VARO P., LAHELMA O., NUURTAMO M., SAARI E., KOIVISTOINEN P., 1980. Mineral element composition of Finnish foods VII Potato, vegetables, fruits, berries, nuts and mushrooms. Acta Agric.Scand.Suppl.22. 89: 1980.

Capsicum and Eggplant Newsletter, 19 (2000): 27-30.

EFFECTS OF LOW NIGHT TEMPERATURE ON PLANT GROWTH OF *CAPSICUM ANNUUM L.*

TARCHOUN, N.*; JEMMALI,A.*; Daly,N.*; BODSON,M.**
*** Institut National Agronomique de Tunisie (INAT) 43 Av. Charles Nicolle- 1082 Tunis.**
**** Faculté des Sciences Agronomiques (FUSAGX) 5030- Gembloux- Belgique**

1. Introduction

Low temperatures induce in some species, morphological and biochemical changes witch include reduction of the plant growth rate, shoot to root ratio and modification of the leaf morphology (Hunner, 1985). After chilling, the cucumber leaves become yellow or necrotic (Salveit and Morris, 1990). *Capsicum annuum* is a chilling sensitive species cultivated in mild winter climates. Studies on vegetative developement of this species under low temperatures conditions are scarce in comparison to those relating to the effect of low night temperature on pollen fertility and fruit quality (Mercado et al., 1997; Pressman et al., 1998). The growth rate and leaf area decreased when pepper plants were cultivated at low night temperature of 17°C in comparison with the plants grown under night temperature ranging from 21 - 25°C (Bhatt and Srivinasa Rao,1993).

The aim of this study was to describe growth of some cultivars of hot and sweet pepper usually cultivated in greenhouse in Tunisia. Investigations were made on plant architecture and fructification traits for plants grown at low night temperature regime compared to those cultivated at optimal night temperature regime.

2. Material and Methods

Seeds of 3 local hot pepper cultivars ('Beldi', 'Baklouti') or F1 hybrid ('B26') and 2 sweet pepper cultivars, 'Clace' and 'Froidure' (INRA- France) were sown in paper pots containing fertilised peat (12-14-24) and germinated in growth chamber at 25 ± 2°C. At 6th-8th leaf, plants were transplanted into plastic pots containing the same substrate and transferred to one of two growth chambers illuminated for 14 hours a day with fluorescent tubes at light flux density of approxmimately 230 $\mu mol.m^{-2}.s^{-1}$(P.A.R). Plants were submitted, during 40 days, either to a low temperature regime (LTR=25/12°C, day/night) or to an optimum temperature regime (0TR=25/20°C). Eight plants per cultivar were placed in each growth chamber. Plants were watered when needed and fertigated with NutriChem solution (N:P:K 22:5:11).

Stem diameter below the first bifurcation, total leaves number per plant and plant height (measured until terminal apex of the most distal point from the basal bifurcation) were recorded at the time of transfer and 20 and 40 days after plant transfer to growth chambers. The four fully developped leaves situated at the four first bifurcations were sampled at the morning, after 40 days of growth in controlled conditions. The leaf area and relative water level were mesured respectively by planimeter instrument and by difference of fresh and dry weight. Bifurcations number per plant and position of the first flower and fruit were recorded.

Data analysis was by the procedure general linear model (GLM) in SAS system. Means were compared using Duncan test at the 5% level.

3. Results and Discussion

Stem diameter of plants grown at optimal night temperature regime (OTR) increased at an average rate of 0.15 mm day-1 during the first 20 days while plants cultivated under low night temperature grew at the rate of 0.08 mm day-1 in the same period After 40 days treatment, stem growth decreased significantly ($P<0.05$) for cultivars 'Clace' and 'B26'(Table 1), they seem to show a chilling sensitivity.

Table 1: Stem diameter of pepper plants (*Capsicum annuum* L.) cutivated at optimal (25/20 °C, day/night) or at low (25/12°C) night temperature regimes. Observations made at the time of transfer (D0) and after 20 and 40 days of treatment (D20, D40).

Cultivar	D0		D20		D40	
	25/20°C	25/12°C	25/20°C	25/12°C	25/20°C	25/12°C
Clace	5.6a	5.3abc	8.2ba	7.7bc	11.6a	10.1bc
Beldi	3.7e	4.8bcd	6.5de	7.1dc	10.4abc	9.3cd
Froidure	5.6a	5.4ab	8.9a	7.6c	10.8ba	9.8bcd
B26	4.5cd	4.3de	6.7de	6.1e	10.9ba	8.7d
Baklouti	5.8a	5.6a	8.8a	8.2ba	10.8ba	9.7bcd

means followed by a same letter were not significantly different at P=0.05

Total plant height can be used to characterize shoot development in relation to temperature treatments. After 20 days of exposure plant height of 'Beldi' and 'Baklouti' was higher at the OTR than at LTR (Table 2). After 40 days, plant height decreased significantly for all cultivars, except for 'B26'. In general, in the OTR, growth rate of plant height increases at an average of 1.11 cm .day-1 during the first 20 days of treatment, and at 1.23 cm.day-1 after 40 days. In LTR (25/12°C), plants grown at a poor rate of 0.8 cm.day-1 during 40 days of treatment. These results are explained by the internodes length, which decreased from a mean value of 8.9 cm ± 0.4 at optimal temperature conditions to 6.2 cm ± 0.7 at suboptimal temperature. Previous studies on the effect of low temperature have described similar growth responses (Lawlor et al., 1988). These results agree wiht those of Gosselin and Trudel (1983) who reported that tomato plants were shorter under the coolest and the warmest conditions than those cultivated at optimal temperature.

Table 2: Height of pepper plants (*Capsicum annuum* L.) cutivated at optimal (25/20 °C, day/night) or at low (25/12°C) night temperature regimes. Observations made at the time of transfer (D0) and after 20 and 40 days of treatment (D20, D40).

Cultivar	D0		D20		D40	
	25/20°C	25/12°C	25/20°C	25/12°C	25/20°C	25/12°C
Clace	7.4bc	8.2abc	26.4c	22.3c	51.4c	43.6de
Beldi	6.6c	8.6 ab	46.7a	40.5b	89.3a	68.0b
Froidure	7.8abc	7.9abc	27.0c	25.0c	47.5dc	40.5e
B26	9.7a	8.7ab	26.2c	24.3c	47.3dc	42.1de
Baklouti	9.1ab	9.3ab	43.8ab	24.0c	53.3c	38.1e

means followed by a same letter were not significantly different at P=0.05

Our study shows that leaf number per plant is not affected by the temperature regime excepted for 'Beldi' cv. No significant differences ($P>0.05$) were generally shown in both temperature regimes. However, the chilling sensitivity was more pronounced for local cultivar of hot pepper 'Beldi' in which, LTR reduces leaf number.

After 40 days of treatment, plants in LTR had a higher number (4 to 6)of axillary shoots which developped on the main shoot below the first order of branching (bifurcation). This phenomenon was not observed in OTR except for 'Beldi'. A negative effect of low night temperature on cell meristem activity and then a loss of apical dominance may be suggested.

Bioregulators can improve growth of pepper plants cultivated in unheated greenhouse. Indeed, El Asdoudi (1993) reported a benefic effect of GA3 at 300 ppm on plant height and leaves number of pepper. In addition, Elsayed (1995) applied several doses of biozyme to some bell pepper cultivars and found that 2 $ml.l^{-1}$ of biozyme increased height and weight of plants of the cultivar 'Blemont'.

Regarding leaf area, in general, no statistically significant differences were observed betwen both treatments except for 'Froidure' which developped a large leaves (140cm^2) at OTR (results not shown). Gosselin and Trudel (1983) reported that an increase in root temperature from 14 to 20°C increased total leaf area of tomato plant while low air temperature reduced it.These differences between our results and the latter study may be attributed to the light intensity applied during our expriment, whereas experiments of these authors were conducted in greenhouse under natural light.

Water content is affected negativly by low night temperature (25/12°C) in all cultivars except the local hot pepper 'Baklouti' caracterized by a small and thin leaves (Fig.1). These results agree with those of Janoudi et al. (1993). Our results can be explained by a physiological desorder induced by low night temperature and resulting in a poor water absorption (Salveit and Morris, 1990).

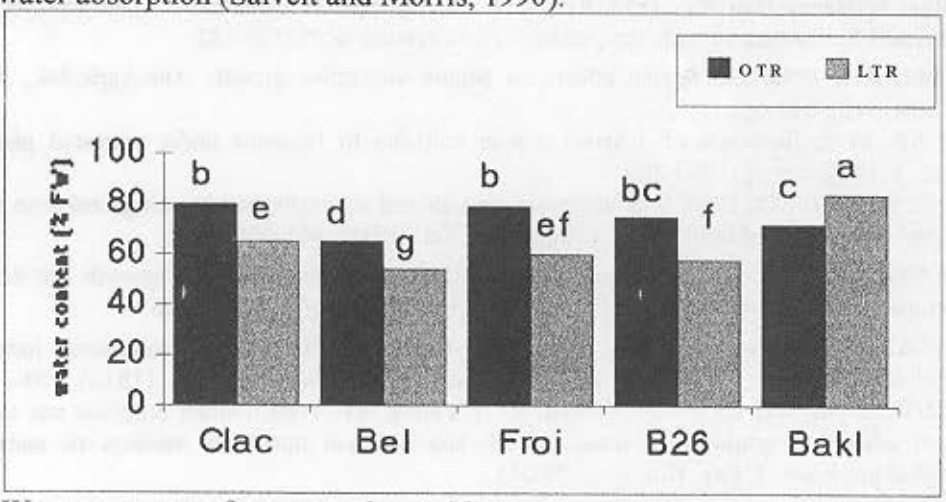


Fig.1: Water content of pepper plants (*Capsicum annuum* L.) cutivated at optimal (25/20 °C, day/night) or at low (25/12°C) night temperature regimes

Bifurcation number per plant, after 40 days of treatment, was negatively affected by LTR, especially in hot pepper cvs 'Beldi', 'Baklouti' and 'B26'(Table 3). For all cultivars, LTR (25/12°C) induce flower abortion before anthesis since plants grown under LTR conditions have developped the first flower beyond the fourth bifurcation

while those exposed to OTR have developped first flower at the first or the second bifurcation (Table3). In addition, the first fruit development occured at the first or the second bifurcation at OTR while it occured at the fourth or the sixth bifurcation at LTR. During 40 days of treatment, 'Baklouti' cv did not developp flower in both temperature regime. These results could explain the poor crop earliness of pepper cultivated in unheated greenhouse. Previous studies reported a similar effect of high temperature in sweet pepper and attributed it to the ethylene action (Aloni et al., 1995). Flower abortion would be associeted to some metabolic activities: a shortage of macronutrients, difficulty of carbohydrate translocation and water deficit (Van Doorn and Stead, 1997).

Table3: Bifurcations number per plant, position of the first flower and fruit of pepper plants (*Capsicum annuum* L.) cutivated at optimal (25/20 °C, day/night) or at low (25/12°C) night temperature regimes.

Cultivar	Bifurcations number per plant		Position of first flower (branching order)		Position of first fruit (branching order)	
	25/20°C	25/12°C	25/20°C	25/12°C	25/20°C	25/12°C
Clace	**17 d**	**11.7ed**	**1.2 c**	**4.1abc**	**1.8 c**	**5.3ab**
Beldi	**46.7a**	**31.6b**	**1.8 c**	**3.6 b**	**2.1 c**	**4.8ab**
Froidure	**14.4de**	**10.7 e**	**2.2 c**	**5.1 a**	**2.8 c**	**5.8 a**
B26	**28.1bc**	**14.9ed**	**2.0 c**	**3.4 b**	**2.3 c**	**4.2 b**
Baklouti	**24.1c**	**13.9de**	-	-	-	-

means followed by a same letter were not significantly different at P=0.05

References

Aloni B; Karni L ; Rylski I, 1995. Inhibition of heat induced pepper (*Capsicum annuum*) flower abscission and induction of fruit malformation by silver thiosulphate. J. Hort. Sci. 70 (2) 251-220.

Bhatt RM; Srivinasa-Rao NK, 1993. Response of bell pepper (*C. annuum* L.) photosynthesis, growth and flower and fruit setting to night temperature. Photosynthetica 28, 127-132.

El Asdoudi AH, 1993. Gebberellin effects on pepper vegetative growth. Ann.Agric.Sci., Ain Shams Univ., Cairo 38(2), 643-652.

Elsayed SF, 1995. Response of 3 sweet pepper cultivars to Biozyme under unheated plastic house conditions. Scientia hort. 61: 285-290.

Gosselin A ; Trudel MJ, 1983. Interaction between air and root temperatures on greenhouse tomato : I. Growth, development, and yield. J. Amer. Soc. Hort. Sci. 108(6), 901-905.

Hunner NPA, 1985. Morphlogical, anatomical and molecular consequences of growth and development at low temperature in *Secale cereale* L., cv. 'Puma'. Amer. J. Bot., 72 ,1290-1306.

Janoudi AK; Widders IE; Flore JA, 1993. Water deficits and environmental factors affect photosynthesis in leaves of cucumber (*Cucumis sativus*). J. Amer. Soc. Hort. Sci. 118 (3), 366-370.

Lawlor DW; Boyle FA; Keys AJ; Kendall AC ; Young AT, 1988. Nitrate nutrition and temperature effects on wheat : a synthesis of plant growth and nitrogen uptake in relation to metabolic and physiological processes. J. Exp. Bot. 39 , 329-343.

Mercado MF; Mar-Trigo M; Valpuesta V ; Quesada MA, 1997. Effects of low temperature on pepper pollen morphology and fertility : Evidence of cold induced exine alterations. J. Hort. Sci., 72 (2) 317-326.

Pressman F ; Mashikovitch H; Rosenfeld K; Shaked R; Gamliel B ; Aloni B, 1998. Influence of low temperature on sweet pepper flower quality and the effect of repeated pollination, with viable pollen, on fruit setting. J. Hort. Sci. & Biotech. 73 (1), 131-136.

Salveit JME ; Morris LL, 1990. Overview on chilling injury of horticultural crops. In : 'Chilling Injury of Horticultural Crops, Ed. C.Y. Wang, pp 3-17.

Van Door WG; Stead AD, 1997. Abscission of flowers and floral parts. J. of Exp. Bot. 48 (309), 821-837.

Capsicum and Eggplant Newsletter, 19 (2000): 31-34.

COMPARATIVE STUDY ON NUTRITIONAL COMPONENTS OF DIPLOIDS, TETRAPLOIDS AND TETRAPLOID HYBRIDS OF *CAPSICUM*

T. Srivalli, Ch.G. Gupta and N. Lakshmi
Cytogenetics Laboratory, Department of Botany, Nagarjuna University,
Guntur District.

****

Chilli, an attractive red pepper belonging to the genus *Capsicum* of the family Solanaceae, is the major cash crop in India with wide range of applications in divrse fields. It has assumed more economic importance after the isolation of the volatile alkaloid capsaicin, which is of considerable medicinal value. Considering the culinary importance, medicinal avail, vitamin content and colouring matter, the demand for chillies in the world market is increasing day by day, especially after the banning of artificial food colours in the west. The important nutritional constituents of the chilli fruits include an alkaloid capsaicin, oleresin, vitamins (A, C, E & P), proteins and sugars. Depending on the genomic constitution in different cultivated species of *Capsicum,* the quantities of different nutritional components vary. Although reports on biochemical constituents of diploid chilli cultivars are present to some extent there is no work on polyploids and polyploid hybrids of chilli in this direction. In the present study it is planned to analyse the nutritional components such as ascorbic acid in unripe and ripe fruits, poteins, sugars, oleoresin and capsaicin in ripe fruits of 8 autotetraploids developed, their corresponding diploids and in some tetraploid hybrids developed.

The materials used in the present study include x180, x206, Santaka, Jawahar, Tc1, Sel 1, Lec 21 of *C. annum,* one of *C.chinense* diploids, their corresponding tetraploids and 12 heterotic tetraploid hybrids developed.

Data on nutritional components is set out in tables 1 and 2. Estimation of ascorbic acid in unripe and ripe fruits of the diploids and the tetraploids revealed a general increase in content on ripening. In diploids, x180 exhibited lowest ascorbic acid content in unripe fruits and Tc1 and Lec 21 exhibited the highest. The ripe fruits of Santaka showed lowest while that of Lec 21 recorded highest (Table 1). Among tetrapoloids, Tc 1 displayed lowest content both in unripe and ripe fruits while highest was recorded in Sel 1 unripe fruits and Santaka ripe fruits. In tetraploid hybrids minimum ascorbic acid content was noticed in unripe fruits of Sel 1 X x206 and ripe fruits of x180 X Santaka and Santaka X x180 (Table 2). In Jawahar X Santaka maximum amount was noticed in both unripe and ripe fruits. Heterosis estimations revealed that, although positive heterosis in ripe fruits over both the parents was observed in 7 hybrids, it was significant in 5 hybrids viz., Jawahar X Santaka, Jawahar X Tc1, Jawahar X *C.chinense,* Sel 1 X x206 and *C. chinense* X x206. In unrpie fruits it was significant in Jawahar X Santaka and *C.chinense* X x206.

The percentage of fruit protein content was estimated in 8 tetraploids, their corresponding diploids and tetraploid hybrids. In tetraploids, decrease in protein content was observed than in their corresponding diploids. In diploids,

the percentage of protein ranged from 10.73 to 12.52 and in tetraploids from 8.87 to 17.89 (Table 1), while in tetraploid hybrids it was between 9.23 to 12.33 (Table 2). Heterosis estimations revealed that Jawahar X Tc1 was superior over the others and showed positive heterosis with respect to this trait over both the parents.

The percentage of sugar content in fruits of both diploids and tetraploids revealed a decrease in tetraploids. In diploids, the percentage of sugar content ranged from 4.40 to 10.67, in tetraploids from 4.07 to 9.13 (Table 1), while in tetraploid hybrids the range was between 4.60 to 13.73 (Table 2). Tetraploid hybrids namely x180 X x206, x180 X Santaka and x206 X Jawahar were superior over others in sugar content, with significant heterosis over both the parents.

The total flavour extracts prepared by solvent extraction of the ground spices are known as oleoresins. The oleoresin consists of fixed oil, capsaicin, pigments, sugars and resin. Thus, its content in a particular chilli variety is very important for spice industry. The oleoresin content was estimated in diploids, tetraploids and tetraploid hybrids. In diploids, lowest percentage of oleoresin was observed in x206 and highest in Sel 1 (Table 1). In tetraploids lowest was observed in Tc 1 and highest in Jawahar. In tetraploid hybrids lowest was observed in Jawahar X Santaka and highest in Jawahar X Tc1 (Table 2). Hybrids x180 X x206, x180 X Santaka, Santaka X x180 and *C. Chinese* X x206 exhibited positive heterosis over both the parents.

For capsaicin content, among parents, sel 1 exhibited maximum content and *C. chinese* showed lowest. In tetraploidds x206 recorded maximum percentage and Tc1 minimum (Table 1). In general, tetraploids recorded an increase in percentage of capsaicin over their corresponding diploids, except in Sel 1, where decrease was noticed. Among tetraploid hybrids, x180 X Santaka recorded lowest percentage and Santaka X Sel 1 recorded highest (Table 2). Santaka X Sel 1 and Jawahar X *C. chinese* exhibited significant heterosis over both the parents.

In the present study, the quantitative estimations revealed that there was a decrease in biochemical constituents in some tetraploids and tetraploid hybrids while an increase was observed in others. Lakshmi *et al.,* (1992) also observed the same in tetraploids of *Capsicum*. The increase in the quantity of chemical constituents can either be the outcome of increased synthesis or accumulation. On the contrary, reduction in the quantity may reflect reduced biosynthesis due to gene suppression or rapid utilization.

One of the author T. Srivalli, CSIR-RA is grateful to CSIR for giving financial assistance and Ch.G. Gupta, UGC-SRF is grateful to UGC for giving financial assistance.

Lakshmi, N. Harini, I and Prakash, N.S. 1992. Studies on ascorbic acid, protein and sugar content of diploid and tetraploid strains of *Capsicum annum* L. J. Indian Bot. Soc. **71:** 299-300.

Table: 1: **Results on Ascorbic acid, Protein and Sugar content in fruits of *Capsicum* diploids and tetraploids.**

Variety	Ascorbic Acid (mg/100 gms)				Protein (%)		Sugar (%)		Oleoresin (%)		Capsaicin (%)	
	Diploid		Tetraploid		Diploid	Tetraploid	Diploid	Tetraploid	Diploid	Tetraploid	Diploid	Tetraploid
	Unripe	Ripe	Unripe	Ripe								
x180	153.00	256.00	126.00	232.00	12.52	11.09	6.74	5.60	14.10	12.82	0.522	0.815
x 206	216.00	280.00	240.00	328.00	11.36	10.91	7.92	6.73	10.52	14.88	0.719	0.831
Santaka	176.00	200.00	240.00	340.00	12.36	11.89	9.73	8.80	14.75	11.98	0.594	0.698
Jawahar	200.00	240.00	240.00	264.00	11.28	8.87	8.40	7.33	14.48	16.12	0.592	0.798
Tc1	264.00	296.00	120.00	192.00	12.25	9.76	10.67	9.13	11.60	8.38	0.521	0.594
Sel 1	200.00	224.00	248.00	304.00	11.28	10.37	6.67	7.13	15.72	14.26	0.750	0.723
Lec 21	264.00	344.00	200.00	256.00	10.73	10.12	4.40	4.07	11.40	12.68	0.552	0.720
C. chinese	224.00	240.00	224.00	256.00	11.99	11.27	6.47	5.87	13.92	11.30	0.358	0.617

Table: 2. **Data on nutritional components in fruits of some tetraploid hybrids of *Capsicum*.**

Sl. No.	Variety	Ascorbic acid (mg/100 g) Unripe	Ripe	Capsaicin (%)	Oleoresin (%)	Protein (%)	Sugar (%)
1.	x180 X x206	144.00	228.00	0.679	15.61	9.59	13.73
2.	x180 X Santaka	192.00	192.00	0.345	14.94	9.95	10.47
3.	x206 X Jawahar	192.00	252.00	0.765	12.48	9.67	9.87
4.	Santaka X x180	216.00	192.00	0.419	13.13	12.33	8.67
5.	Santaka X Sel 1	195.00	351.00	0.975	13.51	9.31	6.80
6.	Jawahar X x206	247.00	338.00	0.687	12.90	10.48	5.67
7.	Jawahar X Santaka	291.00	377.00	0.752	11.37	10.21	5.27
8.	Jawahar X Tc 1	208.00	368.00	0.604	15.91	9.93	7.00
9.	Jawahar X *C. chinese*	252.00	312.00	0.937	14.37	10.56	6.33
10.	Sel 1 X x206	130.00	364.00	0.577	12.78	9.68	6.20
11.	Sel 1 X Santaka	182.00	312.00	0.417	13.20	10.39	4.60
12.	*C. chinese* X x206	273.00	368.00	0.767	15.82	9.23	5.53

THE INTERNATIONAL SWEET PEPPER NURSERY (ISPN)

Terry Berke and S.C. Shieh
Asian Vegetable Research and Development Center (AVRDC), Shanhua, 741, Taiwan email *terry@netra.avrdc.org.tw*

The AVRDC established the International Sweet Pepper Nursery (ISPN) in 1999. Its goals are to introduce heat-tolerant, tropically-adapted sweet pepper inbred lines into tropical production regions, to monitor the performance of this germplasm in diverse environments, and to gather information on pathogens attacking sweet peppers.

The AVRDC has been developing improved sweet pepper inbred lines during the past several years. Major traits of interest include heat tolerance, multiple disease resistance, and tolerance to mites and other insect pests. Recently the AVRDC began to participate in the LIRA[1] sweet pepper breeding program. In the future, heat-tolerant inbred lines developed at the AVRDC from the LIRA program may be included in the ISPN under a LIRA code number.

The 2nd ISPN trial contains 10 entries, all inbred lines, including one long-term heat-sensitive check. Each cooperator in each environment adds a local check. One gram of seed (~160 seeds) is sent per entry. Seeds are prepared for shipment every year in February. An International Co-operator's Guide entitled "Procedures for Sweet Pepper Evaluation Trials" is included with each trial. Each cooperator is asked to measure days to 50% anthesis, days to 50% maturity, aerial fresh biomass (after the last harvest), fresh fruit yield (3 harvests), fruit weight, fruit length, and fruit width. Observations should be recorded on disease(s) and insect(s) present in the plots when damage occurs.

The nursery is grown at the AVRDC during the hot, rainy season and evaluated for the same traits. Entries are screened at the AVRDC for resistance to Phytophthora blight (*Phytophthora capsici*), bacterial wilt (*Ralstonia solanacearum*), bacterial spot (*Xanthomonas campestris* pv. *campestris*), cucumber mosaic virus (CMV), chilli veinal mottle virus (ChiVMV), potato virus Y (PVY), and tobacco mosaic virus (TMV). Disease screening and other results obtained at the AVRDC are summarized and sent to ISPN recipients every year in December, along with an invitation to receive the next ISPN trial.

Seed sets for the 1st ISPN trial were sent to more than 37 cooperators in more than 22 countries in 1999. Feedback has been received from five researchers as of February 2000. The 2nd ISPN trial is currently available to any interested researcher. If you want seeds of the 2nd ISPN, please request them in writing and include your address and import permit, if your country requires one. The AVRDC implemented a Material Transfer Agreement (MTA) in 1999 for distribution with its seeds. The MTA is distributed with each set of ISPN seeds.

References

[1] Palloix, A., T. Depestre, A.M. Daubeze, D. Lafortune, R. Nono Womdim, A.A. Elamin, and C. Duranton. 1998. Breeding multiresistant bell peppers for intertropical cultivation conditions; the "LIRA" program. *In:* (A. Palloix and M.C. Daunay, eds.) Proceedings of the X[th] EUCARPIA Meeting on Genetics and Breeding of *Capsicum* & Eggplant, Sept. 7-11, 1998. Avignon, France.

Capsicum and Eggplant Newsletter, 19 (2000): 36-37.

9TH INTERNATIONAL CHILLI PEPPER NURSERY (ICPN) AT TARI, TAIWAN

S. T. Wang*., C. H. Hsiao*., T. Berke** and S. C. Shieh**.

*Dept. of Horticulture, Taiwan Agricultural Research Institute.189 Chung-cheng Road, Wu-feng, 41301 Taichung, Taiwan E-mail:stwang@wufeng.tari.gov.tw.

**Asian Vegetable Research and Development Center, Shanhua, Tainan, P.O. Box 42,Taiwan 74199 E-mail:terry@netra.avrdc.org.tw

Introduction

In Taiwan hot pepper can grow all year round. From July to October, especially in September and October, the yield is low and average price is about two times higher than other months. The major problems for farmers cultivating hot pepper during this period are diseases such as anthracnose, CMV, ChiVMV, Phytophthora blight, bacterial spot, and bacterial wilt. The most important disease is anthracnose, which causes severe losses even under chemical control.

The Asian Vegetable Research and Development Center coordinates the International Chilli Pepper Nursery (ICPN). This report summarizes the results of the 9th ICPN regional trial in TARI, Taiwan.

Material and Methods

The experiment was carried out at TARI, Taiwan in 1999. Two checks were included [F_1 Delicacy (most popular variety in Taiwan) and PBC142 (AVRDC long term check), plus four F_1 hybrids from TARI]. Twenty-five entries were evaluated in a randomized complete block design with 4 replications, and each replication had 8 plants. The seedlings were raised in a greenhouse in a 72 cell plug tray using a commercial medium, Bio-Mix. The seeding and transplanting dates were 12 March and 3 May. The distance between furrows was 1.4m, and each plot had two rows of plants 50 cm apart. Yield, days to 50% anthesis, fruit weight, fruit length, fruit width, and fruit wall thickness were measured for statistical analysis. Fresh ripe fruits were harvested five times between 1 September and 4 November. Days to 50% anthesis was recorded as the number of days after seeding (DAS). Fruit weight, fruit length, fruit width and fruit wall thickness is the average of 10 fresh ripe fruits for each plot from the third harvest on 24 September.

Result and Discussion

The results are presented in Table 1. Most lines had higher yields than the checks F1 Delicacy and PBC142, but only 9852-15, 9852-18, 9852-173, TARI cross-3, and TARI cross-4 were significantly higher than the checks because anthracnose and bacterial wilt caused high variations in yield. The line 9852-173 had the highest yield because it was tolerant to anthracnose, viruses, and bacterial wilt. Although 9852-173 was not resistant or immune to anthracnose, it had a higher percentage of marketable fresh ripe fruit than the other entries. The lines 9852-173, PBC308 and 97-7127 had higher fruit weight than other lines. The lines 9852-79, 9852-173, PBC308, 97-7127, 97-7644, TARI cross-2 and TARI cross-3 had longer fruit length than other lines. The lines 9852-173, PBC308, and 97-7127 had wider fruits than other lines. The lines 9852-15, 9852-79, 9852-173, PBC308, 97-7127, 97-7195-1 and 97-7644 had thicker fruit walls than other lines. In Taiwan, high quality chilli fruits have long, straight, thick fruit walls and acceptable pungency levels. By Taiwanese standards, the line 9852-173 is the most promising line in this trial for horticultural characters, followed by PBC 308 and 97-7127. Besides 9852-173, 9852-15 also was tolerant to viruses and anthracnose, but sensitive to bacterial wilt. The lines 9852-51, 97-7127, 97-7195-1 and 97-7644 were tolerant to viruses in the field.

One source of tolerance to anthracnose is Perennial HDV(2), but it is far away from quality requirements in Taiwan. The line 9852-173 performed very well for anthracnose tolerance in our field. At least four species of *Colletotrichum [acutatum, capsici, coccodes,* and *gloeosporioides]* cause anthracnose(1). There is little information about strains within species, so it needs laboratory inoculation and more field trial results to confirm the field tolerance of 9852-173.

References

1. Hadden, J. F. and Black, L. L. 1989. Anthracnose of pepper caused by Colletotrichum spp. pp. 189-199. *In*: S. K. Green (ed.) Tomato and Pepper Production in the Tropics. AVRDC, Shanhua, Tainan, 741, Taiwan.
2. Manandhar, J. B., Hartman, G. L. and Wang, T.C. 1995. Anthracnose development on pepper fruits inoculated with *Colletotrichum gloeosporioides*. Plant Dis. 79:380-383.

Table 1. 9th ICPN data for yield, days to 50% anthesis (DAS), and fruit characters at TARI, Taiwan, during the 1999 hot, rainy season.

Entry	Fruit Yield (g/plot)	Anthesis Date (DAS)[1]	Fruit Weight (g)[2]	Fruit Length (cm)	Fruit width (cm)	Fruit wall thickness (mm)
F_1Delicacy (ck)	155	75.3	7.1	11.4	0.91	2.20
PBC142 (ck)	200	78.8	1.7	5.2	0.72	1.35
9852-15	1355	70.0	5.3	7.9	1.15	2.18
9852-17	183	71.5	5.4	9.2	1.14	1.85
9852-18	880	71.5	4.8	7.6	1.08	1.78
9852-19	626	73.5	4.4	7.6	0.97	1.90
9852-51	601	74.8	1.8	4.4	0.87	1.43
9852-54	285	63.3	1.7	6.0	0.71	1.18
9852-61	191	71.0	2.3	6.6	0.70	1.60
9852-77	303	66.0	5.5	8.9	1.25	1.88
9852-78	355	70.0	6.4	10.5	1.34	2.30
9852-79	353	64.8	6.2	9.3	1.14	2.13
9852-100	268	59.8	3.1	6.3	1.00	1.73
9852-110	240	74.8	2.3	5.4	0.90	1.20
9852-170	711	69.0	4.9	7.7	0.95	1.85
9852-173	3392	72.8	8.1	9.3	1.45	2.33
PBC308	783	70.5	8.3	9.8	1.42	2.20
97-7114	168	70.3	7.3	8.5	1.42	2.20
97-7127	689	71.0	9.1	10.5	1.54	2.43
97-7195-1	598	69.5	5.3	8.4	1.00	2.03
97-7644	524	70.3	5.0	9.7	0.97	2.13
TARI cross-1	431	72.8	5.6	8.8	1.05	1.83
TARI cross-2	689	77.3	4.2	9.1	1.06	1.38
TARI cross-3	1095	77.0	5.2	10.1	0.99	1.58
TARI cross-4	1013	>79.0	4.2	9.3	1.02	1.38
LSD0.05	515	3.0	1.0	0.8	0.16	0.38

[1] Days to 50% anthesis: TARI cross-4 was > 79 days and not included in the statistical analysis.

[2] Fruit characters: F1 Delicacy was harvested from only one plot and 9852-17, 9852-78 and 97-7114 from only two plots, so only their average data is shown, they were not in the statistical analysis.

Capsicum and Eggplant Newsletter, 19 (2000): 38-41.

CHILLI PEPPERS IN ASIA

Terry Berke and S.C. Shieh
Asian Vegetable Research and Development Center (AVRDC), Shanhua, 741, Taiwan email *terry@netra.avrdc.org.tw*

Chilli peppers (*Capsicum* spp.) are native to Central and South America. Portuguese traders introduced them to India, Indonesia, and other parts of Asia around 450-500 years ago. They quickly adapted to the wide range of agro-ecological zones found in Asia. They were adopted by local people so quickly that in 1542, the botanist Leonhard Fuchs of Germany recorded them as native to India. Today they are widely grown in many countries of the region and they form an integral part of the local cuisine, such as Indonesian sambal, Thai hot and sour soup, Korean kimchi, and Indian curry.

Botanically, chillies are classified among the Solanaceae, and are closely related to the tomato, nightshade, and potato. They belong to the genus Capsicum, which probably comes from the Latin *capsa*, meaning chest or box, because of its shape (the fruit encloses the seeds very neatly, as in a box). There are many names for chilli peppers in the different countries of Asia. In Bhutan, they are called "ema", in China they are called "la-jiao", in Indonesia they are called "cabe", in Thailand they are called "prik", and in India they are called "chilli". The early Aztecs of Mexico also called them "chilli", and that name is the most commonly one used today around the world, with some variant spellings (chile, chili, chilly, etc.). Many different fruit types are known within the Capsicum species. Mexico, one of the centers of diversity, has over 240 recognized fruit types. Chillies in Asia are primarily the cayenne fruit type, with two general fruit sizes, long or short. Other fruit types are occasionally found in individual countries or regions.

Long chilli peppers are usually straight, green or dark green at the immature stage, and bright or dark red at the mature stage. The length ranges from 9-15 cm long and the pungency ranges from very low to medium-hot. They may be marketed as fresh green fruits, fresh red fruits, dried red fruits, or processed into chilli sauce, chilli powder, etc. Varieties with high dry matter content are preferred for drying. Some representative chilli pepper varieties are listed by country of origin in Table 1. In some countries the area planted to hybrids is >90% (e.g. Korea and Taiwan). Hybrid chilli peppers are gaining popularity in China, India, Indonesia, and some other parts of Asia. Besides the cayenne fruit shape, other types are also occasionally found within Asia. For example, keriting is an unusual fruit type grown in parts of Indonesia and Sri Lanka; keriting fruits are approximately 12-15 cm long, only 0.5 cm wide, and curly, like a corkscrew.

Long chilli peppers vary somewhat in size and color but not in taste. Important fresh fruit quality parameters for processing include: free from blemishes caused by disease or sun bleaching, intense color (bright or deep red), good color stability after processing, and acceptable pungency (pungency level preferences vary according to region). Important dry fruit quality parameters include high dry matter, ease of grinding, good color retention after drying, good color retention after grinding, and free from diseases/insects. India is the major exporter of dry chilli peppers, followed by China (Table 2). The major importing countries are the U.S. and Germany.

Short chilli peppers are usually straight, light green or green at the immature stage, and bright or dark red at the mature stage. The length ranges from 2-7 cm long and the pungency ranges from medium to very hot. They may be marketed as fresh green fruits, fresh red fruits, dried red fruits, or processed into chilli sauce, chilli powder, etc. They are added to dishes to

provide flavor, color, aroma, and pungency. The species may be *Capsicum annuum* or *C. frutescens* (*C. frutescens* is preferred in some countries, such as Thailand). Some representative short-fruited chilli pepper varieties are listed by country of origin in Table 1. Very few short-fruited F_1 hybrids are grown because the cost of producing hybrid seeds is too high.

Many countries grow a short-fruited landrace that is nameless, or simply called "small chilli". In Thailand, these short-fruited types are called prik khee (*C. annuum*) or prik khee noo (*C. frutescens*). (Note: these are classes of peppers, not variety names). To add to the confusion, Thais (and other Asians) also refer to them as bird peppers, probably because birds consume them and then leave their droppings in other areas, spreading them. Thai people claim that only *C. frutescens* can be called prik khee noo (literally, "mouse droppings pepper"). To the casual observer, prik khee fruits look very similar to prik khee noo fruits. It is even difficult for Thais to define what a prik khee noo pepper is, or how it differs from prik khee, other than it has a "fruity" smell.

The AVRDC has conducted numerous pest and disease surveys in Asia. The major insects that attack chilli peppers are aphids (*Aphis gossypii*, *Myzus persicae*), mites (*Polyphagotarsonemus latus*), and thrips (*Scirtothrips dorsalis*, *Thrips palmi*). The major diseases are cucumber mosaic virus (CMV), chilli veinal mottle virus (ChiVMV), bacterial wilt (causal agent *Ralstonia solanacearum*) (in the lowland tropics), Phytophthora blight (causal agent *Phytophthora capsici*) (in the highland tropics and temperate regions), and anthracnose (causal agent *Colletotrichum* spp.). Some diseases and insects are important only in some regions, such as tobacco mosaic virus (TMV) in Korea, or at certain times of the year.

Among the commonly grown varieties in Asia, disease resistance varies considerably. Many varieties from Malaysia and Indonesia are resistant to bacterial wilt. Perennial, from India, is widely used as a source of CMV resistance. However, the varieties commonly grown in most countries have little disease or insect resistance. This causes chilli pepper yields to be low and unstable. Many countries in the region cannot meet local demand for chilli products and have to import them from other countries, primarily as dry chilli peppers (Table 2).

To combat insects and diseases, farmers spray tremendous volumes of insecticides and fungicides on their fields. Farmers typically spray highly toxic "cocktails" (mixtures) containing 4-6 different pesticides every other day during the growing season, with often only a one-day waiting period before harvest. Concern about pesticide residues on fresh chilli peppers is growing in many countries in the region. The AVRDC has therefore produced an International Co-operator's Guide, entitled "Suggested Cultural Practices for Chilli Pepper", to help researchers and extension agents teach farmers integrated pest management (IPM) methods for their crop.

Chilli peppers are important in almost every Asian country. They are the #1 vegetable in Malaysia and Bhutan, for example, and rank at or near the top in terms of growing area in most Asian countries. The area, production, and yield of chilli peppers is difficult to pinpoint. Data is simply not available for some countries, or it is not very accurate. For example, India is the world leader in growing area devoted to chilli peppers, with ~900,000 ha annually (Table 3), but according to FAO statistics there are only 5,300 ha of chilli peppers in India (Table 4). India, China, and Indonesia are among the world leaders in area devoted to chilli pepper. The area in China is probably much larger than reported in Table 3. According to the China APSA country report #1, published in 1996, China had 206,000 ha of chilli pepper in 1993, which produced 2.98 million metric tons, with a yield average of 14.4 t ha^{-1}.

Table 1. Representative varieties of chilli peppers in selected countries.

Country	Long fruit size	Short fruit size[z]
Bangladesh	Zia, Bindu, Baisakhi, Chittagong	
Bhutan	Sha Ema, Begap, Toeb	
China (PRC)	F1 Chung Chiao, F1 Shiang Yen, F1 Su-Jiao, 8212 and 8819	
India	Byadgi, G-3, G-4, Pusa Jwala	Pant C-1, Pusa Sadabahar
Indonesia	Jatilaba, Paris Minyak, and Tit Super	Cabe Rawit
S. Korea	F1 Kumtop, F1 Chohong, F1 Hongilpum	
Malaysia	Cili Langkap, Kulai, and MC-12	Cili Burung
Nepal	Kolusania, Korsani	
Pakistan	Lounghi, Narwala, NARC-4	
Philippines	Hotshot, Matikas	Ligai Abay
Sri Lanka	Ruhunu Miris, Galkunda Miris	Arunalu, MI-2, Mullai
Thailand	Bangchang, Luang, Mun, and Yuak	Huay Sithon, Huaruar, Nong Lan, and Chinda 2
Turkey	Sivri, Carliston, Dolma Biber, Bursa	
Vietnam	IASSV#2, Van Ngo, SG1-2, Sungbo, PVR#9	

Table 2. 1996 estimated imports and exports[z] of chilli + green peppers in selected countries.

	Imports		Exports	
Country	Amount (MT)	Value ($1000)	Amount (MT)	Value ($1000)
Bangladesh	1,000	1,000	5	5
Bhutan	11	6	117	37
China (PRC)	2,821	2,416	33,903	74,732
India[y]	114	178	55,864	60,403
Indonesia	1,946	1,834	672	294
S. Korea	5,248	19,768	862	4,471
Malaysia	20,842	30,719	10,005	3,112
Nepal	785	400	NA[x]	NA
Pakistan	3,911	4,197	NA	NA
Philippines	230	713	NA	NA
Sri Lanka	8,773	9,846	63	231
Thailand	3,436	2,281	466	1,579
Turkey	244	291	528	1,197
Vietnam	NA	NA	2,000	1,400

[z] FAO data. The FAO does not separate data for chilli and green peppers.
[y] 1995 data.
[x] No data available.

Table 3. Estimated area, production, and yield[z] of chilli peppers in selected countries.

Country	Area (000 ha)	Production (000 MT)	Yield (t ha^{-1})
Bangladesh	78.3	234	3.0
Bhutan	NA	NA	NA
China (PRC)	86.0	1,290	15.0-22.5
India	891.8	4,000	2.5-6.5
Indonesia	216.4	411	1.9
S. Korea	132.2	1,758	13.3
Malaysia	1.5	12	5.0-12.0
Nepal	9.5	67	7.0
Pakistan	57.6	374	6.5
Philippines	NA	NA	NA
Sri Lanka	40.4	263	6.5
Thailand	60.5	466	7.7
Turkey	NA	NA	NA
Vietnam	NA	NA	NA

[z] Poulos, J.M. 1992. Problems and Progress of Chilli Pepper Production in the Tropics. *In* (C.B. Hock, L.W. Hong, M. Rejab, and A.R. Syed, eds.) Proceedings of the Conference on Chilli Pepper Production in the Tropics. pp. 98-129. October 13-14, 1992. Kuala Lumpur, Malaysia.

[y] No data available.

Table 4. 1998 estimated area, production, and yield[z] of chilli + green peppers in selected countries.

Country	Area (000 ha)	Production (000 MT)	Yield (t ha^{-1})
Bangladesh	NA[y]	NA	NA
Bhutan	2.5	3	8.5
China (PRC)	353.2	7,033	19.9
India	5.3	48	9.0
Indonesia	111.7	274	2.5
S. Korea	83.0	288	3.5
Philippines	4.8	18	3.8
Sri Lanka	21.6	63	2.9
Thailand	0.9	12	13.3
Turkey	68.0	1,390	20.4

[z] Food and Agriculture Organization (FAO) database at http://www.fao.org.

[y] No data available.

Capsicum and Eggplant Newsletter, 19 (2000): 42-45.

Evaluation of chilli germplasm under Sub-tropical condition.

A.D. Munshi, Subodh Joshi and Gyanendra Singh
Division of Vegetable Crops
IARI, New Delhi.

Germplasm lines are the reservoir of variation which provides basic material for the breeder to develop new varieties. The success of breeding programme depends on the number and quality of the germplasm lines available with the breeder. Keeping in view the above facts an investigation was carried out in the Division of Vegetable Crops, IARI, New Delhi during Kharif 1996, to evaluate chilli germplasm for yield and other desirable characters.

Material and Methods

Thirty genotypes consisting of some released/pre-released varieties, breeding lines and local collections were taken for the study. Sowing was done in mid June and six week old seedlings were transplanted in the field during August. Experiment was laid out in Randomized Block Design with three replications. A spacing of 60 cm x 60 cm was given in 6m x6m bed for each genotype and all the recommended agronomic package of practices were followed in the experimental area. A random sample of 5 plants was used to record observations on days to first fruit harvest, length of fruit (cm), girth of the fruit (cm), fruit weight (g), number of fruits per plant, total yield per plant (g) and yield per hactare (q). Analysis of variance for each character was done as per the technique of Shedecor and Cochran (1967).

Result and Discussion

The details of germplasm used along with their mean, SEM and C.D. value are given in Table 1. All the germplasm differed significantly with respect to different characters studied. Wide range of variation was observed in all the characters except fruit girth which showed narrow range of variation. Days to first fruit harvest varied from 81.53 days (Pusa Sadabahar) to 98.67 days (Mathania Local), number of fruit per plant from 17.17 (LCA-301) to 107.77 (Pusa Sadabahar), fruit weight from 1.35 g (Bengal Local) to 3.3 g (Mathania Local-1), yield per plant from 30.6 g (LCA-324) to 210.28 g (Pusa Sadabahar) and yield per hactare from12.27q (LCA-324) to 84.11q (Pusa Sadabahar). Since the crop was raised in rainy season there was moderate to severe infestation of leaf curl and mosaic virus in all the germplasm and the yield was observed to be less than the normal. Variety Pusa Sadabahar showed significantly better performance than all the germplasm as it is earliest in maturity (81.53) and also having highest number of fruits per plant (107.77), total yield per plant (210.28) and yield per hactare (84.11). Mathania Local-1 a land race from Jodhpur exhibited highest length, girth and fruit weight. The germplasm Sel-19, Bihar Local -1, Orissa Local-1 Utkal Ragini and RHRC. Clusturing Erect were also observed to quite promising with respect to yield and other desirable characters. The germplasm possesing higher number of fruits may be utilized in the hybridization programme as this character was found to be positively associated with fruit yield as reported by Nandpuri et. al. (1970) Rao et. al. (1974) and Joshi and Singh (1983). The breeder can make use of the promising germplasm in their breeding programme according to their objective.

REFERENCES

Joshi, S. and Singh, B. 1983. Variability studies in sweet pepper (Capsicum annum L.). *Haryana J. Hort. Sci.* **12**(1-2) : 124-129.

Nandpuri, K.S., Gupta, V.P. and Thakur, P.C. 1970. Correlation studies in chillies. *J. Res. P.A.U.* 7(3) : 301-303.

Rao, V.V.R., Jaisane, B.G. and Patel, G.J. 1974. Interrelationship and path coefficients of quantitative traits in chilli. *Indian J. agric. Sci.* **44**(7) : 462-465.

Snedecor, G. W. and Cochran, G. W. 1967. *Statistical Methods*. 6 th Edition. The Iowa state Uni. Press Iowa, USA.

Table 1 : Mean performance of chilli germplasm for different characters.

S.No.	Germplasm	Source	Days to first fruit harvest	Length of the fruit (cm)	Girth of the fruit (cm)	Fruit weight (g)	Number of fruits per plants	Yield per plant (g)	Yield (q/ha)
1	Utkal Ragini	Bhuvneswar (Orissa)	87.43	4.88	1.65	1.46	97.87	142.67	57.07
2	KDS- 810	Kalianpur (U.P)	89.40	4.80	1.02	1.39	77.87	107.66	43.06
3	LCA- 206	Lam (A.P)	92.50	5.18	1.87	1.97	49.43	97.51	39.00
4	LCA- 324	-do-	96.67	6.55	1.68	2.26	13.73	30.69	12.27
5	LCA- 312	-do-	95.77	4.12	1.10	1.50	28.80	42.57	17.02
6	LCA- 301	-do-	95.27	5.54	1.76	1.92	17.17	33.02	13.21
7	LCA- 304	-do-	94.47	7.02	2.45	2.30	23.27	52.52	21.00
8	LCA- 283	-do-	96.70	6.08	2.12	2.05	21.60	43.46	17.36
9	LCA- 305	-do-	92.73	5.85	1.90	1.89	25.03	47.30	18.20
10	BC-14 -2	Bhuvneswar (Orissa)	95.03	6.24	1.93	1.98	26.07	49.58	19.83
11	BC-24	-do-	89.10	5.53	1.80	1.73	39.47	68.28	27.31
12	BC-21-2	-do-	89.03	5.40	2.09	1.69	63.53	107.36	44.96
13	Surakta	Bangalore (Karnataka)	92.50	7.27	1.64	2.07	38.07	78.66	31.46
14	Arka Lohit	-do-	89.10	6.02	1.89	2.08	40.27	83.41	33.36
15	HC- 28	Hissar (Haryana)	92.57	5.71	1.58	1.90	37.83	72.01	28.80
16	HC- 44	-do-	87.40	5.08	1.71	1.79	59.37	106.26	42.50
17	RHRC clusturing erect	Rahuri (Maharashtra)	83.97	6.60	2.03	2.07	64.10	133.27	53.30

Table 1 contd.

S.No.	Germplasm	Source	Days to first fruit harvest	Length of the fruit (cm)	Girth of the fruit (cm)	Fruit weight (g)	Number of fruits per plants	Yield per plant (g)	Yield (q/ha)
18	RHRC clusturing pendula	Rahuri (Maharashtra)	83.20	5.79	2.18	2.04	74.17	151.10	60.43
19	Phule-5	-do-	96.23	5.14	1.76	1.84	20.70	38.03	15.21
20	Pusa Jwala	IARI (Delhi)	83.20	9.64	1.58	2.22	65.87	143.64	58.2C
21	Pusa Sadabhar	-do-	81.53	5.53	2.20	1.97	107.77	210.28	84.11
22	Gucchedar	Ludhiana (Punjab)	92.40	5.52	1.59	1.87	40.03	74.67	29.26
23	Punjab Surkh.	-do-	92.97	5.62	1.65	1.98	34.47	68.21	27.28
24	Bihar Local-1	Sasarum (Bihar)	97.60	5.46	1.87	1.98	83.50	165.80	66.37
25	Selection -19	IARI (Delhi)	96.57	6.15	1.86	2.06	92.47	189.72	75.88
26	Bengal Local -1	Hoogly (W.B.)	88.93	2.90	1.73	1.35	26.60	35.49	14.19
27	Mathania Local -1	Jodhpur (Rajasthan)	98.67	12.35	2.59	3.35	18.23	59.90	23.96
28	Mathania Local -2	-do-	97.33	10.52	2.42	3.04	32.63	99.16	39.66
29	Orissa Local -1	Balasore (Orissa)	84.27	2.16	1.66	1.48	38.60	56.79	22.71
30	Orissa Local -2	-do-	88.57	5.16	2.14	1.82	79.90	145.25	58.1C
	Mean		91.37	6.00	1.85	1.96	47.95	91.62	36.67
	Range		81.53-98.67	2.16-12.35	1.02-2.59	1.35-3.35	17.17-107.77	30.69-210.28	12.27-84
	C.V		1.39	8.35	12.15	10.71	15.35	14.35	14.33
	SEM		1.03	0.41	0.18	0.17	6.00	10.73	4.29
	C.D (5 %)		2.85	1.13	0.49	0.47	16.63	29.74	11.89

Capsicum and Eggplant Newsletter, 19 (2000): 46-49.

COLLECTION AND CHARACTERIZATION OF SWEET PEPPER GERMOPLAZM IN ALBANIA.

Mevlud HALLIDRI* PHD
Enver TOME* PHD
*Vegetables and Potato National Research Institute
Rr. S. Kosturi, Tirana, Albania.

Tel/Fax : 00355 42 284 22
Email : IPP@ANEP. EU.AL.ORG.

Introduction.

Sweet pepper (*Capsicum annum*) is one of the most popular vegetables in Albania. It is used extensively by the Albanian people in many ways as fried, salads, pickling, filled with rice, filled with a kind of cheese and so on.
Sweet peppers in Albania are produced all over the country under irrigation system. Almost all the cultivars grown are of indigenous types which are characterized by a wide range of observable variability. The crop production is based in small holdings by individual farmers, in diverse environmental conditions of different regions substantially contributed to the observable vast variability of this crop in the Albania.
The danger of loosing some of this variability is increasing due to several factors. Selection of superior varieties that is practiced by the growers in their fields, in addition to introduction of new cultivars can contribute to the genetic erosion in local Albanian sweet pepper germplasm.
Some efforts have been carried out within the last years to collect, conserve and evaluate the indigenous cultivars of sweet pepper in Albania. This paper describes some of these efforts and the results out of them.

Collection and conservation.

Motivated by their research needs the scientists of the national research centers have always been active in exploring the country's genetic resources. These explorations constituted the main stock of germplasm collections in Albania.
In addition, Albania has had international collaboration in this field. Special links existed and are still a main leg of international cooperation particularly with IPK in Germany. Early collections were carried out in 1941 and 1942 by H. STUBBE who has been director of IPK by that time called Kaiser-Wilhelm-Institute of Crop Plant Research (BEGEMANN&HAMMER, 1993).
The recent breakdown of the old political system has now paved the way for a continuation which is more important than before because of accelerated reintroduction from foreign genebanks of Albanian germpalsm. Such provisions have been made with the German genebank at IPK Gatersleben to send back Albanian accessions. In this way came back to Albania 40 accessions 29 out of which were sweet pepper.
Therefore, with support from IPGRI and the Italian government three emergency collecting missions were organized in 1993 and 1994 (Hammer et al., 1994; Gladis et al., 1995). During the missions some samples belonging to *Capsicum annum* were collected

also. Further collections have been made as a part of a vegetable germplasm program funded by the MAF (Ministry of Agriculture and Food, Albania). This program was executed by the Vegetables and Potato National Research Institute. 15 accessions of sweet pepper were collected.
At present a total number of pepper 130, 85 out of which are sweet pepper landraces, are preserved in the Vegetables and Potato National Research Institute in room condition. This number comprises all collections made previously, the accessions send back to Albania by the German genebank at IPK Gatersleben and some of the resulting breeding lines selected from them in the successive years. We are looking for sending to the Albanian Genetic Resources Center (AGRC) to preserve at -20^{0}C in deep freeze chests.

Characterization and variability observed.
A general multiplication and characterization program has been adopted since 1992 for the various vegetables crop collections in the Vegetables and Potato National Research Institute. A total number of 130 pepper 119 out of which are sweet pepper accessions (including the variants coming from abroad) are characterized for different morpho-agronomic traits during 1997/1998 and 1998/1999. Characterization has been done following a descriptor list derived from the IPBGR descriptor list for *Capsicum* (IPBGR, 1983).
A wide range of variability between and within the sweet pepper accessions has been observed. Several variants (sub-accessions) could be observed within every accession for mostly each single character. Therefore, considering each single character (descriptor), every accession could be divided into a number of variants or sub-accessions equivalent to or less than the number of descriptor states. This indicates the highly variable collection of sweet pepper landraces that could be obtain from Albania.
Table 1 shows the frequency percentage of each descriptor state out of the total variants between and within the accessions could be seen, but a degree of less variability and a general trend towards certain descriptor states have been shown in the following characters :

- Growth habit : about 80% of the variants (sub-accessions) have erect growth habit.
- Stem pubescence : about 90% of the variants have glabrous stem.
- Leaf pubescence : more than 90% have glabrous leaf.
- Fruit position : more than 65.8% have declining position, 21% erect and 13.2% intermediate.
- Fruit shape : about 55% of the variants have conical fruits, and about 37% have elongate fruits.
- Fruit length : 57.9% of the variants produce fruits which are medium in length, i.e. between 7.6-12.5 cm.
- Fruit shape at blossom end : 55.3% are pointed, 31.6 are sunken and 13.1 are blunt.
- Fruit color in immature stage : 68.3% are green, 26.3% are yellow and 2.7% are orange. The other variants are other colours.
- Fruit cross-sectional corrugation : more than 55% are slightly corrugated, 36.8 intermediate and 7.9 are very corrugated.
- Pests and diseases susceptibility : more than 85% were produced a medium susceptibility and the rest low susceptibility.

Conclusion.

This preliminary study reflects the highly variable collection that is preserved in the Vegetables and Potato National Research Institute - Albania, which in turn gives idea how rich are the genetic resources of sweet pepper in Albania.

The variability and mixes within the accessions are also great which necessitate purification and separation of lines from them. This proposes for a suitable breeding program within such highly adapted and popular sweet pepper landraces, a program which has started by Tase L. (1981), Hallidri.M., (1995), Tome E., (1997) needs continuation at present and in the future.

Further collections and studies are needed to cover new areas in the country and new aspects for evaluation especially for fruit quality.

References.

1. Anon., 1994: Regulations on seed and saplings production, multiplication, processing, evaluation, marketing and inspection as well conservation and treatment of plant genetic material, Republic of Albania, Tirana, No. 552 of 14 Nov. 1994.

2. Begeman, F. and K. Hammer, 1993 : Analyse der Situation planzengenetischer Ressourcen in der Bundesrepublik Deutschalnd nach der Wiedervereinigung -unter besonderer Berücksichtigung der Genbank in Gatersleben-sowie konzeptionelle überlegungen für ein deutches Gesamtprogramm. Schriftenreihe A des Bundesministers für Ernährung, Landwirtschaft und Forsten, Heft 422.

3. Begeman, F. and K. Hammer, 1994 (EDS): Integration of Conservation Strategies of Plant Genetic Resources in Europe. Proceedings of an International Symposium on Plant Genetic Resources in Europe held in Gatersleben, ,Germany, December 6-8, 1993.

4. CEEP, 1993 : Report on the environmental situation on Albania, draft national environmentalaction plan. Ministry of Health and Environmental Protection, Committee of Environmental Preservation and Protection, Tirana, July 1993, 71 pp.

5. FAO, 1994b: Rehabilitation of the seed industry in Albania. Report of feasibility study mission, GCP/ALB/001/ITA, June 1994.

6. Frank Begeman, 1995: Report of a mission on Plant Genetic Resources in Albania. Rome, April 1995.

7. Gladis, T., K.Hammer, P.Perrino, W.Podyma and XH. Lufter, 1995 : Report of the third collecting mission in Albania, autumn 1994. Plant Genetic Resources Newsletter.

8. Hammer, K., G. Laghetti, D.Pignone, K.Pistrick. Xhuveli, L. and P.Perrino, 1994: Emergency collecting mission to Albania, 1993. Plant Genetic Resources Newsletter, 1994, No. 97, 59-62.

9. SARA, ,1994: Proposal for an Albanian National Agricultural Research Master Plan by the USAID- funded project (Support for Agricultural Restructuring in Albania (SARA)". Vol. I-VII.

10.White, G.A., 1994: Dire conditions threaten rescue of Albania's rich genetic resources. Diversity, Vol.10 (4), p. 34-35.

11. Genetic resources of capsicum. IPBGR, Rome, 1983

Table 1. Frequency percentages of descriptor states out of total variants (sub-ac cessions) between and within sweet pepper accessions.

Descriptor	Descriptor state and its frequency percentage			
1. Growth habit	Prostrate 0	Compact 21	Erect 79	
2. Stem pubescence	Glabrous 89.5	Sparse 7.8	Intermediate 2.7	Abundant 0
3. Stem colour	Green 100	Green with purplish nodes 0	Green with purplish streaks 0	
4. Leaf pubescence	Glabrous 92	Sparse 8	Intermediate 0	Abundant 0
8. Fruit position	Declining 65.8	Intermediate 13.2	Erect 21	
9. Fruit shape	Elongate 5.2	Oblate 2.6	Conical 55.3	Bell 36.9
10. Fruit length	Short (1-7.5 cm) 36.8	Medium (7.6-12.5 cm) 57.9	Long 5.3	
11. Fruit shape at peduncle attachment	Acute 2.7	Obtuse 31.6	Truncate 55.3	Cordate 10.4
12. Fruit colour in immature stage	Green 68.3	Yellow 26.3	Orange 2.7	Other 2.7
12. Fruit shape at blossom end	Pointed 55.3	Blunt 13.1	Sunken 31.6	
13 Fruit cross-sectional corrugation	Slightly corrugated 55.3	Intermediate 36.8	Very corrugated 7.9	
14. Pest and diseases susceptibility	Low 13.1	Medium 86.9	High 0	

Capsicum and Eggplant Newsletter, 19 (2000): 50-53.

EVALUATION AND SELECTION OF SUITABLE PEPPER ACCESSIONS FOR HOME GARDENS IN NIGERIA

BY

O.A. Denton; O.A. Adetula and A.O. Olufolaji
NATIONAL HORTICULTURAL RESEARCH INSTITUTE
P.M.B. 5432, IDI-ISHIN, IBADAN

INTRODUCTION:

Pepper is a a major spice in Nigeria and considerable diversity exist in the two most commonly cultivated species Capsicum annum and Capsicum frutescence. These species are produced in home gardens as well as on farmers' fields. In home garden systems, peppers feature most frequently in mixed cropping pattern with other vegetables (Celosia, Corchorus, Amaranthus, etc.) and a few staple food crops (eg. cassava). Generally, impure and highly variable landraces are planted but there are social preferences for cultivars with specific morphological, physiological, fruits and yield traits. The desirable traits include medium plant height, early flowering, early number of days to first harvest, long fruiting duration, high fruit number/plant, big fruit weight, long flowering duration and high yields. This paper reports the collection, screening of local pepper germplasm and identification of accessions with one or more of the desirable traits for home garden planting.

MATERIALS AND METHOD:

Germplasm of local pepper cultivars were collected from the different agro-ecological zones of the country. The germplasm was divided into two broad species - C. annum and C. frutescence and the species C. frutescence was seperated into two fruit types: namely - slim fruit shape Cayenn ("sombo") and 'bird eye' small size type ("wewe"). The C. annum was made up of round fruit type only ('Rodo') and the number of accessions of each fruit type evaluated were "Rodo" (35 accessions); "Cayenn" (44 accessions) and 'Bird eye' (13 accessions).

Each fruit type was evaluated for Twenty-eight (28) characters but with special attention on the desirable traits for home gardens during the vegetative, reproductive and post harvest stages of growth (Table 1). The evaluation was conducted on the field from April, 1999 to January, 2000 using a Randomised Complete Block Design with each plot replicated three times at the experimental site of the National Horticultural Research Institute, Ibadan, Nigeria. All the recommended cultural practices for pepper production were carried out.

RESULTS AND DISCUSSION:

Considerable differences in plant traits were observed among the accessions of each fruit type (Table 2). The level of variation, as depicted by the co-efficient of variability (CV) was different for various characters (Table 2) and the number of accessions showing each exhibited one or more of the desirable characters while there was no single accession with all the desirable traits for home garden (Table 3). In each of the three fruit types, majority of

the accessions exhibited 10 - 40% of the desirable traits while only a relatively small number of accessions combined 60% or more of the characters required (Table 3). The accessions showing multiple combination of 50% or more desirable traits will be potentially useful as parents for all future genetic improvement management (Table 4).

Since all the accessions evaluated are local cultivars, initial purification of the promising accessions is necessary so that only selected plants showing the desirable characters are used in subsequent hybridization and selection programme.

TABLE 1: Selected Desirable Characters of pepper for Home Gardens

Fruit Type	Desirable Characters	Mean	Range
Rodo	Medium Plant height (cm)	50.0	42 - 56
	Early flowering (days)	41.3	30 - 46
	Early number of days to 1st harvesting	50.1	
	Long flowering duration (days)	69.5	65 - 90
	Long fruiting duration (days)	75.0	70 - 95
	High number of fruit/plant	58.9	55 - 62
	Large fruit weight (g)	4.1	3.5 - 5.0
Wewe Bird eye	Medium Plant height	50.5	39 - 50
	Early flowering (days)	53.1	41 - 62
	Early number of days to 1st harvesting	68.1	65 - 72
	Long flowering duration (days)	104.1	90 - 145
	Long fruiting duration (days)	124.1	100- 156
	High number of fruit/plant	78.2	68 - 80
	Large fruit weight (g)	0.78	0.4- 1g
Sombo Cayenn	Medium Plant height	50.5	39 - 50
	Early flowering (days)	53	41 - 62
	Early number of days to 1st harvesting	82.1	80 - 90
	Long flowering duration (days)	153.2	150- 200
	Long fruiting duration (days)	166	151- 209
	High number of fruit/plant	125	120- 145
	Large fruit weight (g)	3.2gm	3- 4gm

TABLE 2: Variability among Pepper accessions for the desirable traits

Fruit Type	Desirable character	Range	Mean	CV%
Rodo	Plant height (cm)	25 - 70	44.8	25.1%
	Days to 50% flowering	40 - 68	49.0	21.5%
	Early number of days to 1st harvesting	54 - 70	54.2	10.4%
	Long flowering duration (days)	45 - 90	65.3	20.3%
	Long fruiting duration (days)	55 - 95	74.8	15.5%
	Number of fruit/plant	30 - 62	45.3	24.4%
	Fruit weight	2.0-5.0	3.0	26.3%
Sombo	Plant height (cm)	30 - 70	49.3	16.5%
	Days to 50% flowering	40 - 79	62.1	24.5%
	Early number of days to 1st harvesting	70 -102	92.1	8.4%
	Long flowering duration (days)	90 -200	104.2	25.0%
	Long fruiting duration (days)	95 -215	161.6	24.3%
	Number of fruit/plant	40 -150	96.6	32.1%
	Fruit weight	0.8-4gm	2.0	51.07%
Wewe	Plant height (cm)	35 - 65	45.1	18.4%
	Days to 50% flowering	57 - 84	62.9	11.3%
	Early number of days to 1st harvesting	65 - 84	72.76	8.3%
	Long flowering duration (days)	90 -145	104.1	18.2%
	Long fruiting duration (days)	100 -156	124.1	15.5%
	Number of fruit/plant	28 - 80	46.5	38.3%
	Fruit weight	0.2 - 1g	0.74	51.1%

TABLE 3: Percentage Number of Accessions showing one or more desirable traits for home garden in the three fruit types

No. of desirable characters	Accessions			(% of total Accessions)
	Sombo	Wewe	Rodo	Total
1	25.0	15.4	2.8	43.2%
2	18.0	30.7	17.1	65.8%
3	13.0	15.4	14.3	42.7%
4	-	23.1	11.4	34.5%
5	6.8	7.7	2.8	17.3%
6	-	-	2.8	2.8%
7	2.2	-	-	2.2%
8	-	-	-	-

TABLE 4: Accessions combining 50% or more of the desirable characters for home garden

Rodo	Wewe	Sombo
DA97/422	DT97/414	DA97/381
DT96/317	DT97/186	DT97/212
DT95/276	DA97/452	DA95/147-1
DA97/430	DT95/282	DA97/416
DT97/209		
DA97/370		

Capsicum and Eggplant Newsletter, 19 (2000): 54-57.

MORPHO-CYTOLOGICAL FEATURES OF A HETEROTIC SWEET PEPPER X HOT PEPPER HYBRID: PROMISING FOR PICKLE TYPE CULTIVATION AND RECOMBINANT INBRED LINES (RILs) DEVELOPMENT

Sanjeet Kumar, M.K. Banerjee and G. Kalloo
Indian Institute of Vegetable Research, 1, Gandhi Nagar (Naria), Post.Box # 5002, Post-BHU, Varanasi - 221 005, India. E. Mail: pdveg@x400.nicgw.nic.in

Abstract

Pickle type pepper is a fresh processing market type pepper, commercially cultivated in eastern Uttar Pradesh (India). Fruit size of this type is intermediate between bell shaped sweet pepper and more commonly grown hot pepper (called Simla Mirch and Mirch or chilli in India, respectively). This report describes morphological and cytological features of a sweet pepper ('California Wonder') x hot pepper ('LCA-235') cross, which has been found promising for the cultivation as pickle type. Manifestation of desirable amount of heterosis for yield (111 % and 100.2 % heterosis over MP and BP, respectively) and days to fruit set (-55.3 % and -40.5 % heterosis over MP and BP, respectively) were recorded. Seeds of this cross are being multiplied, to test it under replicated trails. The confirmation of normal meiotic behavior at two stages of meiosis (i.e. MI and AI) and considering involvement of morphologically diverse parents, F_2 plants of this cross are being advanced for the development of RILs.

Introduction

The *Capsicum* species exhibits wide range of morphological and genetic diversity, as even within a particular cultivated species, various horticultural and market types are commercially grown worldwide. One such type of *Capsicum annuum*, namely pickle type (locally called Bharua Mirch) is commercially grown at fairly large scale in eastern Uttar Pradesh (U.P.) India. Pickle type pepper is mainly consumed as pickle and falls in the group of fresh processing market type pepper of the broad classification given by Poulos (1994). The size of the fruit and pungency of pickle type pepper is intermediate between very commonly grown hot pepper and bell shaped sweet pepper (called Mirch or chilli and Simla Mirch, respectively in India). Albeit in recent past, sweet pepper (usually bell shaped) has been introduced and are being cultivated at commercial scale in eastern U.P., hitherto, majority of the pepper growers of this region prefer cultivation of pickle type. This is because of, firstly, pickle type fruits fetches comparatively better price in the market due to their high local demand and, secondly, better adaptability of pickle type land races due to their long history of cultivation in this area. Presently, local land races cover all the areas under pickle type. This is because of non-availability of the pickle type improved variety, since no specific breeding work on the development of improved pickle type pepper was carried out in past. Considering these facts, efforts have been made at this institute to evaluate sweet pepper x hot pepper crosses with the aim to develop heterotic pickle type hybrids. This report highlights the morphological and cytological features of one such cross, which has been found promising for the cultivation as pickle type pepper and also for the development of recombinant inbred lines (RILs).

Materials and Methods

During the season of 1997, a commercial bell pepper cultivar ('California Wonder') was crossed as female parent with a commercially grown chilli cultivar ('LCA-235'). Thirty days old seedlings of parents and F_1 were transplanted during 1998 and observation were recorded on five randomly selected plants on some horticultural characters. Degree of pungency was determined by taste trails. Mid parent (MP) and better parent (BP) heterosis were calculated from the mean observation of each character. Selfed seeds of F_1 plants have been raised and transplanted during current season (i. e.1999) and large numbers of randomly selected F_2 plants are being selfed to facilitate development RILs in subsequent generations through single seed descent method.

For meiotic analysis, appropriate size of flower buds were fixed in 3 : 1 (alcohol : acetic acid), in which few crystals of ferric chloride were added to facilitate proper staining. After 24 hours material was transferred in 90% alcohol and kept till slide preparation. Meiotic slides were prepared after squashing the anthers in 2% acetocarmine solution and observations on pollen mother cells (PMCs) showing metaphase I (MI) and anaphase I (AI) were recorded on meiotic configurations along with chaismata and chromosome segregation pattern, respectively.

Results and Discussion

Average performance of F_1 and parents for all the quantitative characters is given in table 1, along with magnitude of MP and BP heterosis (heterobeltiosis). Besides expression of high amount of heterosis for green fruit yield (111% and 110% for MP and BP, respectively), 50 % fruit set in hybrid plants was found to be very early (21 DAT; days after transplanting) as compared to both the parents viz. 'California Wonder' (59 DAT) and 'LCA-235' (35 DAT), therefore, expressing -55.3 % MP and -40.0 % BP heterosis. Manifestation of MP heterosis and BP heterosis for yield/plant is not attributed due to the increased weight of fruit as evident from expression of negative MP (-46.6 %) and BP (-72.5 %) heterosis for fruit weight. Earlier findings suggest that yield is highly correlated with number of fruits/plant rather than individual fruit weight (Poulos, 1994; Gupta and Yadav, 1984). However, in this hybrid increased yield seems to be attributed mainly by extra early fruiting in the hybrid instead of increased number of fruits/plant. Hence, extra early fruiting habit of F_1 is considered to be most desirable trait of this cross. Expression of mid parent heterosis and heterobeltiosis for earliness leading to increased yield has also been reported by Gopalakrishnan *et al.* (1987).

Fruit size and shape of F_1 plants is presented in figure 1, along with the fruits of parental lines. The average fruit weight and size were recorded as 17 g and 9.5 x 2.0 cm, respectively. Furthermore, fruits of F_1 plants were non-pungent and dark green (turned red at physiological maturity) with thin pericarp. All these fruit traits are ideal for pickle type pepper cultivated in eastern U.P. Hence, the F_1 seeds are being multiplied during this season (i.e. 1999) in order to test its performance along with local pickle type land races (check) under replicated trails. Seed production of this hybrid through hand emasculation is relatively efficient, as large fruited 'California Wonder' with more seeds per fruit is used as seed parent.

Table 1: Performance of parents / F_1 and heterosis of F_1 over mid parent (MP) and better parent (BP)

Parents/F_1	Plant height (cm)	Branches/ plant	Fruit sets*	Fruits/ plant	Fruit weight (g)	Fruit length (cm)	Fruit dia. (cm)	Green fruit yield/plant (g)
C. Wonder	37.2 ± 2.17	13.6 ± 1.07	59	11.2 ± 2.76	62.0 ± 9.30	6.1 ± 0.46	6.50 ± 0.30	696 ± 20.1
F_1	67.4 ± 3.86	14.4 ± 1.36	21	82.0 ± 6.68	17.0 ± 1.83	9.50 ± 0.26	2.00 ± 0.05	1394 ± 12.2
LCA-235	57.8 ± 3.58	2.20 ± 0.46	35	138 ± 17.9	1.75 ± 0.15	4.64 ± 0.12	0.85 ± 0.04	625 ± 36.0
MP (%)	41.8	82.2	-55.3	9.9	-46.6	76.9	-45.6	111.0
BP (%)	16.6	5.8	-40.0	-40.5	-72.5	55.7	-69.2	100.2

* Days after transplanting (DAT), thirty days old seedlings were transplanted

Shifriss and Sacks (1980) hypothesized the use of sweet type cultivars and unrelated hot type cultivars as new potential for developing heterotic hot pepper hybrids, since all the fourteen crosses derived from a common sweet parent and fourteen hot parents examined by them were of hot type. Their result is not in agreement with our result, as our hybrid is of sweet type. This discrepancy can be explained in the light of differences in the parental genotypes utilized during both these studies, which might possess dissimilar combinations of gene(s) and modifiers for pungency. Hence, we speculate that expression of non-pungent trait in cross under report is due to the chance factor, therefore, desirable crosses for traits like pungency etc., which are more influenced by the environmental factors and modifiers genes, should be identified by trail and error. Similar suggestion has been made for the identification of superior crosses for yield, because phenotypic diversity among parents was not related to the heterotic yield performance in pepper (Shifriss and Sacks, 1980).

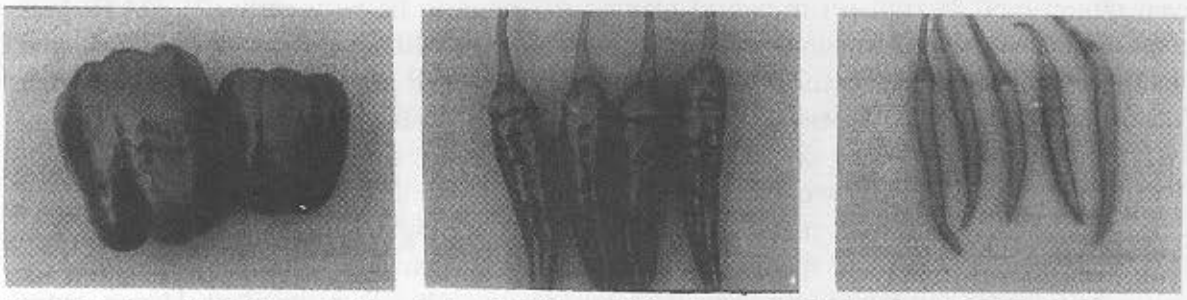


Fig.1: Fruits of 'California Wonder', 'California Wonder' x 'LCA-235' and 'LCA-235'

Table 2: Frequency of meiotic configurations and chaismata at MI in parents and F_1

Parents/F_1	No. of PMCs	Bivalent frequency (range)		Chaismata frequency (range)
		RII	CII	
C. Wonder	23	9.3 (6-12)	2.6 (0-6)	21.9 (18-25)
F_1	25	9.1 (6-12)	2.8 (0-6)	22.1 (19-25)
LCA-235	20	9.9 (7-12)	2.3 (0-5)	22.6 (19-25)

RII & CII: Ring and chain bivalent, respectively

Meiosis of F_1 plant was examined to confirm normal meiotic behavior, so that this cross can be advanced to develop RILs. As expected, meiotic behavior of F_1 plants was found normal and only bivalents were observed at MI with non-significant difference in the chaismata frequency between parents and F_1 (Table 2). Furthermore, 12:12 segregation of meiotic chromosomes was observed at AI in all the PMCs examined (Figure 2). This cross is considered as an ideal material to develop mapping population like RILs, since it is derived from the morphologically very diverse parents and normal chromosome segregation also satisfies one of the assumptions to be fulfilled by material utilized for the development of RILs. Hence, large numbers of randomly selected F_2 plants are being selfed to develop RILs from this cross.

Fig. 2: AI (F_1), showing 12:12 chromosome segregation

References

Shifriss C. and Sacks J.M. 1980. The effect of distance between parents on yield of sweet pepper x hot pepper hybrids, *Capsicum annuum* L. in single harvest. Theor. Appl. Genet. **58**: 253-256.

Poulos J.M. 1994. Pepper breeding (*Capsicum* spp.): achievements, challenges and possibilities. Plant Breed. Abst. **64**: 143-155.

Gopalakrishnan T.R., Gopalakrishnan P.K. and Peter K.V. 1987. Heterosis and combining ability analysis in chilli. Indian J. Genet. Plant Breed. **47**: 205-209.

Gupta C.R. and Yadav R.D.S. 1984. Genetic variability and path analysis in chilli. Genetica Agraria **38**: 425-443.

Capsicum and Eggplant Newsletter, 19 (2000): 58-61.

CHARACTERISTICS OF IMPROVED CHILLI PEPPER CULTIVARS AT SAMARU, NIGERIA

M.D. Alegbejo[1], F.C. Orakwue[2], & S.G. Ado[3]
1 Department of Crop Protection and
2 Department of Plant Science
3 Department of Plant Science
Institute for Agricultural Research
Ahmadu Bello University, Zaria, Nigeria

INTRODUCTION

Chilli pepper is fast becoming a major foreign exchange earner in Nigeria (Anonymous, 1993). It is an important food item consumed in almost every day diet as vegetable and spice. It is extensively used because of its pungency. The pungent principles are present in the flesh and rind as well as the seeds. The fruits are dried in the sun and used hole or powered. It is also used as source made by extracting the fresh pulp by pressure and pickling. In industry it is used in such beverages as gingerale; and its culinary uses are too numerous to mention. Kaduna, Kano and Katsina states contribute substantially to the production of the crop (Alegbejo 1978). Hence the Institute for Agricultural Research Samaru located in Kaduna state collects local and exotic cultivars for evaluation on a regular basis. This trial was conducted to evaluate ten chilli pepper cultivars for good agronomic characteristics (e.g. high yield), early maturity and resistance to pepper veinal mottle Potyvirus (PVMV).

MATERIALS AND METHODS

The two year's trial was conducted at Samaru, northern guinea savanna zone of Nigeria in the 1993 and 1994 wet seasons. Seedlings were raised on heat sterilized soil in a glasshouse. These were watered daily and fertilized with a compound fertilizer N.P.K. (15:15:15). Seven weeks old seedlings were transplanted into the field in the last week of June at 45 cm apart, in two rows 4.5 x 1.2 m) making up a plot. Twenty seedlings were transplanted per plot and each plot made up a replicate. Treatments (pepper cultivars) were arranged in a randomised complete block design with three replicates. Ten pepper seedlings artificially inoculated with PVMV and infested with aphids, Myzus persicae Sulzer were transplanted on a ridge (45 cm apart) in between two adjacent cultivars to serve as source of inoculum. All recommended practices for pepper production (except pesticide application) were observed. PVMV infection was monitored weekly. The following agronomic characteristics, fruit length, plant height, maturity days, and dried fruit yield were taken.

RESULTS AND DISCUSSION

Fruit length ranged from 0.45 to 0.76 cm in 1993, and 0.46 to 0.77 in 1994. Plant height varied from 30.20 to 55.30 cm in 1993 and 30.20 to 55.25 in 1994 (Tables 1 & 2). Maturity days varied from 139 to 165 in 1993 and 140 to 165 in 1994 (Tables 1&2).

Dried fruit yield of 0.4 to 1.03 and 0.42 to 1.05 t/ha were obtained in 1993 and 1994 respectively. Each of the pepper cultivars was either moderately susceptible or highly susceptible to PVMV. These cultivars will be maintained and sent to the varietal release committee of the National Centre for Genetic Resources and Biotechnology, Ibadan for National release to farmers.

REFERENCES

Alegbejo, M.D. 1978. Studies on pepper veinal mottle virus in the northern states of Nigeria. M.Sc. Thesis, Ahmadu Bello University, Zaria. 199P.

Anonymous, 1993. F.A.O. Production year book. F.A.O., U.N.O. Vol 47: 137P.

Table 1. Performance of improved chilli pepper cultivars at Samaru in the 1993 wet season

Pepper Cultivars	Fruit length (cm)	Plant height (cm)	Maturity days	Dried fruit yield (t/ha)	PVMV - infected plants (%)
P-Lalmachi	0.45	55.30	143.00	1.03	31.61
U-Panhanya	0.56	46.40	164.00	1.02	32.90
P-Dan meyere	0.65	35.00	146.00	1.02	34.00
UTC 9 - 14	0.61	41.80	140.00	0.95	30.62
PL 3878	0.67	30.20	145.00	0.85	29.10
U-Dantsiga	0.53	50.50	163.00	0.83	35.12
UY-Dantsiga	0.55	42.10	165.00	0.70	44.51
UK-burgu	0.76	31.50	146.00	0.50	33.50
U-Pusa Jwala	0.53	46.20	155.00	0.45	30.00
P-L2190	0.74	38.00	139.00	0.40	48.00
Mean	0.63	40.50	149.00	0.86	34.30
SD	0.11	7.30	9.20	227	5.31
CV	27.00%	18.00%	6.20%	26.00%	7.00%

Table 2. Performance of improved chilli pepper cultivars at Samaru in the 1994 wet season

Pepper Cultivar	Fruit length (cm)	Plant height (cm)	Maturity days	Dried fruit yield(t/ha)	PVMV-infected plants (%)
P-Lalmachi	0.46	55.25	144.00	1.05	30.25
U-Panhanya	0.54	46.00	165.00	1.00	31.00
P-Danmeyere	0.66	36.10	145.00	1.01	32.45
UTC 9-14	0.62	40.95	141.00	0.94	31.01
PL 3878	0.65	30.00	146.00	0.90	30.20
U-Dantsiga	0.54	50.30	162.00	0.82	33.60
UY-Dantsiga	0.56	42.00	166.00	0.72	43.40
UK-burgu	0.77	32.10	145.00	0.52	32.25
U-Pusa Jwala	0.54	46.00	156.00	0.46	31.00
P-L2190	0.74	38.20	140.00	0.42	47.20
Mean	0.61	40.00	148.00	0.84	34.10
SD	0.10	7.10	9.00	225	5.30
CV	26.5%	17.3%	6.00%	25.5%	6.90%

Capsicum and Eggplant Newsletter, 19 (2000): 62-65.

CHARACTERISTICS AND GROUPING OF F_1 PEPPER (*CAPSICUM ANNUUM L.*) HYBRIDS ON THE BASIS OF CLUSTER ANALYSIS BY MORPHOLOGICAL CHARACTERISTICS OF FRUIT

N. Panayotov, V. Gueorguiev and I. Ivanova

Higher Institute of Agriculture

12 "Mendeleev" Str., 4 000 Plovdiv, Bulgaria

Introduction

In studying the heterosis of pepper a high heterosis effect and a higher adaptability compared to the parent forms was established(Depestre, T. and J. Espinosa,1988). A high heterosis mainly in fruit weight in intracultivar pepper hybrids under the conditions of India was reported by Thomas P. and K. V. Peter (1988). In investigating the characteristics of 6 pepper hybrids 4 of them had significantly longer fruit than the parent forms (Gopalakrishnan, T. R., P. K Gopalakrishnan, K. V. Peter, 1987). The same authors point out the strong changeability in the characteristics in the newly obtained lines of pepper (Gopalakrishnan, T. R., P. K Gopalakrishnan, K. V. Peter, 1987a). Depestre, T. (1988) established a very high inheritance of some parent characteristics in pepper hybrids. According to Cabral, M. J. E. and C.C.C. P. Damiao (1988) the genetic distance between cultivars and hybrids of pepper can be used as a standard for selection of parent couple.

The main purpose of this study was to describe the characteristics of pepper hybrids of Bulgarian and foreign cultivars by the morphological characteristics of the fruit and to group the hybrids and cultivars on the basis of the cluster analysis.

Material and Methods

The trials were carried out in the experimental fields of the Department of Horticulture at the Agricultural University of Plovdiv, Bulgaria. A hybridisation between the following cultivars: 'Zlaten medal 7'(28), 'Kurtovcska kapia 1619'(30), 'Sofijska kapia'(27), 'Kapia 1300'(26), 'Kalinkov 800/7'(22), 'SE-43'(20), 'Doux Marconi Rouge'(21), 'Doux D' Espagne'(24), 'MS-P-509'(23), 'Doux Marconi Sans Semences'(25), 'Doux Marconi Jaune'(29) and 'Corne de Chevre'(30) was made and the hybrid combinations are show in Table 1. To characterise the obtained hybrids in F_1 and the parent form the following characteristics were studied: the cultivars the weight, length, diameter and shape of fruit and thickness of pericarp. The plants were grown by the standard technology in Bulgaria for middle early field production (sowing date – 15 March and transplanting date – 15 May at distance 60 x 15 cm). 30 fruits from the middle stages of different plants were taken randomly for analysis. The analysis of variance were made by Fisher, R. E. , 1958. The estimation of the distance between parents and hybrids by the complex of the studied biometrial characteristics was made on the basis of cluster analysis (Duran, B. and P.Odelle, 1977). The cluster separation was made step by step on the basis of

the minimal distance between the vectors after their normalisation (as a vector we consider the set of fruit parameters, characterizing each hybrid and parent cultivar). As a measure of similarity we used a modified Euclidian distance between the vectors. This was a sum of the common Euclidian distance and a discrete term equal to zero when the shape of the fruits was identical and other than zero when the shape was different. For full compliance with the fruit shape width when grouping the clusters we chose the value of the discrete term higher then the maximum Euclidian distance among the vectors. This made possible the complex studying of the biometrical characteristics.

Results and Discussion

By the studied characteristics a high positive heterosis effect in the analysed hybrids, was establish in the crosses 'Doux D` Espagne' x 'Kalinkov 800/7', 'Kalinkov 800/7' x 'Doux Marconi Sans Semences' (in the reciprocal cross this effect was not established) and 'Doux Marconi Jaune' x 'Kurtovska kapia 1619' (Table 1). The first two hybrids were grouped in a separate cluster. A better character of the fruit, however, compared only to one of the parents, was observed in 'Kapia 1300' in hybridisation with 'Doux D` Espagne' and in 'MS -P- 509' in hybridisation with 'Doux Marconi Rouge'. Reciprocal crosses – 'Doux D` Espagne' x 'Kapia 1300', 'Doux Marconi Sans Semences' x 'Zlaten medal 7', 'Kalinkov 800/7' x 'Doux Marconi Sans Semences' and 'Doux Marconi Rouge' x 'Kapia 1300' had better characteristics of the studied biometrics indices. Applying hybridisation of cultivars with prismatic and conic shape, regardless of whether using them as a female or male component, the fruit shape of the new hybrids was very close to the prismatic shape. The generation of parents with horn and conic shape was not with typical conic shape with elements of horn shape and these hybrids were grouped by the cluster analysis in a separate group.

Eight groups of hybrids and cultivars were formed by the cluster analysis; they are shown as a dendrogramma in Fig. 1. In the first cluster eight parents and nine hybrids were united. The parent cultivars 'Doux Marconi Rouge', 'Zlaten medal 7' and 'Kapia 1300' attracted the highest number of hybrids in this cluster – three from each of them, 'Doux Marconi Jaune' and 'Doux Marconi Sans Semences' – attracted two hybrids and the other three cultivars – 'SE-43', 'MS-P-509' and 'Sofijska kapia' – attracted only one hybrid. In this group the cultivar 'Zlaten medal 7' was a parent with the other cultivars of three hybrids in this cluster - as a female and in the reciprocal cross with 'Doux Marconi Sans Semences' and as a pollinator of 'Doux Marconi Jaune'. The cultivar 'Doux Marconi Rouge', also participated in three combinations as a parent with cultivars with which it was united - two crosses with 'Kapia 1300' and as a pollinator of 'MS-P-509'. This cluster together with the parent couple included the hybrid 'Sofijska kapia' x 'SE – 43' and only one parent – 'Doux Marconi Jaune' – of the hybrid 'Doux Marconi Jaune' x 'Kurtovska Kapia 1619'. One of the uniting elements of this cluster was the shape of fruit – the conic one. In the second cluster four hybrids with prismatic fruit

shape were included. Three hybrids with parent 'Corne de Chevre' were grouped in a separate cluster. 'Doux D' Espagne' x 'Kalinkov 800/7' and 'Kalinkov 800/7' x 'Doux Marconi Sans Semences' were clasified in a separate cluster, which shows a higher influence of the cultivar 'Kalinkov 800/7' in the morphological characteristics of the new hybrids. Another cluster from two cultivars with the same shape included 'Kalinkov 800/7' and 'Doux D'Espagne'. Each of the cultivars 'Kurtovska Kapia 1619' and 'Corne de Chevre' formed a single cluster. The latter cultivar was assorted in a single cluster, because it had very specific shape – a horn one. The hybrid 'MS-P-509' x 'SE –43' was the third single cluster.

Table 1. Morphological characteristics of fruits of the pepper hybrids

N	Hybrids combinations	Weight -g	Length-cm	Diameter-cm	Thickness of pericarp-mm	Shape
1	MS-P-509 x Doux Marconi Rouge	50.00	12.00	3.75	3.1	Conic
2	Kapia 1300 x Doux D'Espagne	79.47	12.70	4.62	3.4	Pricmatic
3	Doux D'Espagne x Kapia 1300	80.06	13.90	4.72	3.5	Conic
4	Doux Marconi Rouge x Kapia 1300	69.54	14.30	3.74	3.2	Conic
5	Kapia 1300 x Doux Marconi Rouge	34.37	12.20	3.54	2.7	Conic
6	MS –P – 509 x Doux Marconi Sans Semences	70.80	10.78	4.50	2.7	Prismatic
7	Zlaten medal 7 x Doux Marconi Sans Semences	25.00	14.00	3.30	3.43	Conic
8	Doux Marconi Sans Semences x Zlaten medal 7	48.42	15.50	3.82	4.0	Conic
9	Doux Marconi Jaune x Zlaten medal 7	47.08	15.20	3.52	4.0	Conic
10	MS-P-509 x Doux D'Espagne	79.31	15.00	5.70	3.8	Prismatic
11	Doux D'Espagne x Kalinkov 800/7	86.66	10.24	4.80	5.5	Prismatic
12	Doux Marconi Sans Semences x Kalinkov800/7	66.66	11.94	4.66	3.5	Prismatic
13	Kalinkov 800/7x Doux Marconi Sans Semences	88.94	15.30	5.54	5.0	Prismatic
14	MS-P-509 x SE-43	65.22	13.40	3.86	5.4	Prismatic
15	Doux Marconi Jaune x Kurtovska kapia 1619	70.94	15.92	4.40	4.8	Conic
16	MS-P-509 x Corne de Chevre	45.35	13.96	3.02	2.9	Conic-horn
17	Sofijska kapia x SE-43	40.83	12.73	2.66	3.2	Conic
18	Sofijska kapia x Corne de Chevre	24.13	11.80	2.10	2.1	Conic-horn
19	Corne de Chevre x Sofijska kapia	23.52	13.90	2.72	3.3	Conic-horn
	5. 0%	7.12	3.27	1.12	0.63	
	GD 1. 0%	9.84	4.37	1.69	0.84	
	0. 1%	13.74	5.74	2.23	1.11	

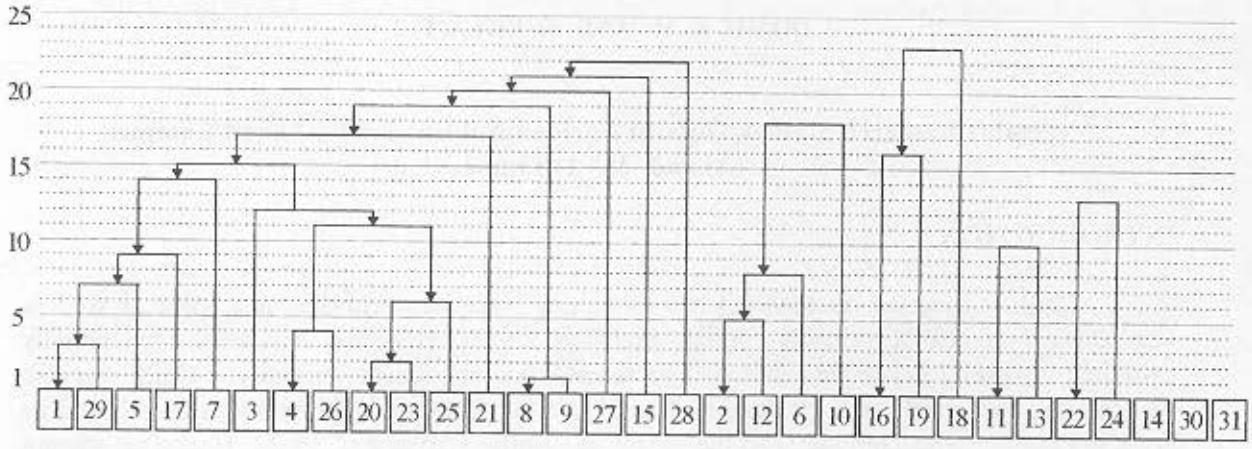


Fig.1 Dendrograme of the pepper hybrids and cultivars clusters.

(1-19-as in Table 1., 20-31- shown in brackets after the name of cultivars in Material and Methods)

Conclusion

As a conclusion it can be pointed out that in three out of the 19 studied hybrids (15.7 %) a high positive heterosis effect was established, as in two of these combinations one of the parents was 'Kalinkov 800/7' and they formed a separate cluster. In analyzing the eight clusters it was found out that the highest effect in the formation of the morphological characteristics of fruit was not only due to the cultivar 'Kalinkov 800/7', but also to the cultivars 'Zlaten medal 7', 'Du Marconi Rouge' and 'Kapia 1300', as the last ones form a common cluster group with the biggest number of their hybrid forms.

References:

1. CABRAL M.J.E. and C.C.C.P. DAMIAO, 1988. Predicao do comportamento de hibridos de pimento pela divergencia genetica dos progenitores. Rev. Brass. Genetics 11: 4: 929-937.

2.DEPESTRE T., 1988. Estudo de la beredabilidad en sentido estrecho en el cultivo del pimento. Agrotecn. Cuba, 20 : 1 : 115-118.

3. DEPESTRE T and J. ESPINOSA, 1988. Estudio del efecto de heterosis en al pimiento (Capsicum annuum L.) en condiciones topicales. Agrotecn. Cuba, 20 : 1 : 87-90.

4. DURAN, B. and P ODELLE , 1977. Cluster analysis. Moscow.

5. FISHER R. E. , 1958. Statisticheskie metodi dlja izsledovatelej. Moskava.

6.GOPALACRISHNAN T.R., P.K. GOPALACRISHNAN and K.V. PETER, 1987. Heterosis and combining ability analysis in chilli. Genet and Plant Breeding, 47 : 2 : 205-209.

7 GOPALACRISHNAN T.R., P.K. GOPALACRISHNAN and K.V. PETER,1987-a. Variability in a set of chilli lines. Agriculture Research Journal Kerala, 25 : 1 : 1-4.

Capsicum and Eggplant Newsletter, 19 (2000): 66-69.

EXPRESSION OF HETEROSIS IN CHILLI (*CAPSICUM ANNUUM* L.)

DOSHI, K. M. AND SHUKLA, P. T.

Vegetable Research Station, Gujarat Agricultural University, Anand Campus, Anand- 388 110,India.

INTRODUCTION

Chilli (*Capsicum annuum* L.) has its unique place in world diet as a spice as well as vegetable. It is also a valuable foreign exchange earner. Heterosis has been commercially exploited in several vegetable crops such as tomato, onion, cabbage, brinjal etc. Chilli can also be exploited by hybrid seeds production. Since the fruit contain a large number of seeds and its cross pollination characteristic is to the extant of 7-60% (Aiyadurai, 1966). Hence an attempt was made to find a suitable cross combination for commercial exploitation of heterosis in chilli.

MATERIALS AND METHODS

The experimental material comprised of ten parents ('S-49', 'Jwala', 'Arkalohit', 'BC-14-2', 'RHRC-50-1', 'RHRC-16-5', 'SG-5', 'ACS-92-3', 'Guchhedar' and 'Balochpur') and their diallel crosses excluding reciprocals. The F_1 seedlings along with their parents were planted in a randomized block design with three replications, at Vegetable Research Farm, GAU, Anand during *kharif* 1998. Each entry had single row plot of 7.2 m length, with 60 x 60 inter and intra row spacing. Five competitive plants from each entry were selected at random and data recorded for various metric and quality characters (Table 1). Heterosis over mid parent and better parent was worked out as per the standard procedure given by Turner (1953) and Fonesca and Patterson (1968), respectively.

RESULTS AND DISCUSSION

The range for mean performance, heterosis over mid parent and heterosis over better parent are presented in Table 1. The maximum range of mean performance for parents and crosses was observed for total capsaicin content, fresh fruit yield per plant and fruits per plant. The range of various heterotic effects was high for fruits per plant, fruit length, fruit girth, fruit shape index and fruit volume.

Considering the heterosis effects, the number of crosses having desirable heterosis were more with primary branches per plant, fruits per plant, fruit length, fruit girth, fruit shape index, fruit volume and fresh fruit yield per plant. The magnitude of desirable heterobeltiotic effect was high with the attributes, fruits per plant, fruit length, fruit girth, fruit shape index, fruit volume and fresh fruit yield per plant. The negative heterosis observed in some of the crosses may be attributed to non-allelic interaction, which can either increase or decrease to expression of heterosis.

A perusal of the top heterotic crosses revealed that not a single cross showed heterosis for all the characters (Table 2). Out of the 45 crosses studied none of the crosses showed significant positive heterobeltiosis for fruit weight and total chlorophyll. The cross BC-14-2 x RHRC-50-1 showed highest heterosis and heterobeltiosis for fruit girth and days to maturity. For fresh fruit yield, 29 F_1's exhibited significant desired heterobeltiosis, of which the crosses, RHRC-16-5 x Guchhedar had the highest value. The crosses, S-49 x RHRC-16-5, Arkalohit x Balochpur, Arkalohit x ACS-92-3, BC-14-2 x SG-5 and BC-14-2 x RHRC-16-5

showed the maximum estimates of all the heterotic effects for days to flowering, plant height, fruit length, fruit shape index and fruit volume, respectively. Only single cross RHRC-50-1 x RHRC-16-5 showed significant positive heterobeltiosis for total capsaicin content, which also had significant positive heterobeltiosis for fruits per plant. The cross Jwala x Guchhedar recorded the highest heterobeltiotic effects for primary branches per plant. For primary branches per plant, fruits per plant, fruit weight, total chlorophyll, total capsaicin content and fresh fruit yield, none of the cross was consistent. Similar results were reported by Joshi *et al.*, (1995), Patel *et al.*, (1997) and Singh *et al*, (1992).

In the present investigation considerable amount of heterosis was observed in desired direction for all the characters except fruit weight and total chlorophyll. The amount of heterobeltiosis was high (30%<) with majority of the crosses. From the above study to become clear that promising hybrids could be obtained in chillies. To make hybrid seed production economical and swift, it is necessary to develop promising ms lines.

REFERENCES

AIYADURAI, S. G., 1966. A review work on spices and Cashewnuts in India Ernakulum-6, ICAR. In spices Vol. 1.

FONESCA, S. AND F. L. PATTERSON, 1968. Hybrid vigour in a seven parents diallel cross in common wheat. *Crop Sci.*, **8** : 85-88.

JOSHI, S.; THAKUR, P. C. AND T. S. VERMA, 1995. Hybrid vigour in bell shaped paprika (*capsicum annuum* L.). *Veg. Sci.*, **22** : 105-108.

PATEL, J. A.; SHUKLA, M. R.; DOSHI, K. M.; PATEL, S. B. AND S. A. PATEL, 1997. Hybrid vigour of quantitative traits in chilli (*capsicum annuum* L.). *Veg. Sci.*, **24** : 107-110.

SINGH, J.; SINGH, T. AND D. S. KHURVE, 1992. Heterosis studies in chillies. *Veg. Sci.* **19** : 161-165.

TURNER J. H., 1953. A study of heterosis in upland cotton, combining ability and inbreeding effects. *Agron. J.*, **45** : 487-490.

Table 1 : Range of parents, crosses and heterosis along with better parents in chilli

Characters	Range				Better parents (Based on *per se* Performance)
	Per se Performance		Heterosis (%)		
	Parents	Crosses	Mid Parent	Better Parent	
Days to flowering	51.67 to 75.00	46.67 to 71.33	-22.56 to 23.55	-26.34 to 17.44	RHRC-50-1 (51.67) Jwala (57.33)
Plant height (cm)	45.67 to 94.00	50.67 to 94.00	-26.89 to 26.46	-31.56 to 24.23	RHRC-50-1 (94.00) RHRC-16-5 (82.33)
Primary branches per plant	4.00 to 6.67	3.67 to 8.67	-31.25 to 51.72	-45.00 to 35.29	Arkalohit (6.67) S-49 & Balochpur (6.33)
Fruits per plant	84.00 to 416.33	103.00 to 736.33	-2.76 to 107.62	-41.31 to 78.81	Arkalohit (416.33) Guchhedar (302.67)
Fruit length (cm)	4.50 to 15.00	4.83 to 15.17	-44.39 to 72.89	-53.33 to 57.14	Balochpur (15.00) S-49 (12.50)
Fruit girth (cm)	2.00 to 6.17	2.43 to 6.60	-40.00 to 65.85	-44.00 to 61.90	SG-5 (6.17) RHRC-16-5 (4.17)
Fruit shape index	1.27 to 6.07	1.17 to 6.27	-50.91 to 71.79	-70.33 to 67.50	Jwala (6.07) Balochpur (4.30)
Fruit volume (cc)	2.17 to 11.17	2.17 to 7.17	-40.91 to 132.26	-55.22 to 100.00	SG-5 (11.17) Balochpur (7.33)
Fruit weight (g)	1.46 to 7.33	1.54 to 7.53	-43.90 to 30.68	-63.11 to 8.36	Balochpur (7.33) S-49 (5.21)
Days to maturity	91.00 to 133.00	86.33 to 131.00	-20.55 to 18.91	-32.03 to 5.28	BC-14-2 (91.00) Jwala (94.67)
Total chlorophyll mg/100g	16.98 to 47.25	18.47 to 46.18	-13.71 to 20.63	-37.85 to 2.13	ACS-92-3 (47.25) RHRC-16-5(44.37)
Total capsaicin content µg/g	44.67 to 2233.0	480.33 to 2120.0	-16.80 to 27.50	-56.73 to 1.63	BC-14-2 (2233.00) Guchhedar (1558.67)
Fresh fruit yield per plant (g)	346.67 to 860.0	593.33 to 1140.00	-8.03 to 77.97	-19.23 to 57.53	Arkalohit (860.00) S-49 (780.00)

Figures in parentheses indicates *Per se* Performance .

Table 2 : Most heterotic crosses for thirteen characters in chilli

Characters	No. of hybrids having significant heterotic effect (based on BP)		Best hybrids based on	
	Positive	Negative	Mid parent	Better parent
Days to flowering	3	39	S-49 X RHRC-16-5 (-22.56)	S-49 X RHRC-16-5 (-26.34)
Plant height (cm)	4	27	Arkalohit X Balochpur (26.46)	Arkalohit X Balochpur (24.23)
Primary branches per plant	12	11	Jwala X RHRC-50-1 (51.72)	Jwala X Guchhedar (35.29)
Fruits per plant	24	7	S-49 X Guchhedar (107.62)	RHRC-50-1 X RHRC-16-5 (78.81)
Fruit length (cm)	8	22	Arkalohit X ACS-92-3 (72.98)	Arkalohit X ACS-92-3 (57.14)
Fruit girth (cm)	9	19	BC-14-2 X RHRC-50-1 (65.85)	BC-14-2 X RHRC-50-1 (61.90)
Fruit shape index	6	24	BC-14-2 X SG-5 (71.79)	BC-14-2 X SG-5 (67.50)
Fruit volume (cc)	5	29	BC-14-2 X RHRC-16-5 (132.26)	BC-14-2 X RHRC-16-5 (100.00)
Fruit weight (g)	-	37	BC-14-2 X RHRC-16-5 (30.68)	S-49 X SG-5 (8.38)
Days to maturity	2	34	BC-14-2 X RHRC-50-1 (-20.55)	BC-14-2 X RHRC-50-1 (-32.03)
Total chlorophyll mg/100g	-	25	Arkalohit X Balochpur (20.63)	S-49 X Balochpur (2.13)
Total capsaian content µg/g	1	43	Jwala X SG-5 (27.50)	RHRC-50-1 X RHRC-16-5 (1.63)
Fresh fruit yield/plant (g)	29	4	BC-14-2 X SG-5 (77.97)	RHRC-16-5 X Guchhedar (57.53)

Figure in parentheses indicates heterosis (%) value.

Capsicum and Eggplant Newsletter, 19 (2000): 70-73.

HETEROSIS AND INHERITANCE OF QUANTITATIVE CHARACTERS IN RED PEPPER FOR GRINDING (*C. ANNUUM L.*)[1]

Velichka Todorova
The Maritsa Vegetable Crops Research Institute, 4003 Plovdiv, Bulgaria

ABSTRACT

The heterosis and inheritance of four significan morfological fruit characters have been studied. 'Gorogled 6' was tested as mother, while 'Buketen 50', 'Negral', 'Belrubi' and'Kalocsai 801' as father parents. In all F_1 hybrids was established negative heterosis compared to the average of both parents for weight and usable fruit part. For the usable fruit part in all crosses was found overdominance of the parent with lower values. The depression in F_2 varies most highly for fruit weight. The weight and usable fruit part vary most strongly by genotype variability. The inheritance coefficient in a broad sense is the highest for the usable fruit part (0.8 - 0.9).

INTRODUCTION

The studies in pepper for inheritance of quantitative characters are of essential importance for the breeding process. The heterosis manifestations show great differences depending on studied characters, the materials used and various regions (Milkova 1981, Lee et al. 1989, Todorov 1995, Zhou et al. 1995).

The purpose of our study was to obtain information for the inheritance and heterosis in red pepper for grinding.

MATERIAL AND METHODS

For mother parent (P_1) we have used the Bulgarian variety 'Gorogled 6', and for father ones (P_2): 'Buketen 50' from Bulgaria, 'Negral' and 'Belrubi' from Spain and 'Kalocsai 801' from Hungary. The plants from parent forms and hybrid generations were grown in 1997 in polyethylene houses - isolators.

The characters: 1 fruit length (cm), 2 diameter at fruit base (cm), 3 fruit weight (g) and 4 usable fruit part (per cent) have been studied. In parents, F_1 and backcross progenies (BCP_1 and BCP_2) were analysed fruits from 20 plants, in F_2 from 80 to 150 plants. The generation average x, dispersion σ^2 (Genchev et al. 1975), hypothetic heterosis (compared to the average of both parents - MP), true (from better in breeding aspect parent - BP) and depression (Omarov 1975) were calculated. The significance of differences among the average arithmetical of parents, heterosis and depressionis determined by Student's t criterion. The structure of phenotype variation in F_2 expressed by genotype σ^2g and ecological variance σ^2e and the inheritance in a broad sense H^2 have found after Rokitskii(1974). The inheritance in F_1 was determined by d/a ratio of Mather and Jinks(1971).

RESULTS AND DISCUSSION

The parent varieties 'Gorogled 6', 'Negral' and 'Belrubi' distinguished significantly by fruit length (Table 1 and 2). In fruit diameter the mother variety does not distinguish

[1] Acknowledgments. The study was partially financed by EC - CIPA CT-94-0222 Joint Research Project "Copernicus'94".

Table 1
Generation average and dispersion

Cha racter	P_1		P_2		F_1		F_2		BCP_1		BCP_2	
	x	σ^2	x	σ^2	x	σ^2	x	σ^2	x	σ^2	x	σ^2
	Gorogled 6 x Buketen 50											
1	10.3	0.93	10.5	0.57	10.7	0.82	10.8	2.65	10.5	1.06	10.5	1.55
2	3.4	0.06	3.0	0.04	3.0	0.10	3.3	0.23	3.6	0.25	3.4	0.19
3	25.7	12.22	25.6	8.89	21.6	14.24	28.6	106.17	21.4	15.53	30.7	53.38
4	92.1	1.08	91.4	1.12	89.2	5.50	91.3	20.90	88.6	16.94	92.3	14.88
	Gorogled 6 x Negral											
1	10.3	0.93	3.1	0.30	9.5	1.77	9.2	2.80	10.2	2.19	5.3	1.13
2	3.4	0.06	4.2	0.16	3.4	0.14	3.4	0.26	3.4	0.15	4.0	0.22
3	25.7	12.22	28.5	20.05	23.0	20.47	26.8	60.36	19.2	19.36	27.0	22.42
4	92.1	1.08	92.8	1.48	91.0	3.05	90.9	10.95	89.1	6.26	91.7	6.05
	Gorogled 6 x Belrubi											
1	10.3	0.93	15.3	2.35	12.5	1.85	11.2	3.41	10.2	2.12	12.6	2.42
2	3.4	0.06	3.3	0.10	3.1	0.19	2.9	0.36	2.8	0.20	2.8	0.20
3	25.7	12.22	54.4	35.42	25.0	27.10	27	100.90	18.9	13.46	38.8	47.08
4	92.1	1.08	95.0	1.19	91.6	3.15	90.0	14.93	89.0	4.56	94.4	2.72
	Gorogled 6 x Kalocsai 801											
1	10.3	0.93	10.3	1.07	10.3	1.69	8.9	2.15	9.8	1.88	10.8	1.64
2	3.4	0.06	2.5	0.14	2.9	0.22	2.7	0.31	3.1	0.18	2.9	0.29
3	25.7	12.22	17.8	8.87	16.6	15.20	14.9	23.70	14.8	17.57	17.2	21.57
4	92.1	1.08	88.5	3.96	87.3	7.47	85.1	22.86	85.7	19.29	86.9	16.12

considerably only 'Belrubi'. 'Gorogled 6' statisticaly significant is distinguished from Belrubi and 'Kalocsai 801'($P < 0.001$) and 'Negral' ($P < 0.05$) by weight and usable fruit part.

In all F_1 hybrids is observed negative hypothetic heterosis effect in fruit weight and usable fruit part with different degree significance. In the case of fruit length and diameter is not observed significant heterosis towards MP. In the crosses of 'Gorogled 6' with 'Negral', 'Belrubi' and 'Kalocsai 801' in F_1 is observed intermediate inheritance for fruit length, which is in support of the reported from Setiamiharadja et al (1990). The same author reports that fruit diameter is inherited with almost complete dominance of one of the parents. Such realationship in this character we have established only with crosses of 'Gorogled 6' with 'Buketen 50' and 'Negral'. Our results for fruit weight do not confirtm the high heterosis towards better parent reported by Lee et al.(1989). Data for true heterosis show, that significant such one there is only for fruit weight and usable part in 'Gorogled 6' x 'Buketen 50' F_1, but it is negative sign and it would not be of interest for practical purposes. By these two characters the inheritance in F_1 expressed through d/a shows overdominance of the parent with lower values in all crosses excluding 'Gorogled 6' x 'Belrubi' F_1 for fruit weight which dominates completely. Such one-way trend in the inheritance in F_1 is not typical for the remaining two characters. The depression in F_2 by fruit length and usable fruit part is with the highest values in 'Gorogled 6' with 'Belrubi' and 'Kalocsai 801' and is with statistic significance. Out of all characters it varies the greatest in fruit weight (-24.3 per cent up to 11.6 per cent). The genotype variability in F_2 has the greatest variation for fruit weight and usable part. The inheritance coefficient is comparatively high as for the studied characters it varies from 0.4 to 0.9. For fruit length and width in separate hybrids it alters from 0.4 to 0.7 which is in support of the found by Zhou et al (1995). The obtained values of H^2 for fruit weight are close to these ones of Milkova (1981). In all crosses it is the highest for usable fruit part (0.8 - 0.9).

REFERENCES

GENCHEV G., E. MARINKOV, V. YOVCHEVA, A. OGNYANOVA,1975. Biometrical methods in the plant-growing, genetics and breeding. Zemizdat. S. /in Bulgarian/

LEE Y.M.,D.Y.SHIM, KWON B.S.,1989.Heterosis of quantitative character in pepper (*Capsicum annuum L.*). Korean Journal of Breeding. v. 21(1). p.28-34.

MILKOVA L.,1981. Inheritance of some quantitative characters in pepper(*Capsicum annuum L.*).Genetics and Plant Breeding. v.14. N 1. p. 35 - 40. /in Bulgarian/

OMAROV D.S.,1975.Agricultural biology. X. 1. 123-127./in Russian/

ROKITSKII P.F., 1974. Introduction in the statistic genetic. Minsk./in Russian/

SETIAMIHARADJA R., D.E. KNAVEL, 1990. Association Of Pedicel Length And Diameter With Fruit Length And Diameter And Ease Of Fruit Detachment In Pepper. Journal of the American Society for Horticultural Science. v.115(4). p. 677-681.

TODOROV J., 1995. Inheritance of the height of red pepper plants for grinding. Eucarpia IX th meeting on Genetics and Breeding on Capsicum and Eggplant. p.99 - 102

Table 2

Heterosis and inheritance in F_1 and F_2

Characters	t exp. P_1 - P_2	F_1 heterosis %			F_2 depression %	$\sigma^2 g$	$\sigma^2 e$	H^2
		MP	BP	d/a				
'Gorogled 6' x 'Buketen 50'								
1	0.77	2.8	1.8	2.86	- 0.4	1.9	0.8	0.7
2	5.18***	-6.9	-1.0	- 1.16	- 10.1***	0.2	0.1	0.7
3	0.15	-15.5**	-15.3***	- 53.07	- 24.3***	94.4	11.8	0.9
4	2.08*	-2.8**	-2.4**	- 7.45	- 2.3 **	18.3	2.6	0.9
'Gorogled 6' x 'Negral'								
1	29.19***	42.5***	0	0.79	3.1	1.8	1.0	0.6
2	8.15***	-11.7	-0.3	-1.03	-2.9	0.1	0.1	0.5
3	2.20*	-14.9**	-10.3*	-2.89	-13.8**	42.8	17.6	0.7
4	2.10*	-1.6*	-1.2	-3.87	0.1	9.1	1.9	0.8
'Gorogled 6' x 'Belrubi'								
1	12.29***	-2.3	0	-0.12	12.1***	1.7	1.7	0.5
2	0.78	-8.0	-7.0	-7.43	4.8	0.2	0.1	0.7
3	18.63***	-37.7***	-2.9	-1.05	-7.4	76.0	24.9	0.8
4	8.83***	-2.0	-0.5	-1.29	1.9**	13.1	1.8	0.9
'Gorogled 6' x 'Kalocsai 801'								
1	0.16	0.2	0	0.8	16.5***	0.9	1.2	0.4
2	8.84***	-0.5	0	-0.02	5.8	0.2	0.1	0.7
3	7.60***	-23.8***	-7	-1.32	11.6	11.6	12.1	0.5
4	7.19***	-3.3**	-1.3	-1.63	2.7**	18.7	4.2	0.8

* P=0.05; ** P=0.01; *** P=0.001

Capsicum and Eggplant Newsletter, 19 (2000): 74-77.

HETEROSIS STUDIES FOR FRUIT YIELD AND SOME ECONOMIC CHARACTERS IN SWEET PEPPER *(Capsicum annuum* L.)

Ahmed, N. and Muzafar Hurra
Division of Olericulture, Sher-e-Kashmir University of Agricultural Sciences and Technology, Srinagar – 191 121 Jammu & Kashmir, India

INTRODUCTION

Sweet pepper *(Capsicum annuum* L.) is a high value crop grown commercially in almost all parts of India for its large green blocky fruits which are used as vegetable. The demand for its fruits is increasing with ever increasing population. Exploitation of heterosis in sweet pepper has been recognised as a practical tool in providing the breeders a means of increasing yield and other economic trails (Joshi 1986; Ahmed *et al.* 1996). Considering the importance of sweet pepper, the present study was undertaken with a view to find out the heterotic response in this crop.

MATERIAL AND METHODS

The experimental material comprised eight diverse lines of sweet pepper (KSPS-464, HC-202, KSPS-4, World Beater (WB), KSPS-461, KSPS-13, Vinedale and HC-201) each crossed to three testers namely California Wonder (CW), Oskash and KSPS-2 during 1996 to develop 24 F_1's. The 11 parents (8 lines and 3 testers) along with 24 F_1's were evaluated during 1997 at Vegetable Experimental Farm, Sher-e-Kashmir University of Agricultural Sciences and Technology, Srinagar in a randomized block design with three replications. In each replication 10 plants each of F_1's and parents were planted in a single row at a spacing of 60 cm between rows and 45 cm between plants within the row. The observations were recorded on five randomly selected plants of each entry for 12 different characters namely days to first fruit set, plant height (cm), plant spread (cm), number of branches per plant, fruit length (cm), fruit girth (cm), pericarp thickness (mm), fruit number per plant, weight per fruit (g) and fruit yield per plant (g).

The heterotic effects were computed as the proportion of deviation of F1 mean values from the better parent (BP) i.e. heterobeltiosis and standard parent (SP) i.e. standard heterosis. The significance was tested by usual method. The better parents were established individually for each character based on their superior mean performances and the commercial cultivar KSPS-2 was used as standard parent. For days to first fruit set (earliness) the parents and the crosses showing low means and negative heterosis were considered desirable while for rest of the traits higher mean values and positive heterosis were considered desirable.

RESULTS AND DISCUSSION

Analysis of variance showed significant differences among parents, crosses and parents vs crosses for the characters (Table-1) indicating sufficient genetic variability whereas significance of parents vs crosses revealed the presence of directional dominance indicating heterosis. Manifestation of heterosis over BP and SP was observed for all the characters and the number of hybrids showing significant heterosis over BP and SP are shown in Table-2. The number of crosses, which exhibited significant desirable heterosis over BP were 13 each for plant height and

plant spread, 7 for branch number, 6 each for fruit length and fruit weight, 1 for fruit girth, 10 for pericarp thickness, 19 for fruit number and 17 for fruit yield. Whereas over standard parent (SP) KSPS-2, the crosses with significant desirable heterosis were 1 each for days to first fruit set and fruit weight, 23 each for plant height and fruit number, 21 for plant spread, 7 for branch number, 10 for fruit length, 8 each for pericarp thickness and fruit yield. Heterosis observed for most of the characters was high and was in varying proportion probably due to dominance gene effects rather than additive genes and it was high especially in crosses involving diverse parents which suggests that diversity based on plant type can be effectively used for exploitation of heterosis. Further there was close agreement between *per se* performance and heterosis as the crosses which showed high mean performance also possessed greater heterosis percentage both over better as well as standard parents. Such positive relationship would be very useful in heterosis breeding for isolating successful hybrids. Out of 24 hybrids, only one hybrid namely Vinedale x Oskash revealed significant desirable negative heterosis (-16.66) over standard parent KSPS-2 and was about 7 days earlier than both BP and SP. The cross KSPS-461 x KSPS-2 had highest mean and exhibited maximum desirable heterosis both over BP and SP for plant height and plant spread. The other best crosses for these characters were Vinedale x Oskash and KSPS-464 x Oskash. For number of branches per plant the crosses KSPS-4 x CW (29.69% and 23.98%), KSPS-461 x Oskash (19.16% and 21.69%) and KSPS-13 x CW (26.27% and 20.71%) were superior and possessed higher mean values than either better or standard parents besides revealing significant positive heterosis. Similar results were reported by Joshi (1986) and Lee *et al.* (1989). With regard to fruit length the cross combinations KSPS-461 x CW (55.00%), KSPS-461 x Oskash (48.05%) and KSPS-464 x Oskash (39.30%) exhibited highest positive heterosis over SP with highest mean fruit length of 11.16 cm, 10.66 cm and 10.03 cm respectively; but for fruit girth only one cross namely HC-201 x Oskash showed significant desirable heterobeltiosis. Similar pattern of heterosis was established by Ahmed *et al.*(1994) and Singh *et al.* (1992).

Among 24 crosses, three crosses namely KSPS-13 x CW, KSPS-13 x Oskash and WB x KSPS-2 revealed highest pericarp thickness of 5.60 mm, 4.86 mm and 4.86 mm respectively and maximum positive heterosis of 37.93% and 31.45%; 19.7% and 15.71% and 19.70% and 10.45% over BP and SP respectively. The cross combination KSPS-461 x KSPS-2 showed highest positive heterosis of 71.73% both over BP as well as SP for number of fruits per plant and recorded highest number of fruits (20.66) followed by KSPS-461 x Oskash with the heterosis of 66.50% over SP and 42.76% over BP and mean of 20.03 and WB x Oskash with the heterosis of 60.25% over SP and 42.55% over BP and mean of 20.00. Similarly for weight per fruit the top heterotic cross was observed to be KSPS-461 x Oskash with the heterosis of 10.95% over SP and 47.93% over BP and had the most ideal mean fruit weight of 67.47 g. Eight hybrids over SP and 17 over BP exhibited desirable positive heterosis for fruit yield per plant. The heterosis was as high as 83.53% and 174.52% over SP and BP respectively. The hybrids KSPS-461 x Oskash, KSPS-461 x KSPS-2, KSPS-461 x CW, KSPS-13 x CW and HC-201 x KSPS-2 revealed highest heterosis of 83.53% and

174.52%; 62.83% and 62.83%; 45.70% and 117.32%; 36.16% and 91.81% and 33.63% and 33.63% over SP and BP respectively with highest fruit yield of 1377.0, 1221.7, 1093.2, 1021.6 and 1002.6 g per plant respectively. Hybrid vigour for fruit yield in sweet pepper has been reported earlier by several workers (Kaul and Sharma,1988; Joshi *et al.* 1995, and Ahmed *et al.* 1996) who attributed increase yield in F_1 hybrid due to overdominance coupled with non-additive gene effects.

Among lines the genotype KSPS-461 which when crossed to all the testers CW, Oskash and KSPS-2 resulted in most heterotic combinations and thus proved to be the best female parent followed by line KSPS-13. Among testers though all the three were important for most of the characters however tester Oskash resulted in superior heterotic combination especially for fruit yield and number followed by tester KSPS-2 and thus proved as elite pollen parents.

The crosses especially KSPS-461 x Oskash, KSPS-461 x KSPS-2, KSPS-461 x CW, KSPS-13 x CW and HC-201 x KSPS-2 which recorded maximum positive heterosis and high fruit yield were also heterotic for most of the economic characters like number of fruits per plant, weight per fruit, fruit length, number of branches per plant, plant height and plant spread. Since most of the yield attributing characters are positively associated and have direct effect on yield, it appears that the high heterosis observed for yield in the above crosses is a result of combined heterosis of yield attributing traits. Joshi (1986) and Ahmed *et al.* (1996) while working with sweet pepper also made similar observations. Exploitation of hybrid vigour even in absence of male sterile system in this crop is economically feasible as it produces very high seed number per fruit from single pollination. The seed rate per hectare being 0.75 to 1.0 kg, its requirement could easily be achieved by manual crossing of parents of heterotic combinations. It is therefore suggested that the hybrids namely KSPS-461 x Oskash, KSPS-461 x KSPS-2, KSPS-461 x CW, KSPS-13 x CW and HC-201 x KSPS-2 which revealed most significant desirable heterosis for yield and yield contributing characters can successfully produced and exploited under temperate regions of our country.

REFERENCES

Ahmed N., Khan S.H. and Tanki M.I. 1996. Studies on exploitation of heterosis in sweet pepper *(Capsicum annuum* L.). Proceedings National Symposium Plant Sciences Research present status and future challanges. Page 68-69 CCS HAU, Hisar, India.

Joshi S. 1986. Results of heterosis breeding on sweet pepper *(Capsicum annuum* L.). *Capsicum Newsletter* **6** : 49-50.

Joshi S; Thakur P.C. and Verma T.A. 1995. Hybrid vigour in bell shaped paprika *(Capsicum annuum* L.). *Vegetable Science* **22** (2) : 105-108.

Kaul B.L. and Sharma P.P. 1988. Heterosis and combining ability studies for some fruit characters in bell pepper *(Capsicum annuum* L.). *Vegetable Science* **15** (2) : 171-180.

Lee Y.M; Shim D.Y. and Kuon B.S. 1989. Heterosis of quantitative characters in pepper *(Capsicum annuum* L.). *Korean Journal of Breeding* **21**(1) : 28-34.

Singh Y; Singh T. and Khurana D.S. 1992. Heterosis studies in chillies *(Capsicum annuum* L.). *Vegetable Science* **19**(2) : 161-165.

Table 1: Analysis of variance for different characters

Source	d.f.	Mean square								
		Days to first fruit set	Plant height	Plant spread	Branch number	Fruit length	Fruit girth	Pericarp thickness	Fruit number	Fruit weight	Fruit yield/plant
Parents	10	48.76**	798.22**	38.76**	0.89**	12.39**	3.24**	0.84**	11.45**	583.90**	52060.24**
Crosses	23	20.03	69.69**	43.59**	1.73**	7.81**	1.03**	1.43**	20.03**	339.94**	174502.03**
Parent vs crosses	1	22.38	4253.34**	501.96**	8.03**	6.59**	0.19**	4.17**	326.84**	599.70**	1588301.66**
Error	68	11.89	14.35	1.99	0.07	0.05	0.02	0.02	0.28	2.19	1215.56

** P < 0.01

Table 2: Number of hybrids showing significant heterosis and best hybrids for each character on the basis of mean and heterosis (%) over BP and SP.

Charaters	No.of hybrids showing significant heterosis		Best hybrids on the basis of		
	BP	SP	Mean	heterosis over BP	heterosis over SP.
Days to first fruit set	0	1	7x10 (23.75), 2x10(30.27)	-	-
Plant height (cm)	13	23	5x11 (54.46), 7x9(50.53) 1x10(50.17)	5x11(43.31), 7x10(42.60) 5x10(29.63)	5x11(56.94), 7x9(45.61) 1x10(44.58)
Plant spread (cm)	13	21	7x9(41.33), 1x10(40.06) 7x10(38.26)	7x10(59.89), 1x10(40.28) 3x11(37.75)	7x9(51.96), 1x10(49.56) 7x10(40.69)
Branch number	7	7	3x9 (7.60), 5x10 (7.46) 5x9 (7.23)	3x9(29.69), 6x9(26.27) 6x11(20.71)	3x9(23.98), 6x9(20.71) 6x11(20.71)
Fruit length (cm)	6	10	5x9 (11.16), 5x10 (10.66) 1x10 (10.03)	6x9(29.03), 4x11(25.41) 8x10(20.61)	5x9(55.00), 5x10(48.05) 1x10(39.30)
Fruit girth (cm)	1	0	4x11(6.16), 6x9 (6.10) 4x9 (6.00)	8x10(24.94)	- -
Pericarp thickness (mm)	10	8	6x9 (5.60), 6x10 (4.86) 4x11(4.86)	3x10(35.29), 6x9(31.45) 2x10(17.35)	6x9(37.93), 6x10(19.70) 4x11(19.70)
Fruit number	19	23	5x11 (20.66), 5x10 (20.03) 4x10 (20.00)	5x11(71.73), 6x9(69.13) 5x9(63.63)	5x11(71.73), 5x10(66.50) 4x10(66.25)
Fruit weight (g)	6	1	5x10 (20.66), 6x11 (61.66) 8x11 (61.40)	5x11(71.73), 2x10(46.13) 8x10(38.38)	5x10(10.95)
Fruit yield (g)	17	8	5x10 (1377.0), 5x11 (1221.7) 5x9 (1093.2), 8x11 (1002.6) 6x9 (1021.6)	5x10(174.52), 5x9 (117.32) 2x10(93.84), 6x9 (91.98) 8x10(68.95)	5x10(83.53), 5x11(62.83) 5x9 (45.70), 6x9(36.16) 8x11(33.63)

Lines: 1. KSPS-464, 2. HC-202, 3. KSPS-4, 4. World Beater 5. KSPS-461, 6. KSPS-13, 7. Vinedale 8. HC201; **Testers** 9. California Wonder, 10. Oskash, 11. KSPS-2.

Capsicum and Eggplant Newsletter, 19 (2000): 78-81.

GENETICS OF YIELD AND ITS COMPONENTS IN CHILLI (*CAPSICUM ANNUUM* L.)

DOSHI, K. M. AND SHUKLA, P. T.

Vegetable Research Station, Gujarat Agricultural University, Anand Campus, Anand- 388 110, India

INTRODUCTION

India is one of the largest producer of chilli (8,32,600 metric tonnes) occupying third place among the vegetable crops in area and production (Anonymous, 1997). A genotype with moderate pungency coupled with amenability for cultivation during most of the season is an ideal dual purpose type of commercial exploitation which could be achieved through intervarietal crossing and selection of improved strains in succeeding generations. For which, knowledge on the genetics and mode of inheritance of various economic traits, which influence the yield, is very much essential. Literature on this aspect is very limited hence, the present study was undertaken to understand the genetic background in the expression of economic characters through diallel technique.

MATERIALS AND METHODS

Ten chilli varieties comprising six pungent and four non-pungent types were crossed in 10 x 10 diallel design in all possible combinations excluding reciprocals during 1997-98. The resultant 45 F_1 hybrids were raised along with their parents in randomized block design, replicated thrice. Forty-five days old seedlings were transplanted at 60 x 60 cm spacing maintaining 12 plants in each cross in each replication. Observations on 13 yield components were recorded in 5 randomly selected and tagged plants in each cross and each replication. Genetic analysis of data was carried out according to Hayman (1954).

RESULTS AND DISCUSSION

The additive component 'D' (Table 1) was significant for all the characters except primary branches per plant. Similarly, the two measures of dominance i.e. 'H_1' (dominance effect) and 'H_2' (proportion of dominance due to positive and negative effect of genes) were significant for all the thirteen traits. The significant D, H_1, and H_2 indicated the existence of both additive and dominant gene actions in the expression of those traits. However, the additive component was in higher proportion than dominant factors for plant height, fruit volume, fruit weight, total chlorophyll and total capsaicin content, indicating preponderance of additive gene action. Similar results was also reported by Ahmed *et al.*, (1982), Rao and Chhonkar (1983), Sekar (1984) and Sarala devi and Arumugam (1999).

The estimate of 'F' value which indicated the relative proportion of the dominant and recessive alleles were positive for all the traits except fruit per plant and

total capsaicin content which indicated more proportion of dominant alleles in the control of those eleven characters. The environmental factor 'E' was significant only for primary branches per plant indicated environmental influences in the expression of this trait.

The proportion of $(H_1/D)^{1/2}$ representing the degree of dominance was more than unity (Table 2) for 8 characters viz., days to flowering, primary branches per plant, fruits per plant, fruit length, fruit girth, fruit shape index, days to maturity and fresh fruit yield per plant indicating the existence of over dominance for these traits and partial dominance for rest of the 5 characters viz., plant height, fruit volume, fruit weight, total chlorophyll and total capsaicin content. Sekar (1984), Joshi (1988), and Sarala devi and Arumugam (1999) also reported similar observations.

The ratio $H_2/4H_1$ was not equal to 0.25 for all the traits under study indicating unequal distribution of positive and negative alleles. The proportion of dominant to recessive genes in controlling the characters as indicated by the ratio KD/KR was more than one for all the traits except fruits per plant and total capsaicin content revealing the presence of high proportion of dominant genes in the control of those yield components. The numbers of genes and gene groups controlling the trait (h^2/H_2) was the maximum for fruits per plant and fresh fruit yield per plant (2-3), while it was less than one for remaining characters.

High heritability was estimated for total capsaicin content, total chlorophyll and fruit weight indicating the less influences of the environment. The present study on genetic analysis of yield and its components suggested pedigree breeding with recurrent selection to exploit both additive and dominance factors simultaneously in the improvement of this crop.

REFERENCES

AHMED, N.; SINGH, J. AND D. S. VIRK, 1982. Inheritance of some quantitative characters in chilli (*capsicum annum* L.). *Capsicum Newsletter*, **1** : 13.

ANONYMOUS, 1997. Agricultural situation in India., **54** : 289.

HAYMAN, B. I.,1954. The analysis of variance of diallel tables. *Biometrics* **10** : 235-244.

JOSHI, S., 1988. Results of genetic analysis in sweet pepper (*capsicum annum* L.). *Capsicum Newsletter*., **7** : 35-36.

RAO, P. N. AND V. S. CHHONKAR,1983. Components of genetic variance for the quantitative characters in chilli. *South India Hort*., **31** : 15-19.

SARALA DEVI, D. AND R. ARUMUGAM, 1999. Genetics of yield components in f_1 generation of chillies (*capsicum annum* L.). *Crop. Res*., **18** : 108-111.

SEKAR, K., 1984. Diallel analysis in chilli. M.Sc. (Hort.) thesis, Tamil Nadu Agricultural University, Coimbatore.

Table 1 : Estimates of genetic parameters in chilli

Character	D	F	H_1	H_2	h^2	E
Days to flowering	54.60** ± 8.74	48.76* ± 20.16	94.48* ± 18.60	69.66* ± 15.81	36.58* ± 10.58	0.41 ± 2.64
Plant height	224.31** ± 16.58	137.61* ± 38.27	180.62** ± 35.30	127.02* ± 30.04	-0.93 ± 20.03	2.66 ± 5.01
Primary branches per plant	0.54 ± 0.42	0.59 ± 1.05	4.23** ± 0.98	3.59** ± 0.83	0.61 ± 0.56	1.11** ± 0.14
Fruits per plant	10797.40** ± 3224.13	-12338.67 ± 7439.04	22078.13** ± 6862.86	17011.41** ± 5832.68	36157.83** ± 3904.17	64.67 ± 972.11
Fruit length	10.39* ± 0.75	2.94 ± 1.72	11.86* ± 1.59	8.03* ± 1.35	2.76* ± 0.90	0.16 ± 0.23
Fruit girth	1.11* ± 0.21	0.63 ± 0.48	2.45* ± 0.45	2.03* ± 0.38	0.13 ± 0.25	0.05 ± 0.06
Fruit shape index	2.11** ± 0.28	1.65* ± 0.64	2.20** ± 0.60	1.60** ± 0.51	-0.01 ± 0.34	0.05 ± 0.09
Fruit volume	7.36** ± 0.45	5.47** ± 1.03	4.85** ± 0.96	3.04** ± 0.82	0.27 ± 0.55	0.05 ± 0.13
Fruit weight	3.32** ± 0.17	0.48 ± 0.41	1.31** ± 0.38	1.15** ± 0.32	0.67** ± 0.22	0.04 ± 0.05
Days to maturity	234.69** ± 32.57	95.92 ± 75.18	361.30** ± 69.33	299.47** ± 58.93	38.95 ± 39.45	0.89 ± 9.82
Total chlorophyll	119.56** ± 1.42	5.36 ± 3.27	14.39** ± 3.02	11.45** ± 2.56	0.80 ± 1.72	1.54 ± 1.43
Total capsaicin conten	298625.33** ± 4283.76	-2047.01 ± 9883.92	34648.41** ± 9118.38	30816.64** ± 7749.61	1978.89 ± 5187.28	18.60 ± 1291.6
Fresh fruit yield per plant	24683.61** ± 2780.91	2239.07 ± 6416.39	54115.5** ± 5919.43	51479.74** ± 5030.89	133777.76** ± 3367.46	766.26 ± 838.47

*, ** significant at 5 % and 1 % level of significance, respectively.

Table 2 : Ratio of genetic parameters in chilli

Character	$(H_1/D)^{1/2}$	$H_2/4H_1$	KD/KR	h^2/H_2	Heritability in narrow sense (%)
Days to flowering	1.32	0.18	2.03	0.53	46.20
Plant height	0.89	0.17	2.03	0.02	67.10
Primary branches per plant	2.78	0.21	1.49	017	22.10
Fruits per plant	1.43	0.19	0.42	2.12	76.60
Fruit length	1.07	0.17	1.31	0.34	72.30
Fruit girth	1.48	0.21	1.47	0.06	44.30
Fruit shape index	1.02	0.18	2.24	0.01	54.00
Fruit volume	0.81	0.15	2.69	0.09	69.40
Fruit weight	0.63	0.22	1.26	0.59	82.20
Days to maturity	1.24	0.21	1.39	0.13	57.00
Total chlorophyll	0.35	0.20	1.13	0.03	93.00
Total capsaicin conten	0.34	0.23	0.98	0.06	95.20
Fresh fruit yield per plant	1.48	0.24	1.06	2.59	48.00

Capsicum and Eggplant Newsletter, 19 (2000): 82-85.

COMBINING ABILITY ANALYSIS FOR FRESH FRUIT YIELD AND ITS COMPONENTS OVER ENVIRONMENTS IN CHILLI (*CAPSICUM ANNUUM* L.).

DOSHI, K.M. AND SHUKLA, P. T.

Vegetable Research Station, Gujarat Agricultural University, Anand Campus, Anand- 388 110, India.

INTRODUCTION

Selection of parents together with the information regarding nature and magnitude of gene effects controlling traits of economic importance leads to desired crop improvement. The knowledge of gene effects and combining ability not only provides information on inheritance of characters but also helps in selection of suitable parents for hybridization and development of promising hybrids for further exploitation. The present investigation was carried out to analyse combining ability of yield and other characters over environments in chilli *(Capsicum annnum* L.) .

MATERIALS AND METHODS

The experimental material comprised of ten parents and their diallel crosses excluding reciprocals . The resulting 55 entries (10 parents and 45, F_1's) were evaluated under *kharif* ans *rabi* season in a randomized block design with three replication at Vegetable Research Farm, Anand during 1998-99. The experimental unit was a single row plot of twelve plants spaced 60 x 60 cm apart for each entry. The observations on fresh fruit yield and its components (Table 1) were recorded on 5 random plants for F_1's and parents. Combining ability analysis was done by Method 2, Model 1 of Griffing (1956). While, Pooled analysis over two environments was done by procedure of Singh (1979).

RESULTS AND DISCUSSION

Highly significant gca and sca variances for all the characters, indicating importance of both additive and nonadditive gene effects. Non significant Gca X E and Significant Sca X E for days to maturity and total chlorophyll indicated that the nonadditive effects were more influenced by environment than the additive effects controlling these traits. Both Gca x E and Sca X E were non significant for fruit girth indicated the phenotypic stability for this trait. The magnitude of σ^2s was greater than σ^2g for fruit girth, fruit shape index, fresh fruit yield and days to maturity, showing that the expression of these characters is predominantly controlled by non additive gene action. However, additive gene action revealed predominant for fruits per plant, fruit length, fruit weight, total chlorophyll and total capsaicin content as these had lower magnitude of σ^2s as compared to σ^2g. These results are in agreement with those of Lippert (1975), Gopalkrishnan *et al.*, (1989) and Patel *et al.*, (1998a).

The estimates of general combining ability effects along with *per se* performance for various characters are presented in Table 2. Gca effects revealed that non of the parent was good general combiner for all the characters. The parents, 'Jwala', 'Arkalohit' and 'Guchhedar' were good general combiners for fruits per plant and fresh fruit yield. The significant gca estimates of parents 'Balochpur' and 'S-49' indicated that they were good combiners for fruit length, fruit shape index and fruit weight. For total chlorophyll and total capsaicin content, 'BC-14-2' and

'Guchhedar' were found to be good combiners . Further 'BC-14-2' also showed significant gca effects for fruit girth and days to maturity.

The top 3 crosses having desired significant specific combining ability effects along with their *per se* performance and heterobeltiosis are listed in Table 3. Most of the crosses having significant sca effects also had high mean values. The cross RHRC-16-5 X Guchhedar recorded significant sca effect and high degree of heterobeltiosis for fresh fruit yield and earliness. The cross combination Arkalohit X Guchhedar exhibited significant sca effect along with higher magnitude of heterosis over better parent for fresh fruit yield and fruits per plant. The F_1 Jwala X ACS-92-3, BC-14-2 X RHRC-50-1 and S-49 X Balochpur recorded significant sca effects as well as significant heterobeltiosis desired for increased fruit length, fruit girth and fruit shape index, respectively. The hybrids SG-5 X Balochpur, BC-14-2 X Balochpur and Arkalohit X BC-14-2 showed significant sca effects for fruit weight, total chlorophyll and total capsaicin content, respectively. It was noted that parents with High X High, High X Low and Low X Low gca effects could produce desirable transgrassive segregants. The complementary epistatic effects in F_1 enhance the desirable plant attributes.

Majority hybrids showed significant sca effects with high heterobeltiosis indicating heterosis breeding will be more effective in this crop. Due to availability of male sterility, hybrid seed production is easy in chilli (Patel *et al.*, 1998b). By transferring the sterility genes in elite inbreds and crossing them with desired parents, commercial hybrid seed production will be economical and quick.

REFERENCES

GOPALKRISHNAN, T.R.; GOPALKRISHNAN, P.K. AND K.V.PETER, 1989. Heterosis and combining ability analysis in chilli. *Indian J. Genet.*, **47** : 205-209.

GRIFFING, B., 1956. Concept of general and specific combining ability. *Aust. J. Biol. Sci.*, **9** : 463-493.

LIPPERT, L.F., 1975. Heterosis and combining ability in red pepper. *Crop Sci.*, **15** : 323-325.

PATEL, J.A.; SHUKLA, M.R.; DOSHI, K.M.; PATEL, B.R. AND S.A. PATEL, 1998a. Combining ability analysis for green fruit yield and yield components in chilli. *Capsicum and Eggplant Newsletter*, **17** : 34-37.

PATEL, J.A.; SHUKLA, M.R.; DOSHI, K.M.; PATEL, S.A.; PATEL, B.R.; PATEL, S. B. AND A.D. PATEL, 1998b. Identification and development of male sterile line in chilli. *Veg. Sci.*, **25** : 145-148.

SINGH, D., 1979. Diallel analysis for combining ability over environments. *Indian J. Genet.*, **39** : 382-388.

Table 1 : Analysis of variance (MS) for combining ability pooled over environments in chilli

Source	d.f.	Fruits per plant	Fruit length	Fruit girth	Fruit shape index	Fruit weight	Days to Maturity	Total chloro-phyll	Total capsa-icin content	Fresh fruit yield/plant
GCA	9	88311.98**	49.99**	5.17**	5.03**	16.32**	1186.67**	691.29**	1812492.36**	106557.11**
SCA	45	4857.62**	4.02**	1.06**	0.57**	0.63**	163.54**	11.94**	16910.60**	13674.36**
Enviro-nment (E)	1	829210.92**	38.40**	1.37**	8.16**	0.09	3626.07**	29.18**	504.37**	6468660.00**
GCA X E	9	10467.33**	1.49**	0.12	0.21**	0.38**	3.49	0.70	225.05**	31934.24**
SCA X E	45	2327.15**	0.47**	0.05	0.11**	0.06**	7.88**	2.09**	428.11**	6550.78**
Error	216	96.75	0.17	0.06	0.05	0.03	2.65	1.31	50.48	595.97
σ^2g	-	3675.64	2.08	0.21	0.21	0.68	49.33	28.74	75518.00	4415.04
σ^2s	-	2380.44	1.92	0.50	0.26	0.29	80.44	5.31	8430.06	6539.19

Table 2 : Estimates of general combining ability effects and *Per se* Performance for 10 chilli varieties pooled over environments

Parent	Fruits per plant	Fruit length	Fruit girth	Fruit shape index	Fruit weight	Days to Maturity	Total chloro-phyll	Total capsaicin content	Fresh fruit yield/plant
S-49	-44.69** (112.67)	0.87** (11.73)	-0.19** (4.42)	0.41** (3.45)	0.79** (4.87)	0.87** (113.67)	-6.06** (22.54)	-99.30** (972.50)	15.22** (575.00)
Jwala	27.46** (235.50)	0.73** (10.53)	-0.56** (2.23)	0.80** (5.25)	-0.39** (2.41)	-8.87** (92.17)	-9.39** (16.77)	9.73** (1218.17)	44.25** (570.00)
Arkalohit	98.18** (318.67)	-1.37** (5.95)	-0.34** (3.08)	-0.17** (2.32)	-0.71** (1.99)	-4.10** (95.67)	5.08** (41.56)	-0.10** (1165.33)	96.61** (636.67)
BC-14-2	-4.08 (197.67)	-2.19** (4.28)	0.22** (3.38)	-0.79** (1.25)	-0.85** (1.37)	-11.89** (88.00)	4.71** (42.76)	530.06** (2215.50)	-126.86** (263.33)
RHRC-50-1	5.41** (158.00)	-1.02** (9.83)	-0.15** (3.77)	-0.25** (2.67)	-0.41** (2.78)	2.08** (122.50)	1.52** (38.05)	81.98** (1338.17)	-37.55** (445.00)
RHRC-16-5	43.02** (240.67)	-0.07 (8.68)	0.05 (4.38)	-0.07 (2.08)	-0.39** (2.71)	2.94** (118.00)	4.01** (43.34)	-41.49** (1125.17)	40.22** (541.67)
SG-5	-81.54** (72.50)	0.98** (8.25)	1.02** (6.38)	-0.37** (1.27)	0.92** (4.39)	-0.61 (111.33)	-4.38** (26.19)	-544.34** (50.00)	-73.66** (305.00)
ACS-92-3	-13.98** (155.33)	-0.13 (6.43)	-0.07 (3.25)	-0.07 (2.02)	-0.03 (2.97)	0.28 (121.83)	4.81** (45.57)	-70.00** (1106.50)	18.14** (515.00)
Guchhedar	60.28** (263.50)	-0.68** (7.37)	-0.42** (3.28)	0.03 (2.32)	-0.55** (2.01)	7.67** (127.00)	3.35** (41.19)	254.09** (1546.17)	52.31** (513.33)
Balochpur	-90.95** (66.33)	2.89** (13.45)	0.44** (3.55)	0.48** (3.73)	1.63** (7.08)	11.62** (126.00)	-3.71** (23.26)	-120.63** (889.17)	-28.66** (413.33)
SE (g_i)	1.91	0.08	0.05	0.04	0.03	0.32	0.22	1.38	4.72

*,** Significant at 5% and 1% level of significance, respectively.

Table 3 : Top three crosses showing sca effects and their *Per se* Performance over environments in chilli

Character	Significant crosses	Sca effects	Mean value	Heterobeltiosis
Fruits per plant	Arkalohit X Guchhedar	91.93**	483.50	51.73**
	BC-14-2 X RHRC-16-5	89.07**	207.83	-13.64*
	S-49 X Guchhedar	84.14**	332.83	26.31**
Fruit length	Jwala X ACS-92-3	2.54**	12.42	17.88**
	Arkalohit X ACS-92-3	2.48**	10.27	59.59**
	Guchhedar X Balochpur	1.79**	13.28	-1.24
Fruit girth	BC-14-2 X RHRC-50-1	1.65**	5.48	45.58**
	S-49 X BC-14-2	1.29**	5.08	48.78**
	ACS-92-3 X Balochpur	1.23**	5.37	51.17**
Fruit shape index	S-49 X Balochpur	1.87**	5.35	43.30**
	S-49 X RHRC-16-5	0.70**	3.65	5.80
	BC-14-2 X SG-5	0.57**	2.03	60.53**
Fruit weight	SG-5 X Balochpur	1.78**	7.29	2.92
	S-49 X SG-5	1.01**	5.67	16.50**
	BC-14-2 X RHRC-16-5	0.85**	2.57	-5.23
Days to maturity	RHRC-16-5 X Guchhedar	-15.54**	102.67	-19.16**
	BC-14-2 X RHRC-16-5	-14.46**	84.17	-28.67**
	BC-14-2 X RHRC-50-1	-13.78**	84.00	-31.43**
Total chlorophyll	BC-14-2 X Balochpur	5.78**	41.76	-2.34
	Arkalohit X Balochpur	4.97**	41.31	-0.59
	S-49 X ACS-92-3	4.22**	38.01	-16.59**
Total capsaicin content	Arkalohit X BC-14-2	247.33**	1965.17	-11.30**
	Jwala X SG-5	175.06**	828.83	-31.96**
	BC-14-2 X Guchhedar	154.60**	2126.50	-4.02**
Fresh fruit yield per plant	RHRC-16-5 X Guchhedar	191.05**	860.00	58.77**
	Jwala X Balochpur	146.33**	738.00	29.53**
	Arkalohit X Guchhedar	117.09**	830.00	30.37**

*, ** Significant at 5 % and 1 % level of significance, respectively,
Figure in parentheses indicates *Per se* Performance.

Capsicum and Eggplant Newsletter, 19 (2000): 86-88.

Macro - mutations in gamma - irradiated chilli (*Capsicum annuum* L.)

L. D. Meshram, M. R. Wandhare, P. L. Kulwal and Swati Bharad.

Cotton Research Unit.

Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola - 444 104

Maharashtra (INDIA).

INTRODUCTION

Induction of mutation by artificial means, like irradiation or any other mutagens results in wider frequency of variability in terms of micro or macro helps a plant breeding programme to build up a material for evolution of crop improvement. The various macro mutation induced by gamma irradiation have been reported in chilli *Capsicum annuum* L. in the present paper.

MATERIAL AND METHODS

Dry seeds of chilli containing 10 - 12 % moisture were irradiated by gamma rays with 10, 20 and 30 kR doses. 100 seeds each were irradiated with each dose. After irradiation, the seeds were sown on the raised beds along with the control to grow the seedling. After 45 days of sowing, the seedlings were transplanted in M_1 generation. For sowing the M_2 generation 100 seeds from each plant from each dose were sown. The visible mutants were isolated and described.

RESULTS AND DISCUSSION

The various morphological mutants recorded in three dose of gamma rays during M_2 generation are given in Table - 1.

From Table - 1 it is seen that the early flowering mutants were observed in 10 kR and 20 kR with the very low frequency Yasoda Raj *et al.* (1972) also reported early flowering mutants in barley. The late flowering mutants were noted in 20 kR and 30 kR doses. Khuspe and Ugale (1977) has also reported such mutants in chilli. The early fruiting & early maturing mutants recorded in the present study have also been noted by Khan & Veeraswamy (1974) and Jones (1965) due to gamma

irradiation. The tall, dwarf, branched type mutants and high yielding mutants have been noted in lower doses of gamma rays. No such mutants were observed in high doses of gamma rays (30kR). Such types of macro mutations were also recorded by many workers.

The leaf forms mutants like small, narrow, long and chlorophyll mutants observed in the present study were also reported by Jones (1965) and Athwal (1963) and chlorophyll mutants by Amano (1972) in chilli.

The variation recorded in frequency of different mutants in M_2 population may be attributed to the indirect role of selection of plants in M_1 generation for raising the M_2 population.

REFERENCES

Amano, E. 1972. Mutation experiment on *Capsicum annuum* National Inst. of Genet Japan : Annual report - Mishima ; Japan (1971) (Abst. P. B. **42** 7017).

Athwal, D. S., 1963. Some X - ray induced and spontaneous mutations in Cicer. The Indi. J. of Genet. and Plant Breed. **23** (1) : 50 - 57.

Jones, S. T., 1965. Radiation induced mutation in southern Pea (Cowpea) J. Hered. **56** : 273 - 276.

Khan Mohamad Ali and Veeraswamy, R., 1974. Mutation induced in red gram (*Cajanus cajan* L) by gamma irradiation and EMS. Rad. Bot. **14** : 237 - 242.

Khuspe, S. S. and Ugale, S. D., 1977. Effect of CO^{60} and EMS (ethyl methane sulphonate) on growth and fruit development of *Capsicum annuum*. J. Mah. Agri. Univ. **2** (1) : 3 - 5.

Yesoda Raj, A., Sudharsan Raj A, & Madhusadana Rao, G. 1972. Mutagenic studies of gamma rays on *Oryza sativa*. Cytol : **37** : 469 - 477.

Table 1 : Frequency of mutation (%) in M_2 generation under various doses of gamma rays.

Name of visible mutants	Doses		
	10 kR 670	20 kR 605	30 kR 415
1. Early flowering mutants	1.49	1.72	–
2. Late flowering mutants	–	1.48	2.16
3. Early fruiting mutants	1.64	1.32	–
4. Early maturing mutants	1.64	1.32	–
5. Tall mutants	1.04	0.99	–
6. Dwarf mutants	1.33	1.65	–
7. Branched mutants	1.33	0.91	–
8. High yielding mutants	2.23	1.98	–
9. Long fruited mutants	2.98	2.97	2.63
10. Small fruited mutants	2.08	2.14	3.37
11. Clustered fruited mutants	1.40	–	–
12. Small leaf mutants	–	–	2.40
13. Narrow & long leaf mutants	–	0.16	0.72
14. Chlorophyll mutants	0.14	1.48	0.72

Capsicum and Eggplant Newsletter, 19 (2000): 89-92.

DOUBLE-STRANDED RNA IN VIGOROUS-GROWING LATERAL SHOOTS EMERGED FROM PEPPER PLANTS INFECTED WITH CUCUMBER MOZAIC VIRUS (CMV)

H.Yamamoto, T.Uemachi, and S.Yazawa.
Graduate School of Agriculture, Kyoto University, Sakyo-ku, Kyoto 606-8502, Japan

INTRODUCTION

Since plants have no immunity system, once they become infected with a virus, they cannot recover from viral damage. In some combinations of plants and viruses, however, new organs formed after the viral infection have resistance against the same virus. We found that the pepper plant, 'Af-5' (*Capsicum annuum* originally from Kenya), infected with cucumber mosaic virus (CMV) developed vigorous-growing lateral shoots a few years after the infection (Yazawa et al. 1996). No CMV particles were detected in the vigorous-growing lateral shoots although CMV was found at a high concentration in other parts of the same plant, and the vigorous-growing lateral shoots were resistant to the second infection with the same virus. This resistance was observed in their cuttings, but not in the grafting partners (scion or rootstock) or the self-pollinated progeny, indicating that the resistance was not due to a genetic mutation (Yazawa et al. 1996).

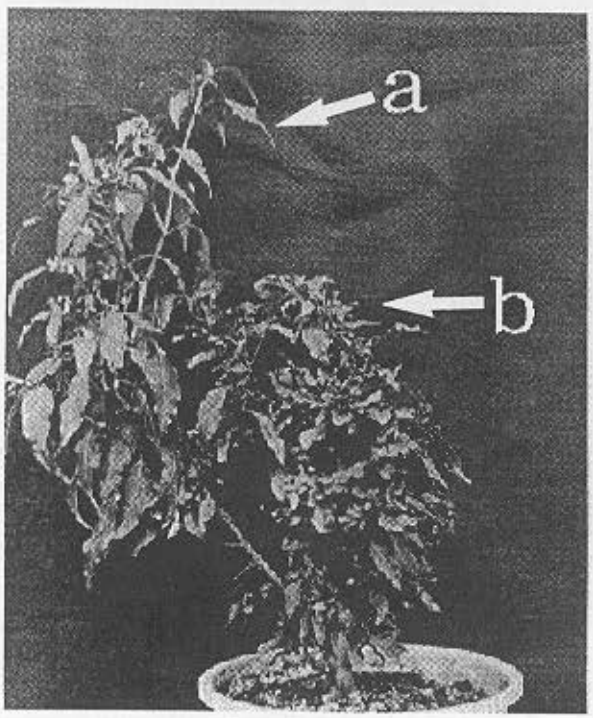


Fig.1 Emergence of vigorous-growing lateral shoots from CMV-infected 'Af-5'

a: Vigorous-growing lateral shoot
b: Shoot exhibiting CMV symptoms

We also found that the resistance is CMV-specific (unpublished). How the vigorous-growing lateral shoots acquired the resistance is not clear, but the resistance seems to be related to the viral genomic RNA, because the resistance is CMV-specific. Plants sometimes acquire resistance to an RNA virus by accumulating the viral double-stranded RNA (dsRNA) (Ohki et al., 1990). Double-stranded RNA is not generally observed in plants unless they are infected with RNA virus (Morris and Dodds 1979). Therefore, if the plants acquired this kind of resistance, they may have dsRNA even though they do not show viral symptoms. In this study, we investigated the shoots of the plants infected with CMV for the presence of CMV-specific dsDNA.

MATERIALS AND METHODS

Two groups of the pepper plant, 'Af-5', were used: One group consisted of the plants infected with CMV and with vigorous-growing lateral shoots, and the other consisted of the plants having no vigorous-growing lateral shoots . The plants with vigorous-growing lateral shoots without CMV symptoms (Fig. 1a) and those with CMV symptoms (Fig. 1b) were examined for the presence of dsRNA. The plants without vigorous-growing lateral shoots with and without CMV symptoms were also examined. Plants were examined for the presence of CMV virus by the ELISA method (Uemachi et al 1995).

Double-stranded RNA was extracted from the shoots according to the method of Valverde (Valverde et al. 1990) with some modifications. The extracts were fractionated by cellulose chromatography and analyzed on 1.0% agarose gel (100V, 25min).

RESULTS AND DISCUSSION

First we checked the shoots for the presence or absence of CMV. The presence of CMV was confirmed only in the shoots exhibiting CMV symptoms in both plants with and without vigorous-growing lateral shoots (Table 1). CMV was not detected in either the vigorous-growing lateral shoots or uninfected plants without vigorous-growing lateral shoots. Fig. 2 shows the pattern of agarose gel electrophoresis of dsRNA in the vigorous-growing lateral shoot of plants infected with CMV and in the shoot of plants without vigorous-growing lateral shoots not infected with CMV. CMV was not detected in either shoot, but the dsRNA in the vigorous-growing lateral shoots (Fig.1a) had one additional band. Fig. 3 shows the dsRNA in the shoots showing exhibiting CMV symptoms in the plants with and without vigorous-growing lateral shoots. CMV was detected in both plants, but only the dsRNAs in the plants with vigorous-growing lateral shoots had one additional band. In other words, the specific dsRNA was not observed in the shoot of plants without vigorous-growing lateral shoots even though it was infected with CMV. Since the DNA size marker is not appropriate for dsRNA, the size of the additional band in Figs.2 and 3 is not clear, but seems to be about 560 bp. Although the dsRNA pattern in the shoots infected and not infected with CMV was different, the additional dsRNS was observed similarly in both the vigorous-growing lateral shoot and the shoot with CMV symptoms in the plants with vigorous-growing lateral shoots. In other words, the same dsRNA was observed irrespective of the presence or absence of CMV in the plants with vigorous-growing lateral shoots.

Viral genomic RNA is double-stranded during the replication, but the additional dsRNA is not considered to be a replication form of viral RNA, because it was also observed in the vigorous-growing lateral shoots in which CMV was not detected. The role of the additional dsRNA is not clear. However, since the dsRNA was not observed in plants infected with CMV without vigorous-growing lateral shoots, there is a possibility

Table 1.CMV concentration in the plants'Af-5'used in this experiment

Plant	CMV symptom	CMV conc. index[z]
Plants with vigorous-growing lateral shoots		
Vigorous-growing lateral shoots (Fig. 1a)	not observed	0
Shoots exhibiting CMV symptoms (Fig. 1b)	observed	50
Plants without vigorous-growing lateral shoots		
Not infected with CMV	not observed	0
Infected with CMV	observed	50

Z: CMV conc. index

Index: Absorbance value at 405 nm in ELIZA methods

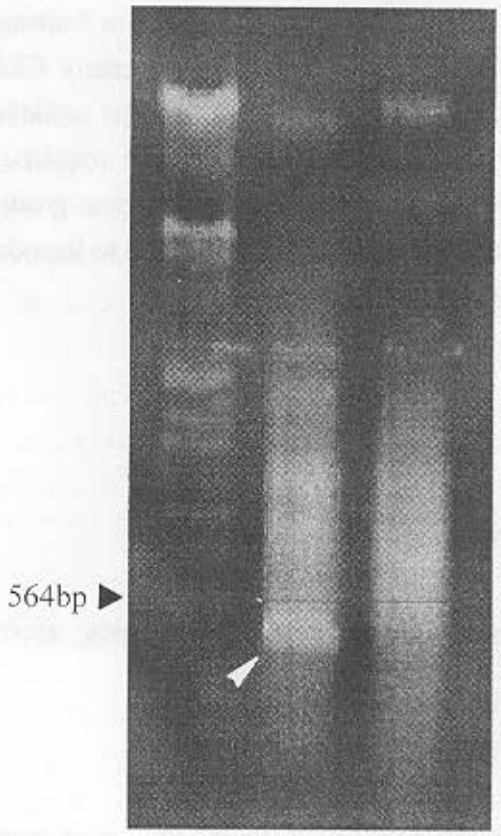
0 : 0.000～0.099

20 : 0.100～0.199

50 : 0.200～0.499

100 : 0.500～

Index value ≧ 20 is considered to CMV infected.



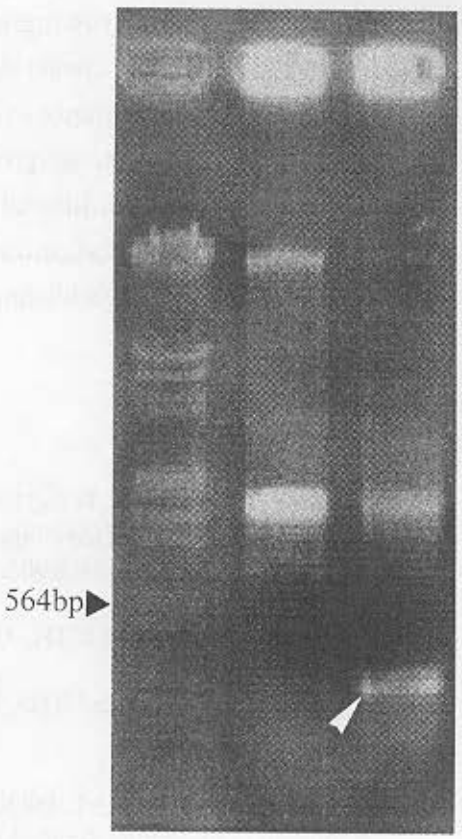


Fig.2 Double-staranded RNA in the shoot in which CMV was not detected

A white arrowhead indicated the additional band

lane1: DNA size marker (λ *Hind*ⅢⅠ*Eco*R Ⅰ)

lane2: Vigorous-growing lateral shoot (Fig.1a)

lane3: Uninfected shoot of the plant without vigorous lateral shoots ('Af-5' seedling not infected with CMV)

Fig.3 Double-stranded RNA in the shoot in which CMV was detected

A white arrowhead indicated the additional band

lane1: DNA size marker (λ *Hind*ⅢⅠ*Eco*R Ⅰ)

lane2: Shoot exhibiting CMV symptoms in a plant without vigorous-growing lateral shoots ('Af-5' seedling infected with CMV)

lane3: Shoot exhibiting CMV symptoms in a plant with vigorous-growing lateral shoot (Fig.1b)

that the dsRNA is produced during the resistance-acquiring process. The CMV-infected plants without vigorous-growing lateral shoots used in the present experiment had been infected with CMV the previous year. Since the emergence of vigorous-growing lateral shoots takes a few years, they are expected to emerge from this plant within a year or two. Valverde et al. (1990) reported that dsRNAs were isolated from symptomless plants including pepper. They also reported that dsRNAs found in pepper were transmitted to the progeny at a high rate, and not through grafting. They indicated that some of the dsRNAs are the genome of cryptic virus (Valverde and Fontenot 1991). Cryptic virus is transmitted to progeny, but in our plants, the resistance was not transmitted to the progeny. Even though there is a possibility that the additional dsRNA is the genome of cryptic viruses, the resistance of vigorous-growing lateral shoots may not be due to the influence of cryptic viruses. We have to investigate the transmission of the additional dsRNA through selfing and grafting. Previously, we reported (Uemachi et al. 1995) the emergence of vigorous-growing lateral shoots from CMV-infected *Capsicum frutescens* in an open field in Southwest Japan (Latitude, 24°58'N). There were many CMV-resistant weedy pepper plants in the area, and there is a possibility that the resistance originated from the vigorous-growing lateral shoots. Further studies are required to elucidate the role of the additional band in dsRNA and the resistance of vigorous-growing lateral shoots. The use of vigorous lateral shoots may be an efficient method to introduce the resistance to plants in addition to traditional plant breeding methods.

REFERENCES

VALVERDE R. A. and J. F. FONTENOT. 1991.
Variation in double-stranded ribonucleic acid among pepper cultivars.
J. Amer. Soc. Hort. Sci.,116:903-905.

VALVERDE R.A., S. NAMETH, O. ABDALLHA, O. ALMUSA, P. DESJARDINS, AND A. DODDS. 1990.
Indigenous double-stranded RNA from pepper (*Capsicum annuum*).
Plant Science.,67:195-201.

OHKI S., Y. TAKAMI, AND T. INOUYE. 1990.
Accumulation of double-stranded RNAs 3 and 4 in the symptomless leaves and green areas of mosaic-affected leaves of tobacco plants infected with cucumber mosaic virus. Ann. Phytopath. Soc. Japan.,56:213-218.

UEMACHI T., H.WATANABE AND S.YAZAWA. 1995.
Emergence of vigorous-growing lateral shoots from a CMV-infected plant of *Capsicum frutescens* L. found on a subtropical island in Japan.
Capsicum and Eggplant Newsletter, 14:56-59.

YAZAWA S., T. UEMACHI, T. HIGASHIDE, AND H.WATANABE. 1996.
CMV resistant developed in vigorous-growing lateral shoots from virus infected plants of *Capsicum annuum* L.. Scientia Horticulturae,65:295-304.

Capsicum and Eggplant Newsletter, 19 (2000): 93-96.

EFFICACY OF MAIZE INTERCROP-IN THE CONTROL OF VIRAL DISEASE (S) OF PEPPER.

**A.A. FAJINMI AND *A.O. OLADIRAN
**Crop Protection Division National Horticultural Research Institute P.M.B 5432, Idi-Ishin, Ibadan, Oyo State Nigeria.
*Botany and microbiology Dept. University of Ibadan. Oyo State Nigeria.

ABSTRACT

The incidence of pepper veinal mottle potvirus (PVMV) disease was monitored in mixed pepper intercrop. Three varieties of pepper (*Capsicum annuum* long cayane) and one variety of maize were used in the study. In the control plot (sole pepper), percentage PVMV disease ranged between 45% to 60% while in the maize/pepper intercrop, infection was less than 4% in all the varieties. Fruit yields were heavier in the maize/pepper intercrop than in the sole pepper plots, which showed significant difference at less than 5% level of probability when compared with the sole pepper cropping. In addition the maize/pepper intercropping gave more agronomic advantages over the sole in fruit number fruit thickness and fruit length.. These attributes probably led to the heavier yield in pepper/maize intercropping model.

INTRODUCTION

Viral disease(s) constitute a major constraint to successful production of pepper (Capsicum spp) irrespective of the geographical location and the horticultural form grown (Cook, 1991). Fajinmi (1995) reported that pepper venial mottle potyvirus (PVMV) disease constitute the most consistent problem for pepper production throughout Nigeria and even in West Africa (Brunt and Kenten 1971).

Once the plant is infected with viral disease, there is no remedial procedure and subsequent loss of all saleable produce from that plant (Boukema,1980, Brunt and Kenten 1971). This has led to poor quality seeds from unimproved land races, low productivity due to lack of agronomic recommendations(Kennedy 1976), high incidence of viral disease and lack of appropriate arrangements in tall companion crops (Fajimi, 1995). This study involves the use of maize intercropping model as a cultural control method in reducing viral disease of pepper and probable increase in yield.

MATERIALS AND METHOD

The experimental study was carried out at National Horticultural Research Institute (NIHORT), Ibadan, Nigeria during 1996 and 1997 growing seasons. Three pepper cultivars- 'NHAV96', 'NHBV96' and 'NHFV96' (obtained from NIHORT) were used for the experiment.

There were six treatments, designated A,B,F serving as sole pepper plots while MA, MB and MF serve as the intercrop plots. Plot size was 10m by 1m. Maize spacing was 1m apart at the rate of two grains per hole. The maize stands were then thined down to one, seven days after planting. Two pepper seedlings were transplanted in between the maize stand at the spacing of 50cm apart. It was a simple randomised block design replicated three times. There was no fertilizer application nor chemical spray applied. The experiment was rainfed.

Viral disease incidence was monitored fortnightly for a period of 14 weeks by counting the number of viral infected pepper stands through symptomatic expression and serological confirmation in each plot. Five pepper stand were selected at random in each

plot at transplant for height monitoring till when the height stabilized. Other agronomic data taken includes, fruit wall thickness and total fruit yield for each plot. The pepper was intercropped in the maize at the rate of 0,000 plants/ha and 10,000 plants/ha respectively.

RESULTS

The results for the years were similar, and therefore the averages of two years data were presented in the tables.

Symptoms of PVMV disease were observed on all varieties especially in the sole pepper plots. The PVMV incidence was relatively high among all the varieties in the sole pepper plots with 'NHBV96' recording the highest incidence of the disease (60%) 'NHAV 96' – 5% and 'NHFV96' – 8%, less than % was recorded in all the varieties intercropped with maize (Table 1). The incidence of the disease has no significant effect on the yield of the infected and the healthy (P> 0.05) in the intercrop. While the effect was high in the sole pepper plot. There was high significant difference in the viral disease incidence in all the varieties in sole pepper plot and those intercropped with maize (P> 0.05). The yield of the pepper varieties in maize intercrop was considerably higher than that of the varieties in the sole pepper plot. (Table 1)

DISCUSSION

The maize intercropping model gave a high degree of protection on the pepper plants against viral disease, this corroborate TARI(1983) finding that intercropping pepper with corn in alternate rows reduces the incidence of virus disease in pepper. The leaves surface area of the maize provided a good landing plate for the vector (aphids) carring virus, which serve as a camouflage for the pepper in the intercrop. There was high viral disease infection recorded in the sole pepper cropping compared to the pepper intercropped with maize. There was probable chance that the virus pathogen might have been deposited on the leaves of the maize and since the viral disease is plant specific it had little or no effect on the maize plant. The use of tall companion crop is to divert and confuse the vector for the virus to land on alternative plant instead of feeding on the host plant (pepper). This alternative plant will serve as means of eliminating the vector of the virus and protecting the pepper plant, as suggested by Nishino et al (1985), that in controlling virus in pepper, the method to be used must be able to eradicate the vectors in order to be effective . Aphids being the major vectors for the virus are normally attracted by green canopy of the plant. They land on the leaf blade of the tall companion plants, and since they transmit the virus non-persistently, they feed, transmit and die there without having any adverse effect on the plant, being plant specific disease, the tall companion plants used as intercrop may probably serve as an extra source of income for the farmer apart from disease control, from their fruit yield after harvest.

The competition between the pepper and maize intercropped together contributed to the increase in height, fruit size and subsequent increase in the yield of pepper compared to the sole pepper plot. This is evidence in the yield of pepper intercropped with maize compared to sole pepper plot (Table 1) This might have been helped by the one metre spacing of the maize plant,, which also is a tall non- branching plant. The high disease incidence of the varieties in the sole pepper plot contributed to their low yield and plant performance. The land equivalent ratio of the pepper intercropped with maize, and

sole pepper proved that the maize had no significant adverse effect or the yield of pepper it was intercropped with (Table 2). Instead, it contributed to the yield increase and agronomic qualities than sole pepper (Table 1).

Table 1 The Agronomic and Disease incidence Data

Varieties	Date of Flowering	Plant Height at fruiting	Average Number of fruit/plant	Fruit Length cm)	Fruit girth (cm)	Fruit wall thickness (cm)	Average Number of seeds	Average fruit weight	Average plant height	PVMV diseases incidence %	Fruit yield tons/ha
Maize/ (MA) NHV 96	9-10th wk	70cm	230	14-17	4-6	0.3- 0.35	84	46g	1.2m	2a	5.176a
(MB)NHB V 96	8-9th wk	65cm	80	11-12	6-7	0.304	75	57g	95cm	4a	3.44b
Maize/ (MF)NHF V 96	10th wk	70cm	260	11-15	2-5-4	0.1-0.12	46	27g	1.5m	3a	5.8a
Sole pepper (A)NHAV 96	7th wk	50.5cm	180	10-15	3-5	02-03	86	3.6g	90.5cm	45b	3.32b
(B)NHBV 96	7-8th wk	50cm	60	10-105	5-6	02-0.35	81	5.23g	80.2cm	60c	2.08c
(F)NHFV 96	8th wk	60cm	210	9-12	2-3	0.08 0.1	45	2g	90.6cm	48b	3.104b
S. E. LSD										5.51 4.5	0.18 0.64

SE- standard error
LSD- least significant
(figures followed by the same alphabets are not significantly different from each other)

Table 2 Land equivalent ratio of sole pepper yield against the pepper intercrop yield.

Pepper Maize Intercrop Yield		Sole pepper yield	Land equivalent ratio
'NHAV 96'	5.176t/ha	3.32t/ha	1.557
'NHBV 96'	3.44t/ha	2.08t/ha	1.654
'NHFV 96'	5.8t/ha	3.104t/ha	1.87

REFERENCES

BOUKEMA, I. W (1980). Allelism of genes controlling resistance to TMV in Capsicum L.,Euphysica 29; 33- 39

BRUNT,A .A and R.H KENTEN (1971) Pepper veinal mottle a new Member of potato virus Y group from Peppers (Capsium annuum L.. and C: Fruitscense L..) in Ghana Annuals of Applied Biology 69:235-2 3

COOK, A.A. (1991)''Pepper breeding for disease Resistance'' Capsicum Newsletter 10:21-25.

FAJINMI A.A. (1995) Studies on pepper veinal mottle poty virus of pepper (Capsicum ssp.) in Ibadan and Environ M.Sc .Thesis- Department of Botany and Microbiology University of Ibadan, Nigeria.

GIBSON,R. W. and PLUM, R.T. (1977). Breeding plant for resistance to Aphids. In Aphids as virus vector- pp. 73-500 Eds K.F.Harris and K.Maramarotch New York Academic Press

KENNEDY, G.G. (1976) Host plant resistance and the spread of plant viruses Enviromental Entomology 5. 827-832.

NISHINO T. T. SHINSU, AND S. SAKOGUCHI (1985) Studies on the virus disease of ginger(3). Control of the virus disease of ginger by flight prevention of aphids using plastic film mulching. Proceedings of the Association for plant protection of Kyushi 31: 135-137.

TARI (1983) Annual report for 1982. Taiwan Agriculture Research Institute. Winfeng Taiwan ROC 17 pp

Capsicum and Eggplant Newsletter, 19 (2000): 97-100.

THE SEGREGATION OF PMMoV RESISTANCE IN THE BACKCROSS GENERATION OF *Capsicum annuum* AND *C.chinense*

Keiko Ishikawa*, Kyoko Sato**, Sataro Ogiwara** and Osamu Nunomura**
*Plant Cell Technology Lab., Faculty of Horticulture, Chiba University, 648, Matsudo, Matsudo-shi, Chiba 271-8510 Japan e-mail ; ishikawa @midori.h.chiba-u.ac.jp
**Nihon Horticultural Production Institute, 207 Kamishiki, Matsudo-shi, Chiba 207-2221 Japan

Abstract

Isolated leaves of *Capsicum annuum* L.cv.'Oh-natsume' (ON), *C.chinense* Jacq. PI 159236 (P1), their F1 hybrid (OP), and backcross population (OPO) were inoculated with pepper mild mottle virus (PMMoV) and incubated under controlled condition in incubator for one week. In P1 leaves, only local lesions were observed. On the other hand, both local lesions and necrosis of veins were observed in OP and OPO leaves. This result showed that heterozygous host plants had rather weak resistance comparing with homozygous host plants.

Introduction

Tobacco mosaic virus (TMV) reduces productivity of pepper seriously (Green, et al., 1991). Recently new type of TMV was isolated from pepper in Japan (Nagai, 1981). This TMV was distinguished from the TMV-OM, TMV-Ob and ToMV (previously described as TMV-L) and supposed to be near to pepper mild mottle virus (PMMoV) or paprika mild mottle tobamovirus (PMMoV) (or paprika mild mottle virus (PaMMV)).

As the genetic sources of resistance against TMV, Plant Introduction (PI) collection was recommended (Sowell, 1982). Within the PI collection, it was also confirmed that *C.chinense* Jacq. PI 159236 (P1) was resistant against PMMoV (Sato, unpublished data). On the other hand, the typical bell type pepper like 'California Wonder', *C.annuum* L. cv. 'Oh-natsume' (ON) was susceptible. So in the breeding program, ON was crossed with P1 to have resistant F_1 hybrid (OP). Then in order to eliminate the pungency introduced from P1, series of backcross between OP and ON (or other bell type sweet pepper) were made. But recent field experiences revealed that the resistance of heterozygous resistant host plants has sometimes become useless under severe condition. So we think it is important to detect the infectivity of homozygous and heterozygous resistant hosts.

In this report, we showed the resistance of ON, P1, their F1 hybrids and the backcross generation and revealed that F1 and the backcross generation had weak resistance comparing with that of P1.

Materials and Methods

Plant materials

The plants of *Capsicum annuum* L. cv.'Oh-natsume' (6 plants, bell type pepper, hereafter described as ON), *C.chinese* Jacq. Plant Introduction (PI) 159236 (5 plants, elongated type pepper, hereafter described as P1), F1 hybrid plants of ON and P1 (6 plants, hereafter described as OP), the backcross populations of OPx ON (76 plants, hereafter described as OPO) were grown in the greenhouse for 1 year. Temperature regime in the greenhouse was 30±5/18±3 ℃(day/night). The heights of the plants were about 0.7 m and

the main stems of each plants were hung to the bars (2 m in the height) with nylon stripes.

Preparation of virus and virus inoculum

PMMoV (pathotype P12) was isolated from the contaminated field in Ibaraki-Pref. Japan. For the preparation of viral inoculum, sensitive plants grown in the greenhouse were inoculated with PMMoV. Twenty days after inoculation, leaves were take from the plants, put in the nylon bags and stored -20 ℃. These leaves were grinned with motor and pistils with 10 to 50 ml of water and then filtrate with a gauze. The filtrates were filled up to 500 ml and used as virus inoculum.

Mechanical inoculation of TMV

Young expanded leaves (several cm) without wounds were taken from ON, P1, OP and OPO. These leaves immediately used for the mechanical inoculation described as follows. Leaves were dusted with carborundum (600 mesh) and mechanically inoculated with viral inoculum. After rinsing the inoculated leaf surface with tap water, the leaves were put in a nylon bag and incubated at 23 ℃ for 4 days. During incubation, symptom development was monitored on a daily basis.

Estimation of infectivity

Infectivity was estimated as described in Table 1, by observing the local lesions and the necrosis of the veins of the inoculated leaves. The infectivity of sensitive plants was estimated as "0". The infectivity of resistant plants were classified from " 1 " to " 5".

Results and Discussion

In the conventional methods, infectivity was estimated by the number of virus multiplied in the inoculated leaves. In those methods, infectivity was easily affected by the number of the first inoculum. And also it was difficult to distinguish the infectivity between the homozygous and heterozygous resistant plants.

On the other hand, in our method infectivity was estimated by the appearance of local lesions and necrosis of veins, and also by the comparison of the area of local lesions and area of necrosis of veins. With these criteria, the resistance of P1, OP and OPO was clearly distinguished.

Using this method, it was showed that OP and OPO had rather weak resistance.

Infectivity of OP was "1" or "2". Especially one of OP was sensitive. Further investigation should be necessary for this line.

In OPO,the segregation of resistant to sensitive plants fitted a 1:1 ratio ($0.05<p<0.1$). And about ninety percent of the resistant OPO showed "1" or "2". So it was concluded that the necrosis of the veins was not suppressed in the heterozygous resistant hosts. This meant that the tolerance of heterozygous resistant plants was rather weak comparing with homozygous resistant plants. This agrees with the reports of TMV resistance of Tomato. The suppressive ability of virus by *Tm*-1 was gene dosage dependent (Fraser, et al., 1980). At high temperature, the resistance of the plants heterozygous for*Tm*-1 could not inhibit the virus multiplication completely (Fraser, et al., 1982).

Surprisingly, one of the 76 plants of OPO showed "5". We should investigate the possibility of the recombination of the resistant gene by further backcross of this plant and ON.

Table 1. Estimation of infectivity of isolated leaves inoculated with PMMoV

Infectivity	Index	Symptoms of the inoculated leave		
		Local lesions	Necrosis of veins	Notes
Sensitive	0	−	−	Virus was multiplied in the whole leaf without symptoms
Resistant	1	−	+	
	2	+	+	area of local lesions < area of necrosis of veins
	3	+	+	area of local lesions = area of necrosis of veins
	4	+	+	area of local lesions > area of necrosis of veins
	5	+	−	

Table 2 The segregation of PMMoV resistance of *Capsicum annuum* L. 'Oh-natsume' (ON), *C.chinense* Jacq. PI 159236 (P1), their F1 hybrid (OP), backcross generation (OPO) .

Parents or crosses	Total no.	Observed		Expected		p
		R[1]	S[2]	R	S	
ON	6	0	6	0	6	-
P1	5	5	0	5	0	-
OP	6	5	1	6	0	-
OPO	76	41	35	38	38	0.05-0.100

1) resistance, which showed infectivity "1" ,"2", "3", "4" and "5".
2) Sensitive, which showed infectivity "0".

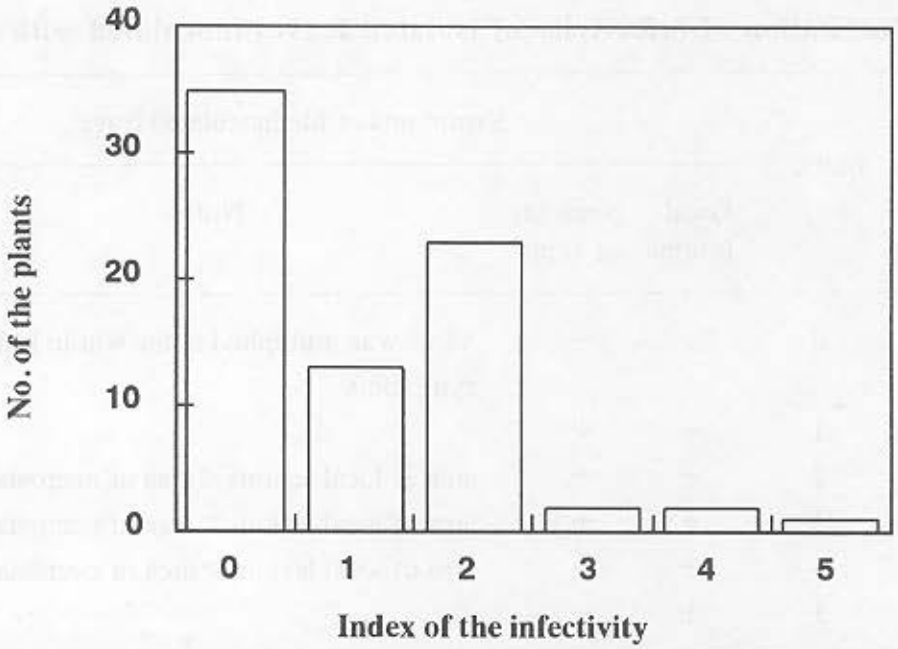


Fig. 1 Segregation of the infectivity in OPO (the backcross generation of *C. annuum* L. cv.'Oh-natsume'and *C. chinense* Jacq. PI159236)

References

Fraser, R. S. S. and Loughlin, S. A. R. 1980 Resistance to Tobacco Mosaic Virus in Tomato:Effects of the Tm-1 Gene on Virus Multiplication. J. Gen. Virol. 48:87-96

Fraser, R. S. S. and Loughlin, S. A. R. 1982 Effects of temperature on the *Tm-1* gene for resistance to tobaccomosaic virus in tomato. Physiological Plant Pathology 20:109-117

Green, S.K. and Kim J.S. 1991 Characteristics and control of viruses infecting peppers: a literature review. in Technical Bulletin Asian Vegetable Research and Development Center No.18:14-22

Kim, S. J. Lee S.J. Kim B.-D and Paek K. H.1997 Satellite-RNA-mediated resistance to cucumber mosaic virus in transgenic plants of hot pepper (*Capsicum annuum* cv. Golden Tower) Plant Cell Rep.16:825-830

Nagai, Y.1981.Bulletin of the Chiba Prefectural Agricultural Experimental Station. No 9. 19 25

Capsicum and Eggplant Newsletter, 19 (1999): 101-104.

MANAGEMENT OF CHILLI DAMPING OFF USING BIOCONTROL AGENTS

S.K. Manoranjitham and V. Prakasam
Department of Plant Pathology
Tamil Nadu Agricultural University
Coimbatore - 641 001, Tamil Nadu, India.

ABSTRACT : Seed treatment with talc based formulations of *Trichoderma viride* and *Pseudomonas fluorescens* effectively reduced the pre-and post-emergence damping off of chillies caused by *Pythium aphanidermatum*. The effect on damping off was more pronounced when these two biocontrol agents were used simultaneously compared to their individual effect *T. viride* at 4g/kg + *P fluorescens* at 5g/kg recorded 31.65, 66.66 and 37.58 per cent increase in shoot length, root length and drymatter production over control respectively. At 20 days after sowing both fungicide (Captan 4g/kg) as well as biocontrol agents (*T.viride* 4g/kg + *P.fluorescens* 5g/kg) treated seeds sown plots recorded *P.aphanidermatum* population of 5.00×10^2 CFU/g soil, as against 11.30×10^2 CFU/g in control.

KEYWORDS : Chillies, damping-off, biocontrol agents, disease control, seedling growth, *Pythium* population.

Chilli is an important spice crop and India is one of the leading country so far as chilli area and production is concerned. The crop is affected by number of diseases caused by fungi, bacteria and viruses inflicting heavy loss in yield. Among the fungal diseases, damping-off caused by *Pythium* spp. in the nursery is a major disease responsible for complete topple down of seedlings. Being a facultative parasite, the population of *Pythium* is always present in the nursery soil and cause disease. The most common mean to check the disease problem in nurseries is by using fungicides. However, continuous use of fungicide leads to environmental pollution besides development of fungicide resistance in pathogens. In view of the aforesaid reasons now a days biological control is gaining importance in disease control. Considering the above facts, the present investigation was carried out out to assess the effect of one fungal and one bacterial biocontrol agent on *Pythium aphanidermatum* population in soil, pre-and post-emergence damping off and seedling growth of chillies under field conditions.

MATERIALS AND METHODS

Talc based commercial formulations of *T. viride* and *P. fluorescens* obtained from the Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore was used for seed treatment. Chilli variety Co.1 was used in the experiment. The treated seeds were sown in 1m x 1m raised beds. In the beds lines were formed at 10cm apart and 50 seeds were sown in each line and there were eight lines per bed. There were seven treatments as mentioned in tables with four replications per treatment. The nursery beds were irrigated daily using rose can. Observations on pre-and post-emergence damping off were recorded. Vigour indices were calculated by following the procedure of Abdul-Baki and Anderson (1973). The population of *Pythium* in soil was estimated following the method of Stanghellini and Hancock (1970).

RESULT AND DISCUSSION

Effect of biocontrol agents on damping - off : The chilli seeds treated with *T. viride* (4g/kg) + *P.fluorescens* (5g/kg) showed the least incidence of 5.50 and 10.75 percent of pre-and post emergence damping-off respectively compared to all other treatments. However, its effect was on par with *P. fluorescens* (10g/kg) + *T. viride* (2g/kg), *T. viride* (4g/kg) and Captan (4g/kg). A maximum of 17.50 per cent pre-emergence and 43.00 per cent post-emergence damping-off was recorded in control (Table.1). Treating the seeds with biocontrol agents greatly reduced the damping-off of chillies. This is in confirmation with the findings of Dumitars and Fratilescu -

sesan (1979) and Wang *et al.* (1990). They reported that *T. viride* protected wheat and cotton seedlings and *P.fluorescens*. Protected cucumber seedlings from damping-off disease respectively. The effect of these biocontrol agents was on par with the fungicide, Captan in the present study. Similar observation was also reported by Krishnamoorthy (1987) where in *T. viride* was as effective as fungicides *viz.*. Fenaminosulf, Captan and TMTD in tomato.

Effect on seedling growth : The influence of antagonistic agents on the growth and seedling vigour of chilli was studied and the results presented in (Table.2) showed that seed treatment with *T. viride* (4g/kg) + *P.fluorescens* (5g/kg) produced more vigorous chilli seedlings and it recorded 31.65, 66.66 and 37.5g per cent increase in shoot length, root length and dry matter production over control. The effect of *T.viride* at 4g/kg in increasing the shoot length, root length and dry matter production was on par with the effect of *P.fluorescens* (10g/kg), *T.viride* (2g/kg) + *P.fluorescens* (5g/kg) and Captan. Increase in shoot length, root length and dry matter production due to seed treatment with *T.viride* and *Pseudomonas* spp. respectively in mungbean and capsicum was also reported by Vidhya (1995) and Harris *et al.* (1994).

Effect on soil population of *Pythium* :Chilli seeds treated with *T.viride* (4g/kg) + *P.fluorescens* (5g/kg), *P.fluorescens* (10g/kg) + *T.viride* (2g/kg), *T.viride* (4g/kg) and *P.fluorescens* (10g/kg) were equally effective with fungicide captan in reducing the pathogen population. However, the maximum reduction was recorded in *T.viride* (4g/kg) + *P.fluorescens* (5g/kg), which reduced the population from 6.5×10^2 to 5×10^2 CFU/g of soil after 20 days. The reduction in the population of pathogen may be due to increase in the density of population of both the antagonists. Campbell (1989) suggested that *Pythium* spp. are poor competitors and thus their population may be replaced due to the competitive effect of antagonists. Based on the results obtained in the present study, damping-off of chillies could easily be managed by treating the seeds with talc based formulations of *T.viride* and *P.fluorescens*.

REFERENCES

ABDUL-BAKI, A.A. and ANDERSON, J.D. 1973. Vigour determination in soybean seed by multiple criteria. *Crop Sci.* **13** : 630 - 633.

CAMPBELL, R. 1989. Biological control of microbial plant pathogens. Cambridge University Press, Cambridge, 218 p.

DUMITARS, L. and FRATILESCU-SESA. 1979. Aspects of the antagonism of *Trichoderma viride* Pers. to *Pythium debaryanum* hesse. *Biologie Vegetala*, **31** : 63 - 67.

HARRIS, A.R., SCHISLER, D.A., RYDER, M.H. and ADKINS, P.G. 1994. Bacteria suppress damping off caused by *Pythium ultimum* var. *sporangiiferum* and promote growth in bedding plants. *Soil Biol. Biochem.*, **26** : 1431 - 1437.

KRISHNAMOORTHY, A.S. 1987. Biological control of damping - off disease of tomato caused by *Pythium indicum*. M.Sc(Ag) thesis, TNAU, Coimbatore, India, 130 pp.

STANGHELLINI, M.E. and HANCOCK, J.G. 1970. A quantitative method for the isolation of *Pythium ultimum* from soil. *Phytopahtology*, **60** : 551 - 552.

VIDHYA, R. 1995. Studies on biological control of mungbean root rot *Macrophomina phaseolina* (Tassi) Goid) by *Trichoderma viride* pers. M.Sc(Ag) Thesis, TNAU, Coimbatore, India, 144 p.

WANG, Z.Y., ZHANG, B.X. and GE, Q.X. 1990. The screening of antagonistic bacteria to control the damping-off of cucumber seedlings. *Acta Agriculturae Universitatis Zhejiangensis*, **16** : 171 - 175.

Table 1. Effect of seed treatment of antagonists on damping off of chilli under field condition

Treatments	Damping off disease (per cent)			
	Pre emergence	Per cent of reduction over control	Post emergence	Per cent of reduction over control
T. viride (4g/kg)	7.50 (15.85)	57.14	12.5 (20.68)	70.93
P. fluorescens (10g/kg)	8.70 (17.15)	50.28	13.75 (21.69)	68.02
T. viride (4g/kg) + *P. fluorescens* (5g/kg)	5.50 (13.49)	68.00	10.75 (19.06)	75.00
P. fluorescens (10g/kg) + *T. viride* (2g/kg)	6.50 (14.62)	62.85	12.00 (20.16)	72.09
T. viride (2g/kg) + *P. fluorescens* (5g/kg)	9.50 (17.74)	45.71	15.75 (23.32)	63.37
Captan 4g/kg	7.50 (15.85)	57.14	11.00 (19.27)	74.41
Control	17.50 (24.71)		43.00 (40.92)	
CD [P=0.05]	2.61		2.17	

Mean of 4 replications.
Figures in parantheses are arcsine transformed values.

Table 2. Effect of seed treatment of antagonists on the growth of chilli seedlings under field condition

Treatments	Shoot length (cm)	Per cent reduction over control	Root length (cm)	Per cent reduction over control	Dry matter production (gm)	Per cent increase over control
T. viride (4g/kg)	15.75	24.01	1.52	44.76	0.768	23.87
P.fluorescens (10g/kg)	15.52	22.20	1.45	38.09	0.723	16.61
T. viride (4g/kg) + *P.fluorescens* (5g/kg)	16.72	31.65	1.75	66.66	0.853	37.58
P.fluorescens (10g/kg) + *T. viride* (2g/kg)	15.82	19.72	1.70	61.90	0.796	28.38
T. viride (2g/kg) + *P.fluorescens* (5g/kg)	14.95	17.71	1.27	20.95	0.721	16.29
Captan 4g/kg	15.65	23.22	1.67	59.04	0.777	25.32
Control	12.70		1.05		0.620	
CD [P=0.05]	0.27		0.28		0.0290	

Mean of 4 replications.

Table 3. Effect of seed treatment of antagonists on the population of *P.aphanidermatum* under field condition in chilli

Treatments	Population of *P. aphanidermatum* (10^2 cfu/g)			
	0 day	10 days	20 days	Mean
T. viride (4g/kg)	6.30	5.80	5.50	5.80
P. fluorescens (10g/kg)	6.00	5.80	5.30	5.60
T. viride (4g/kg) + *P. fluorescens* (10g/kg)	6.50	5.50	5.00	5.60
P. fluorescens (10g/kg) + *T. viride* (2g/kg)	6.00	5.50	5.30	5.50
T. viride (2g/kg) + *P. fluorescens* (5g/kg)	6.50	6.00	5.80	6.00
Captan 4g/kg	6.30	5.50	5.00	5.50
Control	6.80	8.00	11.30	8.60
Mean	6.30	6.00	6.10	

CP [P = 0.05]

d = days — d 0.75

t = treatment — t 1.15

d x t = interaction — d x t 2.00

Mean of 4 replications.

Capsicum and Eggplant Newsletter, 19 (1999): 105-108

SCREENING OF PEPPER LINES FOR RESISTANCE TO PHYTOPHTHORA CAPSICI IN NORTHERN NIGERIA

S.E.L. Alao, and M.D. Alegbejo
Department of Crop Protection
Ahmadu Bello University,
P.M.B. 1044
Zaria, Nigeria

INTRODUCTION

Peppers, (Capsicum annuum (L.) and Capsicum frutescens (L.) are widely cultivated crops in the savanna zones of Nigeria. Although more land is being committed to the production of the crop, average yield has been low compared to what obtains in other parts of the world. Thus while FAO (1996) estimates production values of 10211 kg/ha for Nigeria, estimates for USA, Haty, Isreal China, Chile and Austratia are 23270, 28351, 34375, 17675, 17796 and 16429 kg/ha respectively. Apart from low levels of technological inputs, biotic factors such as pests and diseases also contribute to the low yields obtained. One of such yield limiting disease is the basal stem rot and wilt induced by Phytophthora capsici (Leon.). First reported in 1984 in northern Nigeria, subsequently major disruptions in pepper productions across the country occurred as the disease assumed a regional dimension with more outbreaks been reported from other areas including Ajiwa (Katsina State), Wudil/Jakarade (Kano State), Maigana/Birnin Gwari (Kaduna State), etc. As a result, the Institute for Agricultural Research (IAR), Ahmadu Bello University initiated a multifacetted research project aimed at controlling the disease. Amongst the project outlined was to source for disease resistant breeding materials. This paper reports the investigetions carried out with respect to the objective.

MATERIALS AND METHODS

A total of seventeen (17) chilli and fourteen (14) sweet pepper lines were screened for resistance to the P. capsici. The isolate was collected from survey tours to the Ajiwa Irrigation Project of Katsina State in 1988.

Inoculum suspension was prepared by harvesting P. capsici mycelia growing on five (5) day old culture. Media was oat meal agar at 25°C. Harvested mycelia was homogenised in 200ml sterile distilled water using a waren blender.

Three week old seedlings of the various lines of pepper were obtained from a nursery. After carefully washing the roots with running tap water, the roots up to the collar region were immerssed for 10 min in freshly prepared inoculum suspension. Seedlings were transplanted into heat sterilized soil to which nitrogenous fertilizer N.P.K. at the rate of 0.01g/kg soil was added. Three (3) seedlings were transplanted per pot. Each treatment was replicated five times. Uninoculated seedlings were likewise transplanted as check. Pots were transfered to the glasshouse where daily observations on plant mortalities were taken. Experiment was terminated at four (4) weeks after transplanting.

RESULTS

The results are presented in Tables 1 and 2. All tested lines of sweet peppers had100% mortalities by the second week week after transplanting. In the case of the chilli pepper lines (Table 2), lines U-Kimba, P-2289 and p3875 had mortalities ranging from 8.3 to 93.3% at second week after inoculation in the first trials. However, in subsequent trials, both p-2289 and p-3875 developed 100% mortalities by the second week after transplanting. Inrespective of the intial mortalities recorded by the end of the first week, all susceptible entries (lines) developed 100% mortality. However, U-Kimba a local, chilli line did not develop full maximum death rates in any of the trials.

DISCUSSION

The local upright fruiting chilli lines U-Kimba, had low percentage mortality of the high inoculum pressure and irrespective of the period of exposure. Cultivars immune to P. capsici attack according (Smith et al., 1967) are very unlikely to be found as they reported that under prolonged exposures of pepper plants to the pathogen, resistance breaks down. Barksdate et al. (1984) also recommended the use of prolonged incubation period and use of high inocolum concentrations to be used when screening for resistance to P. capsici in peppers.

The mechanism of resistance to P. capsici (Smith et al., 1967) is governed by 2 distinct domin at genes that act independantly and without any additive effects. However, this is contradicted by the report of Yamakawa et al. (1979) who inferred that resistance was conferred by a single incompletely dominant gene whose response to pathogen attack was constant irrespective of the method of inoculation Therefore, U-Kimba with a low percentage mortality (8.3%) could not be satisfactorily explained.

High mortalities were recorded for the exotic varieties such as Anaheim, pipierto, mild california, caloro, cherry Red, california long slim, Hungarian Yellow Wax and Cubannelle. This agrees with the report of Peter et al. (1984) who recorded high levels of susceptibilities to P. capsici by their varieties. However, other varieties obtained from the Asian Vegetable Research and Development Centre (A.V.R.D.C.) which showed high susceptibilities in this study are not reported in literature to be susceptible. Strain variation of P. capsici have been reported (Tucker, 1931). All the local lines tested were highly susceptible to the pathogen except U-Kimba which is resistant.

REFERENCES

Barksdale, T.H, Papavizas, G.C. and Johnson, B.A. 1984. Resistance to foliar blight and crown rust of pepper caused by Phytophthora capsici. Plant Disease 68: 506-509.

Chapman, N.P. 1984 Economic returns to pump users in northern zone. Bauchi State Agricultural Development Programme, Northern zone, Azare; Second Fadama Seminar, 3rd-6th March 1984 54-66.

Table 2. Screening chill: pepper lines for resistance to Phytophthora capsici.

Lines	Percentage mortalities at			
	First Trial		Second Trial	
	1WAT*	2WAT	1WAT	2WAT
U-Kimba	0	8.3	0	0
U-NA	50.0	100	0	100
U-Pusa 1wala	42.0	100	75.0	100
U-Sakarho	n.t	n.t	42.0	100
U-2289	n.t	n.t	66.7	100
P-2289	33.3	83.3	50.0	100
P-2190	58.0	100	83.3	100
P-3875	42.0	93.3	33.3	100
057-585	75.0	100	n.t	n.t
Dantsiga	42.0	100	25.0	100
Lalmirchi	50.0	100	56.0	100
Panhauya	62.8	100	25.0	100
Kundu	75.0	100	50.0	100
Karshin burgu	42.0	100	42.0	100
Cubanella	50.0	100	n.t	n.t
U-Danmeyere	16.7	100	83.3	100

*WAT = weeks after transplanting
n.t = not tested in trial indicated.

FAO Production year book 1996. Vol 50.
Peter, K.V., R.W. Goth, and R.E. Webb, 1984. Indian hot pepper as sources of resistance to bacterial wilts 1. phytophthora root rots and root knot nemalodes. Horticultural Science 19(2): 277-278.
Sharma, P.P. and Saini, S. 1970. Inheritance of resistance of P. capsici (Leon.) in C. annuum (L.). Haryama Journal of Horticultural Sciences, 8(1/2): 51-57
Smith, P.G., Kimblr, K.A., Grogan, R.G. and Millett, H.A. 1967. Inheritance in peppers to Phytophthora root rot. Phytopathology 57 (4): 377.
Tucker, C.M. 1931. Taxonony of the genus Phytophthora de Dary. Res. Bull. Univ. No. Agric. exp. sta. 153, 1-208.
Yamakawa, K., Mochizuki, T and Yasui, H. 1979. Screening cultivated and wild red peppers to P. capsici resistance and its inheritance Review of Plant Pathology 61(4): 2042.

Table 1. Screening sweet pepper lines for resistance to Phytophthora capsici (Leon.):

Lines	Percentage mortalities at First trial		Second trial.	
	1WAT*	2WAT	1WAT	2WAT
Californian Long Slim	42.0	100	75.0	100
Cherry Red	75.0	100	33.3	100
Bellbey	0	100	16.7	100
Anaheim	75.0	100	33.3	100
Pipierto	75.0	100	33.3	100
Hengarian Yellow wax	63.0	100	n.t	n.t
Mild californian	75.0	100	n.t	n.t
Caloro	33.3	100	n.t	n.t
Santa Fe Grenada	50.0	100	n.t	n.t
Ex-Ajiwa	n.t	n.t	66.7	100
Ex-Samaru	n.t	n.t	58.0	100
OY1	n.t	n.t	66.7	100
OY2	n.t	n.t	66.7	100
KO1	n.t	n.t	75.0	100
SO2	n.t	n.t	75.0	100

*WAT = weeks after transplanting
n.t = not tested in trial indicated.

Capsicum and Eggplant Newsletter, 19 (1999): 109-110.

SCREENING OF ADVANCED BREEDING PEPPER LINES FOR RESISTANCE TO BASAL STEM ROT AND WILT

M.D. Alegbejo & I.D. Erinle
Department of Crop Protection
Institute for Agricultural Research
Ahmadu Bello University, Zaria, Nigeria

Introduction

Pepper root rot and wilt incited by Phytophthora capsici Leonian is a widespread disease (Jianhua et al., 1998; Ribeiro et al., 1997). It was first reported in northern Nigeria at Ajiwa, Katsina State in the mid 1980s (Erinle, 1990). It is fast becoming a very important disease and often causes complete crop loss at the onset of fruiting (Alegbejo, 1998). Both Capsicum annuum L. (Sweet) and C. Frutescens L. (chilli) peppers are heavily attacked. Another serious outbreak was reported recently (Alegbejo, 1998) at the Abdullawa irrigation site of Katsina State.

The disease is controlled in the following ways: prevention of the carry over of the disease; removal and destruction of early infected plants, early transplanting; fertilization of pepper field with chicken dung (The gas released by the dung fumigates the soil sufficiently to Kill the pathogen); Seeddressing with fungicides such as Apron plus at the rate of 1: 100 (W/W) before planting. This results are usually unsatisfactory and are either cumbersome or expensive. Hence five advanced breeding pepper lines allegedly tolerant to P. capsici were obtained from the Asian Vegetable Research and Development Centre (AVRDC) Taiwan and screened for resisistance to the disease using a susceptible line L5962-2 as check.

Materials and Methods

The trial was conducted at Samaru Northern Guinea Savanna zone of Nigeria in March 1991. Seedlings of the Six pepper lines were raised in an insect-proof screenhouse on heat sterilized soil. Six week old seedling were transplanted into 30cm diameter clay pots filled with soil infested with P. capsici. There were twenty pots per line. The plants were fertilized with a compound fertilizer, N.P.K. (15:15:15). The interior of the screenhouse was sprayed with dimethoate (Rogor) at the rate of 1.30g a.i. per litre to kill insects. The plants were watered daily. Seedlings were observed for wilt and basal stem rot symptoms. Disease severity was rated on individual plants using a visual scale of 1-7, where:

1 = No visible wilt Symptoms

2 = Mild wilt Symptoms on the leaves

5 = Moderate wilt symptoms but most plants recover later

7 = Very severe and irriversible wilt symptoms and eventual death of plant

The level of resistance was determined using the scale outlined below:

Rating	Percentage infection	Disease severity
Resistant	1.00-15.90	1.00-2.90
Moderately resistant	16.00-25.90	3.00-4.90
Moderately susceptible	26.00-36.90	5.00-6.90
Highly susceptible	37.00 and above	7.00

Results and Discussion

One line (2230) was resistant, four lines (2289, 2284, 3289 and 2227) were moderately resistant while the check L-5962 was highly susceptible (Table 1). The resistant line reported in this paper has been tried on-farm alongside farmers cultivars and found to be better. It has been multiplied and made available to the Katsina Agricultural and Rural Development Authority (KTARDA) who in turn distributed it to farmers in the affected areas of the state. It is hoped that this cultivar will reduce the menace caused by this disease in the affected areas.

Reference

Alegbejo M.D. 1998. Touring report to Abdullawa irrigation site in Katsina State to asses the incidence of pepper wilt. Mimeograph 3p.

Erinle, I.D. 1990. Touring report to Ajiwa. (Katsina) pepper wilt and other trials Mimeograph 5p.

Jianhua, L., Y. Yuhong., W. Lin and Z. Yefang. 1998. Resistance to Phytophthora blight in hot pepper germplasm Capsicum and Eggplant Newsletter 17: 64-65.

Ribeiro, C.S. da C., C.A. Lopes and F.J.B. Reifschneider. 1997. Identification of sources of ju enile resistance in Capsicum spp. to Phytophthora Capsici Capsicum and Eggplant Newsletter 16:101.

Table 1. Reaction of pepper lines screened for resistance to basal Stem rot and wilt at Samaru in 1991.

Pepper line	Basal stem rot & wilt (%)	Disease severity 1-7
2289	16.20	3.00
2284	18.31	3.10
3289	24.51	3.15
2230	0.00	1.00
2229	26.01	3.25
L-59622 (check)	100.00	7.00

Capsicum and Eggplant Newsletter, 19 (1999): 111-114.

VIABILITY AND SOME PHYSIOLOGICAL INDICES OF SEEDS OF DIFFERENT AGE FROM VEGETABLE SPECIES PEPPER *(CAPSICUM ANNUUM L.)*

N. Panayotov and N. Stoeva
Higher Institute of Agriculture
12 "Mendeleev"Str., 4 000 Plovdiv, Bulgaria

Introduction

The seed age provide essential influence on the seed properties and on the viability processes. In seeds with different age, the sowing qualities and also the physiological properties are changed. The investigations for activity of some enzymes and other physiological characteristics in seeds of vegetable crops are very limited (Guertlier, G., 1989, Hentegs, D.L. et al., 1991,Kermasha, S. et al., 1990). The studies on the development of old seeds are limited too (Ali, N. et al., 1991). The studies on physiological and enzyme activity and on some qualities of pepper seeds are very confined (Smith, P.T. and B.G. Cobb, 1991, Watkins, J.T. et al., 1983).

The main purpose of this study was to investigate on species level the changes in the viability and in the some physiological characteristics, depending on the age of the seeds of species pepper (*Capsicum annuum L.*)

Materials and Methods

The trials were carried out in 1993 in the Department of Horticulture at the Higher Institute of Agriculture - Plovdiv, Bulgaria. As object of studies were used seeds from vegetable crops pepper with age from two to eight years, belonging to 16 cultivars, with crops years -1985-1991, shown in Table 1. The seeds were kept in conditions of storehouses of firm "Vegetable seeds " Ltd-Plovdiv, Bulgaria. In the moment of putting for storage, the sowing qualities of the seeds were first class, by Bulgarian State Standard (BSS 601 - 1985).

The germination energy, germinability (by BSS 601 - 1985), rate of germination (by Piper H., 1952), simultaneity of germination (by Strona, G., 1966) were determined. The analysis of variance were made by Fisher, R. E. , 1958. The physiological characteristics: content of raw fat (by Suckle, in Stambolova, M. et al., 1978), content of total soluble protein (by Lowry, R. N. et al., 1951), intensity of respiration, activity of enzymes: peroxidase (Bojarkin, A.N., 1951), catalase, acid phosphatase and ATP-se (Ermakov, A.I., 1972) were analysed in the six-day sprouts during the time of determination of the germination energy.

Results and Discussion

With the change of the seeds age, the viability is changed too. The germination energies (Table 1) were very low in four-year-old seeds of cultivar 'Biala shipka' -2.4 % and in eight-years seeds from cultivar 'Shumenski ratund'-6.4% and reached to 89.9 % in two-year-old seeds from cultivar 'Sivria 600'. In this cultivar was determined and the highest germinability-96.4% and lowest was in the seeds from 'Shumenski ratund' with crop year-1985-55.4%.

In the requirements for the second class by BSS were included to the four-year-old seeds,with the exception of 'Biala shipka' (1989), 'Zlaten medal 7' (1990) and 'Kapia UV' (1990). As a genotype response in the frame of the species,it could be pointed out the fact, that the five-year-old seeds from cultivar 'Novoselska kapia 379' was the requirements of the first class with germination -88.2 %. The other seeds from this age and some four-year-old seeds were not even in second class. The viability of the pepper seeds was kept comparatively high mainly in the two-year-old seeds. In this crop a tendency was observed, in different from the other species vegetable crop from this family (Aladjadjian, A. and N. Panayotov, 1994), that with the increase of the age the sowing quality sharply decreases. The rate of germination was highest in the two-year-old seeds and changed from 4.3 to 4.6 days. It decreases very sharply from five-year-seeds and

reached to 9.7 days in eight-year-old seeds. The simultaneity of germination followed this tendency from 7.5 -10.4 % of two-year-old seeds to 4.8 % and 4.6 % in seven- and eight-year old seeds, respectively. Most of the obtained results were statistically significant.

Table 1. Sowing quality of pepper seeds with different age.

N	Cultivars	Crop year	Age	Germination energy-%	Germinability-%	Rate of germination-days	Simultaneity of germination-%
1	Sumenski ratund	1985	8	6.4	55.4	9.7	4.6
2	Kalinkov 800/7	1986	7	19.1	57.8	8.1	4.8
3	Pazardziski edar	1987	6	23.9	64.1	8.2	4.9
4	Vesna	1988	5	39.6	67.6	7.9	5.2
5	Novoselska kapia 379	1988	5	28.1	88.2	7.7	5.4
6	Biala sipka	1989	4	2.4	66.0	7.3	5.5
7	Novoselska kapia 379	1989	4	46.2	78.5	6.9	6.0
8	Kozi roga	1989	4	72.5	88.3	5.1	6.3
9	Sofijska kapia	1990	3	71.1	85.1	5.9	6.5
10	Zlaten medal 7	1990	3	62.9	70.9	5.8	5.5
11	Buketen 50	1990	3	59.6	82.0	5.5	6.3
12	Kapia UV	1990	3	54.6	72.3	5.5	5.2
13	Albena	1990	3	49.1	75.8	4.5	7.4
14	Balgarski ratund	1991	2	76.8	89.2	4.6	8.1
15	Albena	1991	2	83.4	89.6	4.3	7.5
16	Sivria 600	1991	2	89.9	96.4	4.5	10.7
GD	5.0%			25.8	18.1	1.7	3.7
	1.0 %			37.4	37.4	2.5	5.7
	0.1 %			56.1	56.1	3.8	8.1

Table 2 shows the content of raw fat. What is impressive, is that the content of raw fat decreases in older seeds, which corresponds to their lower viability. The lowest value was observed in the six-year-old seeds of 'Pazardziski edar'-15.69 % (from 85.93 % to 95.45 % in comparison with the two-year-old seeds). Increased amount of the fat was observed in younger seeds i.e. two- and three-year-old seeds and the values changed from 19.76 % in 'Bulgarski ratund' (two-year-old) to 23.0 % in 'Buceten 50' (three-year-old).

The greatest content of total soluble protein was observed in the two-year-old seeds from 710 γ/ml extract in 'Albena' to 720 γ/ml extract in 'Bulgarski ratund'. On some occasions on the samples with older seeds lower content of total soluble proteinis was observed -on 'Vesna' (five-year-old), 'Pazardziski edar' (six-year-old) and 'Shumenski ratund' (eight-year-old). This obviosly is connected with the aggregation of easily soluble proteins, occurring during the ageing of the seeds (Nikolova, A. and K. Gajdardzieva, 1988). This in turn reflected on the lower viability observed in the seeds in the above-mentioned samples.

The respiration intensity is a process which characterises, the physiological state of the seeds and is closely connected with their age peculiarities. Kimenov, G., 1994 pointed out that during the germination the sprouts of older seeds are with weaker respiration processes. The increase of respiration intensity is the first reaction of the waking-up of the seed, while at the same time the growth of the sprouts is connected with the activity of the respiratory enzymes (Dencheva, A. et al., 1985). The six-day-old sprouts from eight-year-old seeds of 'Shumenski ratund' and in six-year-old seeds of 'Pazardziski edar' had the weakest respiration-12.6 mg CO_2/h/100 g and 13.2 mg CO_2/h/100 g, respectively, which also had the lower germination energy and germination. High value was observed in some two-year-old seeds - from 26.8 mg CO_2/h/100 g in 'Albena' to

29.2 mg CO_2/h/100 g in 'Bulgarski ratund', and also in the three-year-old seeds- from 'Albena '- 25.6 mg CO_2/h/100 g.

Table 2 Physiological behaviours of pepper seeds with different age.

N*	Raw fat-% Dry weight	Total Soluble protein-γ /ml extract	Intensity of respiration - mgCO_2/h/ 100g	Peroxidase- U/g fresh mater	Catalase- Cm^3O_2 min	Acid phosphatase - mgP_2O_5/ 100 mg protein	ATP-se- mgP_2O_5 /100g protein
1	19.06	480	1.26	180	2.90	3.00	3.20
2	18.79	560	1.46	210	3.10	3.05	3.60
3	15.69	480	1.32	162	3.20	3.05	3.33
4	17.88	340	1.86	180	4.00	3.40	3.60
5	18.62	640	2.92	150	3.80	2.85	3.70
6	18.58	490	1.95	160	3.60	2.70	3.65
7	18.43	560	1.85	170	3.90	2.90	3.75
8	19.19	520	2.15	180	3.80	2.60	2.90
9	18.68	480	2.18	152	4.20	2.85	3.05
10	21.38	520	2.06	138	4.80	2.90	3.15
11	23.00	530	2.45	142	3.90	3.00	3.10
12	22.00	690	2.38	140	3.80	3.20	3.00
13	20.53	660	2.56	150	4.20	2.65	2.90
14	19.76	720	2.92	146	4.50	2.80	2.60
15	22.18	710	2.68	150	4.60	2.90	2.50
16	20.31	715	2.85	168	4.20	2.70	2.50

Note: * The name of cultivars, crop years, age are shown in Table 1.

The activity of the enzyme peroxidase was highest in the seeds from 'Kalinkov 800/7' (1986)-210 U/g, followed by 'Shumenski ratund' (1985), 'Vesna' (1988) and 'Kozi roga' (1989)-180 U/g for each of them. To some extent it can be concluded that the sprouts of the younger seeds had comparatively lower peroxsidase activity. A reverse tendency was observed with regard to the enzyme catalase, where the sprouts of the younger seeds had higher activity- from 3.80 cm^3 O_2/g/min in 'Kapia UV' (three-year-old) to 4.80 cm^3 O_2/g/min in 'Zlaten medal 7' (three-year-old). There was an exception in 'Vesna' (five-years old) where high catalase activity also was observed- 4.00 cm^3 O_2/g/min. The intensity of this enzyme depends and changes further with the age of the seeds.

With regard to the enzyme acid phosphatase in most of the cases its activity in the sprouts increases with the increase of the age of the seeds and was between 2.60 mg P_2O_5/ 100 mg protein in the two-year-old seed in 'Sivria 600' to 3.40 mg P_2O_5/ 100 mg protein in the seven-year-old seeds from 'Kalinkov 800/7', which coincides with the decrease of the sowing characteristics. According to Varbanov, M., 1982, the acid phosphatase is higher in sprouts of seeds with lower germination. A similar tendency was observed in the enzyme ATP-se, The activity of this enzyme was highest in the seeds between four and eight years of age. These seeds had lowest sowing qualities. Dencheva, A. et al., 1985 states that together with the ageing of the seeds their viability and the level of the ATP decrease too. Probably this is connected with its complete decomposition as a result of the increased ATP activity - a fact established by us, too. High values were observed and in some three-year-old seeds – 'Sofjiska kapia', 'Zlaten medal 7', 'Buketen 50' and 'Kapia UV' - from 3.00 to 3.15 mg P_2O_5/ 100 mg protein.

Conclusions:

In the investigation on species level in the seeds from vegetable species-pepper, it was

established that the viability was kept comparatively high in two-year-old seeds, and in some cases in four-year-old seeds.

The young seeds were with higher content of oils and total protein. In those seeds the enzyme activity of peroxidase was lower and the catalase was higher.

With increase of the seed age values of the enzymes acid phosphatase and ATP-se were changed, and usually their activity increased.

References:

1. ALADJADJIAN A. and N. PANAYOTOV, 1994. Fizicni svojstva na semena s razlicna vazrast ot domati i piper. Naucni trudove na V Nacionalen simposium s mesdunarodno ucastie"Fisika i zemedelie" 125-129.
2. ALI N., R. SKIRVIN, W.E. SPLITTSTOESSER, W.L. GEORGE, 1991. Germination and regeneration of plants from old cucmber seed. Hortscience (USA) 26 :7, 917-918.
3. BDS-601, 1985. Seme. Pravila za vzemane na probi i metodi za opredelane na posevnite mu kacestva.
4. BOJARKIN A. N., 1951. Biohimia. Moskva.
5. DENCHEVA A. D. KLISURSKA, B STEFANOV, K. GAJDARFZIEVA, A. NIKOLOVA, 1985. Savremenno sastoanie na vaprosa za fiziologo-biochimicnoto osnovi na ziznenostta i ziznenata sila na semenata-osnova na produktivnostta na rasteniata. Fiziologia na rasteniata 7: 100-108.
6. ERMAKOV A. I. , 1972. Metodi biohimiceskogo zsledovania rastenii. Moskva.
7. FISHER R. E., 1958. Statisticheskie metodi dlja izsledovatelej. Moskva.
8. GUERTLIER G., 1989. Adaptatiive control of respiration and some enzymes by the axis of germinatity pea seeds under NaCl streess. Agrochimia (Ytaly) 33:1-2, 98-106.
9. HENTEGS D.L., C. M. WEAVER, S.S.NIELSON, 1991. Changes of selected physical and chemical componenets in the development of the hard-to-cook bean defect. Journal of food science an official publications of the Institute of Food Technologyst (USA) 56:2, 436-442.
10. KERMASHA S. I ALLLI, N. METCHE, 1990. Studie on the transaminase systems in French ean (*Phasiolus vulgaris*) seed. Biotechnology and applied biochemistry 12:3, 301-314.
11. KIMENOV G., 1994. Fiziologia na rasteniata. Universitetsko izdatelstvo "Sveti Kliment Ohridski",Sofia.
12. LOWRY R.N. et al., 1951. Journal of Biology and Chemistry 193: 262-275.
13. NIKOLOVA A. and K. GAJDARDZIEVA, 1990. Beltacen mehanizam v zarodishite na prorastvani semena ot carevica s razlicna ziznenost i ziznena sila. Fiziologia na rasteniata 8:II, 546-549.
14. PIPER H., 1952. Das Saatgut. Zweite Auflage. Berlin.
15. SMITH P.T. and B.G. COBB, 1991. Phisisological and enzymatic activity of pepper seeds (*Capsicum annuum*) during primicy. Phisiologia Plantarum 82:3, 433-439.
16. STAMBOLOVA M., T. CHOMONEVA, T. ARGIROVA, 1978. Rakovodstvo za prakticheski zanyatiya po biochimya. Nauka i izkustvo, Sofia 134-135.
17 STRONA G., 1966. Bsshtee semenovodstvo polevnih cultur. Moskva. 362-363.
18 .VARBANOV M., 1982. Aktivnost na kiselata fosfataza v lista i semena na diploidni i avtotetraploidn sformi na zaharno cveklo. Fiziologia na rasteniata 6 : 450-453.
19. WATKINS J.T. et al., 1983 . Journal of the American Soc. for Horticultural Science 108:3, 356-360.

Capsicum and Eggplant Newsletter, 19 (1999): 115-118.

Evaluation of eggplant (*Solanum melongena* L.) germplasm under Sub-tropical condition

Ravinder Kumar, S.S. Gupta, Narendra Singh, Anil Chandra
Division of Vegetable Crops
I.A.R.I, New Delhi-110 012, India.

Introduction

Eggplant or brinjal or aubergine (*Solanum melongena* L.) being the crop of Indian origin has also developed some secondary variability in China. It is an important vegetable crop of Indian Sub continent and an immense variability exist in this region. The importance of germplasm as basic tool in crop improvement is well recognised. Preliminary evaluation of germplasm is prerequisite for utilisation of plant genetic resources. Hence, the present investigation was undertaken with a view to evaluate the eggplant germplasm for yield and other desirable characters.

Material and methods

The experiment was conducted at the Experimental Unit of Division of Vegetable Crops, IARI, New Delhi, during kharif season of 1997 with twenty-eight germplasm consisting of some released varieties and pure lines. Nursery sowing was done in last week of June and four weeks old seedlings were transplanted in the last week of July. The experiment was laid out in Randomised Complete Block Design with three replications. Normal cultural practices were followed for raising the crop. A random sample of five plants was used to record observations on plant height, days to first harvest from sowing, fresh weight per fruit, number of fruits per plant, total yield per plant and calculated yield per hectare. Colour and shape of the fruit were also observed. The data was subjected to statistical analysis by adopting analysis of variance as per the technique of Shedecor and Cochran (1967).

Results and Discussion

The details of germplasm used along with their mean, SEM, and C.D. values are given in Table 1. All the germplasm differed significantly with respect to different characters studied. Wide range of variation was observed in all the characters. Plant height varied from 75.33 cm (PPL) to 107.67 cm (KS-227), days to first harvest from 80.00 days (PPL) to 105.00 days (CHBR-3), average fresh weight per fruit from 51.67 g (Aruna) to 203.00 g (DBR-31), number of fruits per plant from 5.67 (AB-1) to 22.00 (DBSR-91), yield per plant from 0.77 kg (CH-157-16-4-1) to 1.91 kg (DBR-31) and yield per hectare from 153.67 q (CH-157-16-4-1) to 382.67 q (DBR-31). Singh *et al.* (1974) also observed significant differences for plant height, days to flower, fruit weight and yield per plant among 24 lines of brinjal. The highest number of fruits per plant was observed in DBSR-91 which is a small-fruited variety. Other small-fruited lines DBSR-44, JB-64-1-2, Aruna and RHRB 9-2-1-1, also produced around 20 fruits per plant. The number of fruits per

plant was also high in long fruited lines such as PB-30, PPL and DBL-11. Most of the small fruited and long fruited lines were found early bearer (took less number of days to first harvest). The highest yield was found with DBR-31 which has oval-round, purple, glossy fruits. Kalda *et al.* evaluated 30 diverse genotypes of brinjal and found high variability for number of fruits per plant, fruit weight and fruit size index. The germplasm possessing early maturity, more number of fruits per plant and higher fruit weight may be utilised in hybridisation programme. The breeder can make use of the promising germplasm in their breeding programme according to their objective.

References

Kalda, T.S.; Suran, B.S. and Gupta, S.S. 1988. Phenotypic genotypic variation and heritable components of some biometrical characters in eggplant. South Indian Horticulture. 36(3) :110-113.

Singh, S.N.; Singh, Dharam; Chauhan, Y.S. and Katiyar, R.P. 1974. Genetic variability, heritability and genetic advance in brinjal. Progressive Horticulture. 6(1) : 15-18.

Snedecor, G.W. and Cochran, G.W. 1967. Statistical Methods. 6th Edition. The Iowa State Uni. Press, Iowa, USA.

Table1. Mean performance of eggplant germplasm for different characters

S. NO.	Germplasm	Source	Plant height (cm)	Number of days to first harvest	Average fresh weight/ fruit (g)	Number of fruits/ Plant	Yield/ plant (kg)	Yield (q/ha)	Fruit shape	Fruit colour
1.	PB-33	Pantnagar (U.P.)	82.33	95.00	89.33	11.67	1.18	236.67	Long	Purple
2.	PB-30	Pantnagar (U.P.)	104.67	83.67	63.67	20.67	1.33	266.80	Long	Light purple
3.	D-2-88-6	Sabour (Bihar)	97.33	91.33	129.33	9.67	1.14	288.47	Round	Purple
4.	Punjab Sadabahar	Ludhiana (Punjab)	82.67	82.33	84.67	16.00	1.42	284.07	Long	Dark purple
5.	PPL	I.A.R.I (Delhi)	75.33	80.00	70.67	19.33	1.27	254.93	Long	Light purple
6.	PK	I.A.R.I (Delhi)	95.67	92.00	121.67	10.33	1.36	272.00	Long	Purple
7.	DBL-11	I.A.R.I (Delhi)	90.33	87.33	81.67	19.33	1.68	335.80	Long	Dark purple
8.	DBR-31	I.A.R.I (Delhi)	81.67	94.33	203.00	9.67	1.91	382.67	Oval-round	Purple
9.	DBR-8	I.A.R.I (Delhi)	97.33	91.33	194.67	8.00	1.63	325.07	Round	Dark purple
10.	DBSR-91	I.A.R.I (Delhi)	83.33	84.67	65.00	22.00	1.65	330.47	Oval-round	Dark purple
11.	DBSR-44	I.A.R.I (Delhi)	80.00	85.67	63.00	20.33	1.35	270.00	Oval-round	Dark purple
12.	CH-157-16-4-1	Ranchi (Bihar)	91.33	95.00	95.00	8.67	0.77	153.67	Oval-round	Lighti green
13.	NDB-26	Faizabad (U.P)	82.00	91.00	90.00	14.00	1.32	263.67	Oblong	Purple
14.	NDB-28-2	Faizabad (U.P)	103.00	90.00	74.00	18.00	1.46	291.33	Long	Dark purple
15.	KS-352	Kalyanpur (U.P)	103.00	101.33	98.33	10.67	1.33	225.20	Long	Purple
16.	KS-331	Kalyanpur (U.P)	103.00	89.67	103.00	12.67	1.46	324.53	Long	Purple
17.	KS-227	Kalyanpur (U.P)	107.67	93.33	173.00	7.67	1.22	244.53	Round	Purple
18.	KS-224	Kalyanpur (U.P)	91.33	92.33	187.67	7.67	1.48	296.67	Round	Light purple

Table 1 contd.

S. NO.	Germplasm	Source	Plant height (cm)	Number of days to first harvest	Average fresh weight/ Fruit (g)	Number of fruits/ Plant	Yield/ Plant (kg)	Yield (q/ha)	Fruit shape	Fruit colour
19.	JB-15	Jabalpur (M.P.)	88.33	93.33	82.00	12.67	1.29	258.33	Long	Purple
20.	JB-64-1-2	Jabalpur (M.P.)	89.00	92.00	52.67	20.33	1.40	280.73	Oval	Purple
21.	CHBR-2	Ranchi (Bihar	91.33	90.67	174.33	8.33	1.34	268.87	Round	Purple
22.	CHBR-3	Ranchi (Bihar)	82.33	105.00	165.00	7.67	1.11	221.53	Oval-round	Dark purple
23.	AB-1	Anand (Gujrat)	91.33	103.00	162.33	5.67	1.00	200.00	Round	Light purple
24.	AB-2	Anand (Gujrat)	101.33	91.67	129.00	11.67	1.36	271.67	Oval	Purple
25.	BB-3-1	Bhubaneswar (Orissa)	99.33	95.67	163.33	12.33	1.63	336.93	Oval	Purple
26.	BB-16-3	Bhubaneswar (Orissa)	104.33	100.00	150.67	8.00	1.13	225.53	Oval-round	Purple
27.	RHRB-9-2-1-1	Rahuri (Maharashtra)	85.00	89.33	64.33	19.00	1.41	282.67	Oval	Purple
28.	Aruna	Akola (Maharashtra)	84.67	87.33	51.67	20.67	1.20	240.13	Oval	Light purple
	Mean		91.76	91.73	113.68	13.31	1.34	270.10		
	Range		75.33-107.67	80.00-105.00	51.67-203.00	5.67-22.00	0.77-1.91	153.67-382.67		
	C.V.		5.57	3.19	8.06	16.22	16.33	10.23		
	SEM		2.95	1.69	5.29	1.25	0.13	15.96		
	CD at 5%		11.14	6.38	19.98	4.71	0.48	60.25		

Capsicum and Eggplant Newsletter, 19 (1999): 119-122.

PLANT DENSITY IN RELATION TO VEGETATIVE AND YIELD PERFORMANCE OF FOUR ACCESSSIONS OF SOLANUM GILO

BY
OLUFOLAJI, A.O.
NATIONAL HORTICULTURAL RESEARCH INSTITUTE,
P.M.B. 5432,
IBADAN,
NIGERIA

ABSTRACT

A field study was conducted in a split plot experiment to determine the influence of plant densities (140,000; 80,000 and 60,000 plants/ha.) using (50 x 25; 50 x 50 and 50 x 75 cm spacing respectively) on the yield of four accessions (NH94/36; NH94/343; NH94/37-2 and NH94/35) of Solanum gilo. The results indicated that all accessions produced different fruit size, colour, shapes and taste. Accessions 'NH94/35 gave the highest fruit yield followed by 'NH94/36; accession 'NH94/343' was intermediate while 'NH94/37-2' gave he least fruit yield. The highest plant density produced the highest yield. Therefore, there is every possibility of exploring higher than 140,000 plants/ha.in future studies.

INTRODUCTION

Solanum gilo, one of the egg-plant related species is widely cultivated in the tropics especially Nigeria, Ghana, Ivory Coast and Kenya (Purseglove, 1968; Monma *et al* 1996). Solanum gilo are cultivated for their fruits, the immature ones are eaten as salads, cooked as vegetables and for seasoning other foods (Kogbe, 1983; Lester, 1990). Being an often cross pollinated crop, possess considerable diversity for plant types, fruit yield and yield attributes and thus offers an opportunity to exploit the genetic diversity for development of hybrid varieties (Ahmed, *et al*, 1998).

Although, the fruits of solanum gilo are seasonally found in the Nigerian local markets, little agronomic studies have been carried out to compliment the breeding work (Omidiji, 1983). Some spacings (100 x 100cm; 90 x 60cm; and 60 x 45cm) have been utilized for the production of egg plant under varying conditions (Ahmed et al, 1998). While, in Nigeria, the influence of four spacing (90 x 120; 90 x 60; 45 x 60 and 45 x 45 cm) on the yield of egg plant were compared. It was observed that the total fruit yield, number of fruits per plant and per square metre increased with increase in spacing up to the widest spacing used but the response to the total fruit yield was not significant in the local species of egg plant (Kogbe, 1983).

The present study was aimed at determining the response of four accessions of egg plant to three population densities in order to culturally manipulate the crop for optimum yield.

MATERIALS AND METHODS

Seeds of four accessions ('NH94/36'; 'NH94/343'; 'NH94/37-2'; and 'NH94/35') of solanum gilo were sown in nursery trays in May, 1998. At three weeks after sowing, seedlings were transplanted into sandy loam field soil with pH 6.8 at 50 x 25; 50 x 50; and 50 x 75cm spacing in four replicates and a split plot arrangement involving 48 plots each of 1 x 1.5 m.

At 2 weeks after transplanting, plants were fertilized with NPK 15:15:15 at the rate of 200kg/ha. All necessary cultural operations were undertaken during the period of crop growth.

Vegetative plant characters involved measurement of plant height, branch number, leaf number, leaf area at sixteen weeks (Physiologic maturity) while the reproductive characters involved addition of all harvests in term of fruit number and weight per plot. All data were analysed using analysis of variance in which the least significant difference was calculated for the main plot, (accessions), the sub-plot (population density) as well as for the interaction.

RESULTS

Generally, there was an increase in the measured plant characters with age up till 16 weeks after sowing thereafter growth became constant. At maturity, accession 'NH94/36' and 'NH94/37-2' gave similar but significantly taller plants than accessions 'NH94/343' and 'NH94/35' both of which gave similar values (Table 1).

Plant height were similar at the three (140,000; 80,000 and 60,000 plants/ha.) densities utilized in the study. The effect of interaction showed that 'NH94/36' and 'NH94/37-2 gave similar but taller plants at the two lower densities than at the highest.

Accession 'NH94/36' produced more branches than all the other three accessions. The lowest density also produced the highest branch number. Accession 'NH94/36' at (60,000 plants) produced the highest branch number.

Higher leaf number was obtained in 'NH94/36' than the other three accessions which gave similar leaf number. Leaf number was similar in the two lower densities but better than in the highest plant densities. Accession 'NH94/36' at the two lower densities gave the best interaction.

The leaf area was similar but significantly higher in 'NH94/343' and 'NH94/35' than in 'NH94/37-2'. The leaf area was similar but significantly better at the two lower than at the highest plant density. Accession 'NH94/35' at the lower densities gave the best interaction.

Fruit number was similar in accessions 'NH94/36' and 'NH94/37-2' but significantly better than in accessions 'NH94/343' and 'NH94/35'. More fruits were obtained at the highest density than at the lower ones. Interaction showed that 'NH94/37-2' at the highest plant density gave the highest fruit number per square metre.

Accession 'NH94/35' was superior in fruit weight followed by 'NH94/36' and 'NH94/343' while 'NH94/37-2' gave the least weight. The highest plant density also gave the highest fruit weight. While the interactive effect showed that 'NH94/343'and 'NH94/35' at the highest plant density gave the highest fruit weight (Table 1).

DISCUSSION

In this study, variation in the vegetative characters in terms of stem height, branch number, leaf number and leaf area of the different accessions conformed to two groups, with 'NH94/36' being superior to the other three accessions. These observations support those of Olufolaji and Makinde, 1994 that differences exist in the morphological and yield attributes among different accessions of egg plant.

The four accessions of solanum gilo utilized in this study posses distinct fruit size, shape, colour and taste. Accession 'NH94/36' has small white fruits with deep green stripes, very sweet taste. Accession 'NH94/37-2' has small creamy white fruits, mildly sweet taste. Accession 'NH94/343' has big yellowish green watery tasting fruit while accession 'NH94/35' has big green with deep green striped fruits, very bitter taste (Olufolaji and Makinde, 1994)

Accessions 'NH94/36' and 'NH94/37-2' produced numerous small fruits while 'NH94/343' and 'NH94/35' produced big fruits. However, the high fruit number of the former was not significant enough to counteract the total fruit weight such that the few fruits of 'NH94/35' gave the highest yield ($4kg/m^2$).

In spite of the closeness of the plants at the highest density (140,000 plants/ha.) fruit number and weight were highly encouraged. Kogbe, 1983 also reported similarly that plant population of 9,000 to 49,000 plants/ha. gave similar yield.

Accession 'NH94/35' was superior in yield to all the other accessions but the very better fruit taste is a disadvantage in terms of domestic use of the crop. Nevertheless, the pharmaceutical importance may be exploited. Accession NH94/36 also gave a better fruit yield than the other two accessions, thus its domestic use should be encouraged.

REFERENCES

1. Ahmed, N; Khan, N.A; Tanki, M.I. and Wani, S.A. 1998. Heterosis Studies in Eggplant. (Solanum melongena L.) Capsicum and Eggplant Newsletter, 17:76-79.
2. Deanon, J.R. 1967 Eggplant, Tomato and Pepper in Vegetable Production in South East Asia. Edit James E. Knott and J.R. Deanon Jr University of Phillipines Press 366p.
3. Kogbe, K.O.S. 1983 Effect of spacing on the yield of local and exotic species of eggplant. Acta Horticulturae, 123; 291-295.
4. Lester, R.N; Jaeger, P.M.L; Bleijendaal – Spierings, B.M.H; Bleijendaal, H.P.O; and Holloway, H.L.O. (1990). African eggplants – a review of collecting in West Africa. FAO/IBPGR Plant Genetic Resources – Newslwtter No. 81/82.
5. Monma, S.Sato, T. and Matsunaga, H. 1996. Evaluation of resistance to Bacterial Fusarium and Verticillum wilt in Eggplant and Eggplant – related species collected in Ghana. Capsicum and Eggplant Newsletter 15:71-72.
6. Olufolaji, A.O. and Makinde, M.J. 1994. Evaluation, characterization and fruit production pattern of eggplant germplasm. Capsicum and Eggplant Newsletter 13: p. 100 – 103.
7. Omidiji, M.O. 1983. Evaluation of some F_1 hybrids and cultivars of the local Eggplant, Solanum gilo Raddi in South Western Nigeria. Acta Horticulturae 123:91-98.
8. Purseglove, J.W. 1968. Tropical crops – Dicotyledons. Longman Group Limited. Burnt. Mill. Narlow, Esses, U.K. 719p.
9. Sakata, Y. 1992 Taxomomic relationship between solanum melongena (eggplant), Solanum incanum and solanum marginatum based on chloroplast DNA. Capsicum Newsletter. 8th Meeting, Genetic and Breeding on Capsicum and Eggplant. Rome (Italy) p. 276-282.

Table 1: The effect of accessions, plant densities and their interactions on the vegetative and yield characters of solanum gilo

Cultivar	Stem height Cm	Branch Number	Leaf Number	Leaf area cm^2 '000	Fruit Number	Fruit wt. Kg/m^2
(V_1) NH94/36	301.3a	32.92a	645.4a	142.02c	154.83a	3.45b
(V_2) NH94/343	213.3b	15.33b	338.3b	755.60a	91.67b	3.36bc
(V_3) NH94/37-2	269.0a	23.75b	425.8b	579.29b	154.33a	3.02c
(V_4) NH94/35	202.5b	17.55b	365.0b	695.60a	100.50b	3.97a
LSD (P=0.05)	42.55	12.55	99.5	125.96	22.55	0.390
Spacing						
(S_1) 50 x 25cm	262.5a	9.66c	407.1b	21.70b	166.58a	4.04a
(S_2) 50 x 50cm	265.0a	16.00bc	485.0a	76.50a	124.58b	3.07b
(S_3) 50 x 75cm	256.1a	39.67a	493.3a	81.63a	109.67b	2.73c
LSD (P=0.05)	42.55	12.55	79.5	10.56	22.55	0.279
Interaction						
V_1 S_1	221.5	26.50	451.3	32.04	165.25	3.90
V_1 S_2	275.0a	20.00	777.5a	69.62	147.75	3.49
V_1 S_3	281.3a	40.00a	707.5a	148.09	151.50	2.98
V_2 S_1	210.0	8.00	337.5	21.29	136.50	4.67a
V_2 S_2	220.0	14.00	350.0	38.91	87.75	2.77
V_2 S_3	210.0	24.00	327.5	46.09	50.75	2.64
V_3 S_1	230.0	4.75	432.5	11.78	198.0a	3.54
V_3 S_2	300.0a	14.00	400.0	23.25	138.1	2.96
V_3 S_3	277.0a	15.00	445.0	50.72	126.75	2.59
V_4 S_1	212.0	7.00	311.5	169.25	160.75b	4.01a
V_4 S_2	213.5	8.58	354.0	182.75a	115.0	3.52
V_4 S_3	209.0	14.35	350.0	184.50a	102.0	3.35
LSD (P=0.05)	62.59	10.95	105.56	25.599	28.39	0.351

***Means followed by different letters are significantly different at P=0.05**

Capsicum and Eggplant Newsletter, 19 (1999): 123-126.

GENETICS OF QUALITY TRAITS IN EGG PLANT *(Solanum melongena* L.)

Ahmed, N. Mehdi, M. and Raj Narayan
Division of Olericulture, Sher-e-Kashmir University of Agricultural Sciences and Technology, Srinagar – 191 121 Jammu & Kashmir, India

INTRODUCTION

Egg plant *(Solanum melongena* L.) is an important fruit crop which holds a covoted position in India as a leading summer and rainy season vegetable. In Jammu and Kashmir, there is a preference for pink or purple fruit colour and during summer, the local population dry fruits in sun for use in off winter season. Because of specific preference for colour and dried product, there is a need to develop varieties with higher dry matter percent and having desirable pink or purple fruit colour. For rendering a permanent genetic improvement of quality traits, the breeder must have adequate knowledge of heritability and magnitude of gene action involved especially components of genetic variances viz. additive, dominance and their interactions. This helps the breeder to design and execute appropriate breeding procedure in cultivar development programme. Hence, an experiment was conducted to examine the gene effects for quality traits namely dry matter content and anthocynin pigmentation in two crosses of egg plant.

MATERIALS AND METHODS

The experimental material comprised six generations (P_1, P_2, F_1, F_2, BC_1 and BC_2) of two intervarietal crosses viz. APAU Selection-4 x Local Long (Sel-4 x LL) and Sada Bahar x Local Long (SB x LL). These crosses were used to study the inheritance of quality characters viz. dry matter content and anthocynin pigmentation which imparts purple fruit colour. The six basic generations were developed during 1996 and 1997 and were evaluated during summer 1998 at Vegetable Experimental Farm of Sher-e-Kashmir University of Agricultural Sciences and Technology, Srinagar in a randomized block design with three replications. The plants were planted at a spacing 60 cm x 45 cm and a healthy crop was raised following recommended package of practices. In each replication the number of plants allocated to different generations were: $P_1 = P_2 = F_1 = 10$, $BC_1 = BC_2 = 30$ and $F_2 = 60$. In addition, non experimental plants were also grown around the experimental plots to avoid border effects. The anthocynin pigment which imparts purple fruit colour was estimated from fresh fruit skin of each plant of cross SB x LL by the method of Swains and Hills (1959) and expressed as ug/g. The percent dry matter was calculated from both the crosses Sel-4 x LL and SB x LL by taking 100 g composite sample drawn from five random fruits of each plant. The sample was first cut in to pieces and dried in a oven at 60±2°C till dry weight of the sample remained constant. The generation means were analysed following weighted least squares method suggested by Mather and Jinks (1971). The three parameter model was first fitted to estimate the genetic parameters viz. mean [m], additive [d] and dominance [h]. Where the three parameter model was inadequate, a six parameter model was fitted which included additive x additive [i], additive x dominance [j] and dominance x dominance [l] interaction effects in addition to m, [d] and [h]. The heritability in narrow sense and genetic gain were calculated as per the method suggested by Johnson *et al.* (1955).

RESULTS AND DISCUSSION

Means of different generations and estimates of the gene effects are presented in Table 1 and 2. F_1 mean indicated over dominance and dominance of low dry matter content parent in cross Sel-4 x LL and SB x LL respectively over high dry matter content parent. This was also substantiated by significant negative dominance and dominance x dominance components in 3 and 6 parameter models respectively in the both the crosses. Where as for anthocynin content over dominance of higher parent was observed (Table 2) which was also evident by significant dominance component in both the models. The continuous variation observed in F_2, BC_1 and BC_2 segregating populations revealed polygenic inheritance for both the characters. The joint scaling test for dry matter content and anthocynin pigmentation showed significant x^2 value. This indicated the inadequacy of simple three parameter model and suggested the presence of non allelic interactions in the inheritance of both the quality attributes. To estimate interaction components a six parameter model was fitted. For dry matter content, in cross Sel-4 x LL all the genetic components namely additive, dominance, additive x additive, additive x dominance and dominance x dominance were found significant. Though all the components were significant however the magnitude of dominance component [h] was high as compared to other components. Where as in cross SB x LL only additive x additive and additive x dominance interaction components were significant and thus are important in the inheritance of dry matter content. For anthocynin pigmentation all the components except dominance x dominance were significant in cross SB x LL with dominance component being high as compared to other components. Although dominance component was high but the other components viz., [d], [i] and [j] being significant suggested the importance of both additive and non additive gene effects in the inheritance of dry matter content in cross Sel-4 x LL and anthocynin content in cross SB x LL. The importance of both additive and dominance components has also been reported for these characters by Din *et al.*(1997) and Chadda and Hegde (1988). Further, the estimates of dominance and dominance x dominance components having opposite signs in the cross Sel-4 x LL for dry matter content showed the presence of duplicate type of gene interaction which suggests that selection for this trait migh be difficult while complementary type gene action was observed in cross SB x LL for anthocynin content leading to predominant non additive gene effects.

Heritability and genetic gain are important parameters in selection programme. The results presented in Table 3 indicated moderate heritability and genetic advance for dry matter content and high heritability and genetic advance for anthocynin content suggesting that selection will be effective in isolating desirable recombinants from segregating populations.

Since both additive and non additive gene effects are important in genetic control of these quality traits a recurrent selection procedure could be adopted for generating transgressive segregants. The heritability being moderate to high the selections made would be more reliable and the genetic gain expected from segregating population would be as high as 22.20 percent for dry matter content and 47.99% for anthocynin pigment.

Table 1. Mean dry matter content (%) of different generations and components of generation means

Mean dry matter content (%)		Three parameter model		Six parameter model	
Sel-4 x LL	SB x LL	Sel-4 x LL	SB x LL	Sel-4 x LL	SB x LL
P_1 = 8.36±0.19	9.54±0.23				
P_2 = 9.06±0.18	9.10±0.21	m = 9.19**±0.07	9.11**±0.08	m = 5.32**±0.77	7.48**±0.88
F_1 = 7.46±0.21	9.11±0.28	[d] = 0.45**±0.12	0.35**±0.14	[d] = 0.35**±0.13	0.24**±0.15
F_2 = 8.98±0.14	8.31±0.14	[h] = -0.54**±0.14	-0.72**±0.17	[h] = 12.50**±1.98	1.69**±2.33
BC_1 = 9.36±0.18	9.25±0.20			[i] = 3.39**±0.76	1.82**±0.86
BC_2 = 10.29±0.19	8.29±0.26	x^2 = 95.10**	22.20**	[j] = 1.14**±0.59	1.46**±0.72
		(3 d.f.)		[l] = -10.36**±1.29	-0.06±1.56

*, ** Significant at 5% and 1% level respectively.

Table 2. Anthocynin content (µg/g) of different generations and components of generation means of cross SB x LL.

Means	Three parameter model	Six parameter model
	SB x LL	SB x LL
P_1 = 7.42±0.20		
P_2 = 4.58±0.17	m = 4.63**±0.12	m = 2.47*±1.05
F_1 = 10.37±0.25	[d] = 0.04±0.12	[d] = 1.43**±0.13
F_2 = 6.40±0.19	[h] = 5.93**±0.26	[h] = 7.65**±2.70
BC_1 = 8.70±0.23		[i] = 3.53**±1.04
BC_2 = 5.80±0.29	x^2 = 297.83**	[j] = 2.97**±0.78
	(3 d.f.)	[l] = 0.24±1.74

*, ** Significant at 5% and 1% level respectively.

Table 3. Heritability (narrow sense) and genetic gain of crosses Sel-4 x LL and SB x LL.

S.No.	Character	Heritability		Genetic advance		Expected genetic gain	
		Sel-4xLL	SBxLL	Sel-4xLL	SBxLL	Sel-4xLL	SBxLL
1.	Dry matter content (%)	0.53	0.60	1.63	1.84	18.14	22.20
2.	Anthocyanin content (ug/g)	-	0.77	-	3.05	-	47.99

REFERENCES

Chadda M.L. and Hegde A.K. 1988. Heterosis studies in brinjal. *Punjab Horticulture Journal* **28** : 91-94.

Din G.; Tanki M.I. and Ahmed N. 1997. Gene action in brinjal *(Solanum melangena* L.). *Haryana Journal of Horticultural Sciences* **15** : 306-308.

Johnson H.W.; Robinson H.F. and Comstock R.E. 1955. Estimates of genetic and environmental variability in soybeans. *Agronomy Journal* **47** : 314-318.

Mather K. and Jinks J.L. 1971. Biometrical genetics. Chapman and Hall Ltd. London pp 71-95.

Swain T and Hills W.E. 1959. The phenolic constituents of *Prunus domestica* I Quantituents. *J.Sci.Food Agric.* **10** : 63-68.

Capsicum and Eggplant Newsletter, 19 (1999): 127-130.

LINE X TESTER ANALYSIS FOR COMBINING ABILITY IN BRINJAL (*Solanum melongena* L.)

D. Prasath, S. Natarajan and S.Thamburaj
Horticulture College and Research Institute
Tamil Nadu Agricultural University
Coimbatore-641003 (TN)-India.

INTRODUCTION

In any sound breeding programme, the proper choice of parents based on their combining ability is a pre- requisite. As such studies intended to determine the combining ability not only provide necessary information regarding the choice of parents but also simultaneously illustrate the nature and magnitude of gene action involved in the expression of desirable traits. Accordingly, the present investigation was undertaken to have an idea of the nature of gene action for yield and other important attributes in brinjal (*Solanum melongena* L.). Brinjal also known as eggplant a native of India. It is the most widely grown vegetable in Asian countries, specially in India, China, Philippines and Japan. Line x Tester analysis is a useful tool for preliminary evaluation of genetic stock for use in hybridisation programme with a view to identify good combiners, which may be used to build up a population with favourable fixable gene for effective yield improvement.

MATERIALS AND METHODS:

The experimental materials consisted of 13 parents (Including ten lines Viz., Arka Nidhi, Pant Rituraj,H 9,SM 6-6,180,190,193,195,202 and 221 and three testers Viz., CO 2, MDU 1 and Annamalai). Thirty F1 S were developed and evaluated along with parents in a Randomized Block Design with three replication at the college orchard, Department of Olericulture, Horticultural College and Research Institute, TNAU, Coimbatore during kharif 1997.Two row plots of ten parents were spaced at 60 x 60 cm for each entry. The observation of ten important characters was recorded from five randomly selected plants from each treatment. Combining ability analysis was computed according to the model given by Kempthorne (1957).

RESULTS AND DISCUSSION:

The analysis of variance revealed highly significant difference among the genotypes indicating great wealth of variability among the genotypes selected for all the economic triats (Table 1). The parents Vs hybrids comparison was significant for all the traits indicating the expression of heterosis effects. The analysis of variance for combining ability revealed significant variance for females for plan height, branches per plant and days to first flowering whereas, variance for females x males were highly significant for all the characteers. The variance due to GCA and SCA were prominent for all the characters in the present investigation. The variance due to SCA was higher than that of GCA suggesting the predominance of non-additive geneaction in the expression of characters and thus offers scope for improvement through heterosis breeding. This is further strengthened by the significance of GCA and SCA variances and their ratios.

These findings are in agreement with results of Kale *et al.*, (1992) and Sadawarte *et al.*, (1993).

The estimates of general combining ability effect for various characters are presented in Table 2. None of the parents proved to be good general combiner for all the characters. The female parent 190 possessed significant negative *gca* effect for days to 50 per cent flowering and positive *gca* effects for plant height, percentage of long-styled flowers, fruits per plant and yield per plant. For yield per plant the female parents H-9,190,202 and 221 and pollen parent CO 2 had significant positive *gca* effects. Among the male parents MDU 1 showed significant *gca* effects for plant height, branches per plant , days to 50 per cent flowering , fruit length , fruit girth and fruit weight. The significant *gca* estimate of parents Arka Nidhi , Pant Rituraj, 190, 193 ,202 and MDU 1 indicated that they have good contributing genes for increased plant height. Though the parents Pant Rituraj, SM 6-6 ,180, 193 , and MDU 1 were poor general combiners for yield per plant, they were good combiners for branches per plant.

The crosses having desired significant specific combining ability , *per se* performance and standard heterosis are presented in Table 3. The *sca*, which represents the predominance of non-additive gene action, is a major component that may be utilized in heterosis breeding. Out of 30 crosses the hybrids 190 x Annamalai, 221 x Annamalai, 193 x MDU1 and Pant Rituraj x CO 2 displayed significant positive *sca* effect, high *per se* performance and high degree of heterosis for fruit yield. In brinjal showing high *sca* for yield also exhibited high or average *sca* effects for yield component traits. Similar results have been reported by Sing and Kumar (1998): Randhawa *et al.*,(1991) and Prakash *et al.*,(1994). The hybrid 202 x CO 2 exhibited significant possitive *sca* effects as well as standard heterosis for fruit girth and fruit weight. The cross combination Pant Rituraj x MDU 1 and Pant Rituraj x CO 2 recorded significant *sca* effects desired for number of branches per plant.

From this study it can be concluded that only non-additive gene effect was found to be responsible for expression of traits and the crosses 190 x Annamalai, 221 x Annamalai, 193 x MDU1 and Pant Rituraj x CO 2 could be exploited for hybrid vigour in brinjal.

REFERENCES :

Kale, P.B., S.W. Mankar, V.N. Dod and R.V.Wankhade (1992).Combining ability in eggplant (*Solanum melongena* L). Crop Res.,**5**: 140-145.

Kempthorne O (1957). An introduction to genetic statistics. Johnwiley and sons, Newyork, pp. 458-471.

Prakash Shivashankar K.T and Gowda P.H.R (1994). Line x Tester analysis for combining ability in brinjal (*Solanum melongena* L). Crop Res.,**8** (2): 296-302.

Randhawa J.S., J.C.Kumar and M.L.Chadha (1991) Line x Tester analysis for the study of some economic characters in brinjal (*Solanum melongena* L). P.A.U.J.Res.,**28** (2): 192-198.

Sadawarte,K.T., R.V.Wankhade., P.B.Kale.,V.N.Dod and A.T.Joshi (1993). Combining ability in brinjal. (*Solanum melongena* L). PKV .Res .J.,**17** (1): 37-43.

Sing B and Kumar N (1998).Studies on hybrid vigour and combining ability in brinjal (*Solanum melongena* L.) Veg.Sci **15** (1): 72-78.

Table 1.Analysis of variance and estimate of combining ability variance for ten characters in Brinjal

SOURCE	Df	PLANT HEIGHT (cm)	BRANCHES PER PLANT	DAYS TO FIRST FLOWERING	DAYS TO 50 % FLOWERING	PERCENTAGE OF LONG STYLED FLOWERS	FRUIT LENTH (cm)	FRUIT GIRTH (cm)	FRUIT WEIGHT (gm)	FRUITS PER PLANT	YIELD PER PLANT (kg)
GENOTYPES	42	420.54**	5.46**	60.67**	66.77**	112.48**	18.12**	25.76**	2538.88**	272.86**	1.13**
PARENTS	12	509.22**	4.79**	56.17**	66.99**	83.05**	21.04**	14.74**	559.95**	142.54**	0.22**
HYBRIDS	29	243.46**	3.81**	64.48**	64.66**	72.15**	16.55**	28.62**	2801.80**	317.51**	0.71**
PARENTS Vs HYBRIDS	1	4491.69**	61.50**	4.13**	125.38**	1635.45**	28.71**	71.42**	18661.5**	514.95**	24.3**
LINES	9	439.92**	5.87**	117.84**	98.28	93.04	22.38	41.99	2820.55	378.11	1.07
TESTERS	2	249.75**	10.93**	7.89	5.63	0.18	26.66**	13.48	2790.59	270.02	0.13
LINES X TESTERS	18	144.53**	1.98**	44.08**	54.14**	69.70**	12.50**	23.61**	2793.67**	292.49**	0.60**
ERROR	58	0.70	0.15	0.47	0.46	0.08	0.17	0.16	0.36	0.33	0.002
GCA		1.85	0.03	0.38	0.19	0.04	0.08	0.09	0.15	0.47	0.002
SCA		84.44	1.89	17.06	16.61	17.88	6.45	8.33	933.59	102.38	0.19
GCA/SCA		0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.002	0.005	0.01

Table 2.General Combining Ability for ten characters in Brinjal

PARENTS	PLANT HEIGHT (cm)	BRANCHES PER PLANT	DAYS TO FIRST FLOWERING	DAYS TO 50 % FLOWERING	PERCENTAGE OF LONG STYLED FLOWERS	FRUIT LENTH (cm)	FRUIT GIRTH (cm)	FRUIT WEIGHT (g)	FRUITS PER PLANT	YIELD PER PLANT (kg)
LINES										
ARKA NIDHI	3.30**	-0.06	7.02**	5.81**	0.26**	0.91**	-1.51**	-25.76**	6.41**	-0.30**
P.RITURAJ	8.49**	1.83**	-1.34**	1.12**	0.05	-2.08**	1.09**	18.32**	-2.72**	-0.02*
H-9	-6.31**	-0.32**	5.93**	4.81**	-2.73**	-2.20**	3.82**	0.62**	0.61	0.20**
SM 6-6	-3.30**	0.28**	-1.71**	-1.01**	-4.52**	-0.49**	-0.79**	-7.50**	-8.79**	-0.71**
180	-2.24**	0.50**	-0.78**	-1.79**	-0.43**	-0.11	-0.08	18.82**	-8.01**	-0.88**
190	5.30**	-0.68**	1.40**	-2.12**	7.80**	1.21**	-2.55**	-14.05**	11.63**	0.58**
193	8.01**	0.08	-0.02**	0.08	-0.53**	2.55**	-0.98**	-7.75**	1.05**	-0.02
195	-14.45**	-0.59**	-1.20**	-1.92**	-1.04**	-1.57**	-0.78**	-14.47**	4.90**	-0.11**
202	1.33**	0.08	-4.58**	-5.26**	-0.43**	0.60**	3.50**	30.70**	-5.55**	0.16**
221	-0.40**	-1.12**	-1.91**	0.30	1.59**	1.17**	-1.73**	1.09**	0.28	0.27**
TESTERS										
CO 2	-0.86**	-0.22**	-0.58**	-0.05	0.02	-1.01**	-0.13	1.22**	-0.74*	0.06**
MDU 1	3.22**	0.68**	0.17	-0.41**	-0.09	0.16*	0.73**	8.98**	-2.56**	0.02
ANNAMALAI	-2.36**	-0.46**	0.40**	0.46**	0.06	0.85**	-0.60**	-10.20**	3.30**	-0.07**

* and ** Significant at P=0.05 and P=0.01, respectively

Table 3. Crosses showing desired significant *sca* effect ,*per se* performance and their standard heterosis

Character	Crosses	Sca effect	Mean value	Standard heterosis	S.Em ±
PLANT HEIGHT(cm)	PANT RITURAJ x CO 2	7.61**	94.6	11.21	
	190 X ANNAMALAI	4.19**	86.5	1.66	0.69
BRANCHES PER PLANT	PANT RITURAJ x MDU 1	1.34**	11.5	45.76	
	PANT RITURAJ x CO 2	0.93**	8.9	13.56	0.31
DAYS TO FIRST FLOWERING	202 X C0 2	-2.65**	66.1	-2.36	0.56
DAYS TO 50% FLOWERING	202 X CO 2	-3.48**	80.7	-3.20	0.55
LONG STYLED FLOWERS(%)	190 X ANNAMALAI	2.02**	64.6	21.32	
	221 X ANNAMALAI	4.64**	58.5	13.17	0.23
FRUIT LENGTH(cm)	193 X ANNAMALAI	3.42**	19.5	14.97	0.34
FRUIT GIRTH(cm)	PANT RITURAJ x CO 2	2.34**	18.2	7.01	
	202x CO 2	2.52**	20.8	22.22	0.33
FRUIT WEIGHT(g)	202 X CO 2	39.4**	156.6	83.56	
	180 X ANNAMALAI	44.0**	138.0	61.75	0.49
FRUITS PER PLANT	190 X ANNAMALAI	7.48**	56.5	43.73	
	221 X ANNAMALAI	1.43**	39.1	10.12	0.47
YIELD PER PLANT(kg)	190 X ANNAMALAI	0.33**	3.523	60.07	
	221 X ANNAMALAI	0.49**	3.363	52.83	
	193 X MDU 1	0.61**	3.281	49.09	
	PANT RITURAJ x CO 2	0.41**	3.127	42.11	0.034

Capsicum and Eggplant Newsletter, 19 (1999): 131-134.

CORRELATION AND PATH COEFFICIENT ANALYSIS IN EGG PLANT (*Solanum melongena* L.)

Ahmed. N. Lone D.I and Nayeema J.
Division of Olericulture, Sher-e-Kashmir University of Agricultural Sciences and Technology, Srinagar-191121, India.

INTRODUCTION

Egg plant (*Solunum melongena* L.) having its primary centre of origin in India has accumulated wide range of variability for most of the characters and thus provides the breeders an opportunity for evolving a type of plant architecture that will boost fruit quality and productivity. Before initiating any effective selection programme it is necessary to know the importance and association of various components with yield and among each other as unfavourable association between the desired attributes under selection may result in genetic slippage and limit the genetic advance and the yield being the end product of many correlated characters, the selection for this character would be more effective when it is based on component characters which are highly heritable and positively correlated. When more number of variables are considered in correlation, the association becomes more and more complex. The use of path co-efficient analysis under such situations would be more useful as it makes clear the direct and indirect associations and identifies the most reliable yield contributing characters. To understand association among various characters forty four egg plant genotypes of diverse origin were evaluated for thirteen characters under Kashmir conditions.

MATERIALS AND METHODS

Present investigation on correlation and path coefficient analysis in egg plant was carried out at Vegetable Experimentnal Farm, Division of Olericulture, Sher-e-Kashmir University of Agricultural Sciences and Technology, Srinagar during the year 1997. The experimental material consisting of forty four genotypes having distinct diversity in plant characters were planted in a randomized block design with three replications. Each genotype consisted of twenty plants in two rows were transplanted at a spacing of 60 cm between the rows and 45 cm between the plants. All recommended agronomic practices were followed to raise healthy crop under irrigated condition. Observations were recorded on ten randomly selected plants for thirteen characters namely days to first fruit set, plant height (cm), plant spread (cm), fruit length (cm), fruit girth (cm), branch number, fruit number, weight per fruit (g), fruit yield per plant (g), stalk length (cm), fruit density (g/ ml ^{3}), dry mater content (%) and fruit colour (anthocynin pigment ug/g). Correlation coefficients were computed by using the formulae of Al-Jibouri *et al.* (1958) while path coefficients were obtained following the method of Dewey and Lu (1959).

RESULTS AND DISCUSSION

The phenotypic and genotypic correlation coefficients between different pair of characters presented in Table 1 revealed higher estimates of genotypic correlation coefficients than the phenotypic correlation coefficients there by suggesting an inherent association between various characters. Fruit yield per plant was found significantly and positively correlated both at genotypic and phenotypic level with weight per fruit girth, fruit number, and fruit density and with plant spread it had positive and significant correlation only at genotypic level. This type of positive association suggested that fruit yield in egg plant can be improved by selecting genotypes having greater fruit weight, fruit number, fruit girth fruit density and larger plant spread. Vijay *et al.* (1978), Kalda *et al.* (1996), and Yadav *et al.* (1997) also reported such positive and significant association of fruit yield with weight per fruit, fruit number and fruit size respectively. On the other hand fruit yield showed negative correlation with branch number as observed by Srivastava and Sachan (1973) and dry matter content indicating that selection for higher branch number and dry matter content from the germplasm under study shall have adverse effect on fruit yield. Among other characters, fruit length, stalk length, plant height and days to first fruit set showed non significant but positive correlation with fruit yield. Yadav *et al.* (1997) reported similar results and suggested that although these characters had non significant correlation with fruit yield but having positive association needs due consideration during selection programme along with component characters which showed significant positive association.

Fruit colour recorded a positive but significant association with dry matter content. Dry matter content showed positive and significant association with fruit length while it had strong significant negative

correlation with fruit girth and weight per fruit. It is therefore suggested that selection of long fruits with less girth and weight can lead to increase dry matter content of fruits. Fruit number showed non significant positive correlation with days to first fruit set, plant height and plant spread but having positive association, it is expected that selection of early genotypes with increased plant height and spread may results in production of more fruits per plant. Weight per fruit had a strong significant and positive correlation with fruit girth, where as fruit girth had a strong positive and significant association with fruit yield per plant. Weight per fruit being dependent upon fruit girth, it appears that selection of fruits with more girth may be useful for increasing fruit weight which subsequently can result in increased fruit yield per plant.

Path coefficient analysis measures the direct influence of one variable upon the other and permits separation of correlation coefficients in to components of direct and indirect effects. This partitioning of total correlation in to direct and indirect effects provide the actual information on contribution of the characters and thus forms the basis for selection of suitable characters to improve the yield. Study of path analysis revealed that among characters weight per fruit and the fruit number showed the maximum direct effect on fruit yield and the correlation coefficient recorded for these characters with fruit yield were positive and highly significant (Table 2). It clearly indicates that weight per fruit and number of fruits per plant are the most important components of yield and thus more weightage should be given to these characters in selection programme. The other characters viz. fruit length, plant spread, stalk length, fruit girth, days to first fruit set and fruit density also exerted direct effect on yield and had positive correlaton coefficient and there fore these characters should also be considered in selection programme for improvement of yield potential of egg plant along with main characters weight per fruit and fruit number. On the other hand characters viz. plant height, dry matter and .branch number had negative direct effects on yield and thus have no significance in selection programmes. While looking in to indirect effects, the characteres like days to first fruit set showed indirect positive effects towards yield via stalk length, plant spread and fruit number. Plant height showed the high indirect positive effects on yield via fruit density. Similarly plant spread exhibited high indirect positive effects on fruit yield via plant height, fruit girth, and weight per fruit and fruit length via dry matter, plant height and weight per fruit. Fruit girth and branch number exhibited high indirect effects on yield via weight per fruit. Fruit number exhibited high indirect effect on yield via fruit density and dry matter while weight per fruit via fruit girth, plant spread and fruit length. Stalk length exhibited high indirect positive effects on yield via plant height and plant spread where as fruit density and dry matter exhibited high indirect positive effect on yield via weight per fruit and fruit girth respectively. Present study on correlation and path coefficient analysis in general revealed that characters like weight per fruit, number of fruits per plant, fruit length, plant spread and fruit girth are of great importance and must be considered in selection programme under present set of material for improvement of yield potential of egg plant.

REFERENCES

Al-Jibouri H.A.; Miller P.A. and Robinson H.F 1958. Genotypic and environmental variances and covariances in upland cotton crosses of interspecific origin. *Agronomy journal* , **50** : 633-37.

Dewey, D.R. and Lu, K.H. 1959. A correlation and path coefficient analysis of components of Gested Wheat Grass Seed Production. *Agronomy Journal* **51** : 511-18.

Kalda T.S.; Suran B.S. and Gupta S.S. 1996. Correlations and Path coefficient analysis of some biometric characters in egg plant. *Indian Journal of Horticulture* **53**(2) : 129-34.

Srivastava L.S. and Sachan S.C.P. 1973. Correlation coefficient and path analysis in brinjal. *Indian Journal of Agriculture Sciences* **43** (7) : 673-75.

Vijay P.P.; Nath P. and Jalika S.H. 1978. Correlation and path coefficient analysis a some biometric characters in brinjal *(Solanum melongena* L.). *Indian Journal of Horticulture* **35**(4) : 370-72.

Yadav, D.S.; Prasad A. and Singh N.D. 1997. Character association in brinjal *(Solanum melongena* L.). *Indian Journal of Horticulture* **54** (2) : 171-75.

Table 1. Genotypic and phenotypic correlation coefficients for different pairs of characters in egg plant *(Solanum melongena* L.)

Characters		Plant height	Plant spread	Fruit length	Fruit girth	Branch number	Fruit number	Weight per fruit	Stalk length of fruit	Fruit density	Dry matter content	Fruit colour	Fruit yield per plant
Days to Ist fruit set	r g	0.0525	0.1671	-0.0210	-0.0458	-0.0944	0.1341	0.0065	0.2664	-0.1096	-0.0380	-0.0826	0.1421
	r p	0.0452	0.1547	-0.0207	-0.0398	-0.0722	0.1292	0.0097	0.2488	-0.0914	-0.0301	-0.0737	0.1416
Plant height			0.5111**	0.2606	0.1393	0.0287	0.0315	0.1489	0.3229*	-0.1808	-0.0394	-0.0056	0.1577
			0.4797**	0.2446	0.1293	0.0155	0.0346	0.1374	0.2998*	-0.1633	-0.0368	-0.0022	0.1512
Plant spread				0.1123	0.2434	0.0477	0.0761	0.2299	0.3146*	-0.1857	0.0003	-0.0210	0.3036*
				0.1036	0.2306	0.0384	0.0718	0.2188	0.2933	-0.1627	0.0039	-0.0192	0.2849
Fruit length					-0.1348	-0.0627	-0.1558	0.1886	0.2621	-0.0113	0.3046*	0.2944	0.2129
					-0.1285	-0.0588	-0.1500	0.1845	0.2548	-0.0016	0.2979*	0.2900	0.2091
Fruit girth						-0.0891	-0.2186	0.7486**	0.1957	0.1586	-0.5653**	-0.0652	0.5018**
						-0.0850	-0.2126	0.7393**	0.1942	0.1511	-0.5488**	-0.0628	0.4935
Branch number							-0.0442	-0.3263*	-0.0760	-0.2560	-0.1876	-0.0351	-0.3173*
							-0.0460	-0.2968	-0.0728	-0.2321	-0.1795	-0.0374	-0.2932
No. of fruits per plant								-0.2879	-0.0311	0.1990	0.1559	0.0756	0.4143**
								-0.2828	-0.0318	0.1943	0.1528	0.0739	0.4198**
Weight/fruit									0.1407	0.2070	-0.4191**	0.1040	0.7006**
									0.1378	0.2036	-0.4102**	0.1028	0.6904**
Stalk length of fruit										-0.0410	0.0133	-0.0582	0.1910
										-0.0390	0.0143	-0.0576	0.1831
Fruit density											0.0726	0.1843	0.3116*
											0.0714	0.1779	0.2986*
Dry matter content												0.3416*	-0.2522
												0.3382*	-0.2372
Fruit colour													0.1572
													0.1517

* Significant at 5% level.
** Significant at 1% level.

Table. 2 Path coefficient analysis showing the direct and indirect effects of different characters on yield in egg plant (*Solanum melongena* **L.**).

Characters	Days to first Fruit set	Plant height	Plant spread	Fruit length	Fruit girth	Branch number	Fruit number	Weight per fruit	Stalk length of fruit	Fruit density	Dry matter	Correlation with fruit yield yield per plant
Days to Ist fruit set	0.0289	0.0015	0.0048	-0.0006	-0.0013	-0.0027	0.0039	0.0002	0.0077	-0.0032	-0.0011	0.1421
Plant height	-0.0048	-0.0912	-0.0466	-0.0238	-0.0127	-0.0026	-0.0029	-0.0136	-0.0295	0.0165	0.0036	0.1577
Plant spread	0.0125	0.0384	0.0751	0.0084	0.0183	0.0036	0.0057	0.0173	0.0236	-0.0139	0.0000	0.3036*
Fruit length	-0.0044	0.0547	0.0236	0.2098	-0.0283	-0.0132	-0.0327	0.0391	0.0550	-0.0024	0.0639	0.2129
Fruit girth	-0.0014	0.0043	0.0076	-0.0042	0.0312	-0.0028	-0.0068	0.0234	0.0061	0.0050	-0.0176	0.5018**
Branch number	0.0024	-0.0007	-0.0012	0.0016	0.0022	-0.0252	0.0011	0.0082	0.0019	0.0065	0.0047	-0.3173*
No.of fruit per plant	0.0914	0.0215	0.0519	-0.1062	-0.1490	-0.0301	0.6818	-0.1963	-0.0212	0.1356	0.1063	0.4143**
Weight per fruit	0.0051	0.1158	0.1788	0.1451	0.5821	-0.2537	-0.2239	0.7776	0.1094	0.1610	-0.3259	0.7006**
Stalk length of fruit	0.0105	0.0127	0.0124	0.0103	0.0077	-0.0030	-0.0012	0.0056	0.0394	-0.0016	0.0005	0.1910
Fruit density	-0.0016	-0.0027	-0.0028	-0.0002	0.0024	-0.0038	0.0030	0.0031	-0.0006	0.0150	0.0011	0.3116*
Dry matter content	0.0033	0.0034	0.0000	-0.0264	0.0490	0.0163	-0.0135	0.0363	-0.0012	-0.0063	-0.0866	-0.2522

Residual effect = 0.2416

ANNOUNCEMENT

FIFTH INTERNATIONAL SOLANACEAE CONFERENCE

Nijmegen, The Netherlands, 24-29 July 2000

The Fifth International Solanaceae Conference will be hosted by the Botanical garden of the University of Njimegen. The scientific programme will consist of plenary lectures and oral presentations, dealing with the following topics:

- **Taxonomy**: classification, molecular impact, problems and progress related to both wild and cultivated species.
- **Conservation**: diversity, *in situ* and *ex situ* conservation, landraces, etc., databases for building an International Solanaceae Network (ISIN).
- **Biotechnology**: genetic engineering.
- **Crop Science**: breeding tools, domestication, future developments and prospects of miscellaneous crop plants.

An abstract book will be prepared and will be available at the Conference. The Organising Committee intends to publish Proceedings of the Conference. An Editorial Committee will review and edit selected papers from the presentations at the Conference. The Proceedings book will cost approximately NLG 150.

Info:

- **For registration and accomodation**:
  Conference Agency University of Nijmegen
  Mary Bluyssen, P.O.Box 9111 - 6500 HN Nijmegen, The Netherlands
  Phone: +31 24 3612184 - Fax +31 24 3567956 - Email: m.bluyssen@buro.kun.nl
- **Concerning scientific programme**
  Conference Secretariat, Botanical Garden
  University of Nijmegen, Toernooiveld 1 - 6525 ED Nijmegen, The Netherlands
  Phone: +31 24 3652883 - Fax: +31 24 3653290 - Email: bot.garden@mailbox.kun.nl
  Internet: http://www-bgard.sci.kun.nl/bgard/

15th BIENNIAL NATIONAL PEPPER CONFERENCE

Lafayette, Louisiana, USA, 1-3 October 2000

The 15th Biennial National Pepper Conference will be held at the Hilton Lafayette and Towers. Conference sessions will include contributed oral and poster presentations and will be published in the Proceedings of the Conference.

Info:

Carl Motsenbocker - Department of Horticulture - LSU AgCenter
137 J.C. Miller Hall - Baton Rouge, LA 70803 - USA
Tel.: (225) 388 1036 - Fax: (225) 388 1068 - Email: cmots@unixl.sncc.lsu.edu

National Pepper Conference - c/o Pickle Packers International
P.O.Box 606 - St. Charles, IL 60174-060666, USA
Fax 630 584 0759

XIth EUCARPIA MEETING ON CAPSICUM AND EGGPLANT GENETICS AND BREEDING

9-13 April 2001 - Antalya, Turkey

The XIth Eucarpia Meeting on Capsicum and Eggplant will be held in Turkey, April 9-13, 2001. During the meeting the latest developments in Capsicum and Eggplant genetics, breeding, germplasm enhancement, pathology and related fields will be discussed. The scientific program will consist of keynote lectures, oral and poster presentations according to the conference topics. A full day technical excursion to pepper and eggplant growing areas and greenhouses in the Antalya region and variety demonstration plots will be included in the program. A stimulating hospitality program is planned for accompanying persons. The meeting will be held in Antalya which has 75 % of total greenhouse area in Turkey. This area is not only known for its natural beauty, but also for its history.

The Meeting is organized by the Horticulture Department of the Çukurova University, Adana, the Horticulture Department of the Akdeniz University, Antalya and the Citrus and Greenhouse Researcj Institute of Antalys.

Abstract

Abstracts of 150-250 words should be submitted to the Secretariat by October 15th, 2000. Please send the original and two copies by mail. The abstracts must be in English. Use single line spacing and a pitch of 12 characters per inch. Use an electric typewriter with carbon ribbon or a laser printer. Do not use a dot matrix printer. Type the title in bold with capital letters. Do not underline the title. Space one below the title. Type the author's name(s) in lower case and underline the name of author presenting the paper or poster. Include the name(s) and full address(es). Space two lines and type the entire abstract as one paragraph in lower case.

Registration Fees

The fee for participants is $ 350 and includes participation in all scientific sessions, meeting proceedings, lunches and coffee breaks, a full day technical excursion to pepper and eggplant fields in Antalya region, welcoming reception and a farewell dinner. The student price is $200. For registration after October 15th, 2000, the fee will be $380.

Accompanying persons

Registration fee will be $200 and includes the welcoming reception, farewell dinner and full-day tour. After October 15th 2000 the fee will be $230.

Variety Demonstration

In addition to the oral and poster sessions, demonstration of a greenhouse-type pepper and eggplant varieties will be organized. Participants or private companies are invited to send list of the varieties they would like to exhibit. The demonstration fee is $150/variety. To this end 100 seeds per variety are needed. They should be sent to the Meeting Secretariat, accompanied by a Health Certificate, by August 31, 2000.

Info:

Dr. H. Yildiz Dasgan
Çukurova University, Agricultural Faculty, Horticulture Department, 01330 Adana, Turkey
Tel.: +90 322 3386388 - Fax: +90 322 3386896 - Email: eucarpia@mail.cu.edu.tr.
Internet: www.cu.edu.tr/eucarpia

BOOK REVIEW

Bosland PW and Votava EJ, Peppers: Vegetable and Spice Capsicums, CABI Publishing, New York, USA, pp. xi + 204, ISBN 0-85199-335-4.

Peppers: Vegetable and Spice Capsicums is a new addition to the Crop Production Science in Horticulture Series by CABI Publishing. This series examines economically important horticultural crops from the major production systems in temperate, subtropical, and tropical climatic areas. Within each book, cropping systems ranging from open field and plantation sites to protected plastic culture and glasshouses are encompassed. Emphasis is placed on the scientific principles underlying crop production practices rather than on providing empirical recipes for uncritical acceptance.

Peppers: Vegetable and Spice Capsicums is a concise and readable source of information on capsicums for students, crop advisors, and researchers in plant science, food science, general agriculture and applied biology. The book has sound scholarship and is brimming with knowledge that is essential to any person serious about capsicums. Black-and-white pictures, diagrams, and tables illustrate the book. The book is the most up-to-date comprehensive coverage of capsicums available. The book has 204 pages with chapters covering history, taxonomy, botany, seeds, genetics, plant breeding, chemical composition, production, harvesting, postharvest handling, and diseases, disorders, and pests of capsicums.

This book is available from CABI Publishing, CAB International, Willingford, Oxon, OX10 8DE, UK, or GOTOBUTTON BM_1_ www.cabi.org. In North and Central American orders should be sent to Oxford University Press, 2001 Evans Road, Cary, NC, 27513, USA or www.oup-usa.org.

RECIPES

Terry Berke has sent us some recipes, in which pepper or its derivates are used. We are pleased to share these recipes with our readers, hoping that you find them interesting.

♠♠♠♠♠

Spamigo (from T. Berke)

This dish combines the wonderful flavours of chilli peppers and Spam.

- 3 tomatillos
- 1/15 oz can sweet corn
- 1/4 oz can mild green chillies
- 1 tsp. salt
- 1 can Spam
- 1/15 oz can tomatoes
- 2 jalapeno peppers
- 1 tsp. black pepper

Chop all ingredients finely and cook 30 minutes over medium heat, stirring occasionally. Serve with corn chips as a garnish.

*****

Smothered Red Peppers Paprikash (from "*Please To The Table - The Russian Cookbook*" by Anya von Bremzen and John Welchman)

A very popular dish in Hungary.

- 3 Tb. vegetable oil
- 2 medium-size onions, cut in half and thinly sliced
- Salt and freshly ground black pepper, to taste
- 6 large red peppers, cored, seeded, and cut into strips
- 3 canned Italian plum tomatoes, finely chopped
- 2 tsp tomato paste
- 1/3 cup chicken broth
- 1 tsp. sweet Hungarian Paprika
- 1-1/2 Tb. vinegar
- 1/8 tsp. sugar, or more to taste

Heat the oil in a large skillet over medium heat. Add the onions and sauté until softened but not coloured, 5 to 7 minutes. Stir in the paprika and toss with the onions until they are deeply coloured. Add the peppers and continue to sauté, stirring occasionally, for 10 minutes. Do not allow the vegetables to brown. Stir in the tomatoes, tomato paste, broth, and salt and pepper. Allow the mixture to boil, reduce the heat, cover, and simmer the peppers until tender, about 30 to 35 minutes, adding more liquid, a little at a time, if it evaporates. Turn off heat, stir in the vinegar and sugar and allow the mixture to cool. This can be served warm, at room temperature, or cold.

❦❦❦❦❦

Espelette Sauce
(translated from *http://www.visite-online.tm.fr/pbe/dossiergastronomie/recette/piment.htm*).

From the Basque region of France. Espelette is a famous pepper variety from France.

- 6 onions
- 50 g butter
- 2 Tb. Espelette pepper paste
- ¼ cup cream

Mince the onions. In a frying pan, melt the butter and sauté the onions. Add the Espelette pepper paste, mix, then add the cream. Salt to taste. Heat very well. To be served with grills of pig or ox.

✿ ✿ ✿ ✿ ✿

North Carolina Barbecue Sauce (from the June 1998 issue of *Chile Pepper magazine*).

- 2 cups vinegar
- 1 large jalapeno, chopped
- 1 tsp. Black pepper
- 1 Tb. salt
- 1 tsp. Cayenne pepper flakes
- 1 Tb. brown sugar

Combine vinegar and salt, stir to dissolve salt. Add other ingredients and shake until well mixed. Use immediately or store in fridge.

♣ ♣ ♣ ♣ ♣

Chilli and Mango Ricotta Ice Cream (from "*Cool Green Leaves and Red Hot Peppers*", by Christine McFadden and Michael Michaud)

- 140 g/5 oz sugar
- 1 Habanero chilli, deseeded
- 800 g mango fruit pulp
- ½ cup lime juice
- 250 g/9 oz ricotta cheese
- 6 Tb. plain yoghurt

Put the sugar and habanero in a small saucepan with 300 ml/½ pint water and bring to a boil, then simmer for 5 minutes. Cool and remove the habanero. Puree the mango with the lime juice and cooled syrup. In a large bowl, mix together the ricotta and yoghurt until smooth, then mix in the mango puree. Freeze in an ice cream maker, or pour into a shallow container, cover with Saran-wrap, and freeze for about 2 hours. Whisk until smooth, then freeze again. Making ice cream with ricotta cheese saves all that messing about making custard, and the results are just as creamy. You can use any chilli, but the Habanero is the ultimate burn experience. You may need to open the kitchen window while boiling the chilli syrup.

✱ ✱ ✱ ✱ ✱

Chiles en Nogada (from Patricia Wriedt, from the Searchable Online Archive of Recipes).

Designed to celebrate Mexican Independence Day (Sept. 16), as the dish represents the red, green, and white colours of the Mexican flag.

- 10 Poblano chillies, peeled and deseeded (substitute Anaheims)

Stuffing:

- 1/2 kg Pork ground
- 1 med Onion
- 2 garlic cloves
- 1/2 c citron chopped*
- 1/2 c almonds chopped
- 1/2 kg Beef ground
- 1 cup tomato puree
- Salt and pepper to taste
- 1/2 c raisins
- 1/2 c pine nuts
- 1 c fresh fruits: apple, pear, and apricot in little cubes

*citron: a candied, dried citron; substitute candied lemon, or omit.

Sauce:

- 2 c walnuts
- 1/2 cup milk
- 1 1/2 cup cream
- Cinnamon powder
- 1/4 cup cream cheese
- Sugar and salt

- Garnish: Red pomegranate seeds and parsley leaves.

Prepare the stuffing: In a sauce pan put vegetable oil, in the blender make a puree with onion and garlic, add to the vegetable oil when it is hot, let the onion fry until brown (not black). Add the meat, cook until the meat is brown, add the red tomato puree, add salt and pepper and let it boil, add the chopped fruits and cook until dry. Let cool.

Sauce: Mix all in the blender until soft and have a sauce consistency, season to taste with salt and cinnamon, this sauce will be cold over the stuffed chillies.

Fill all the chillies with the meat. Pour the white sauce over them and garnish with the pomegranate seeds (just a few to add red colour to the dish, because this dish has the Mexican flag colours: green, white and red) and with some parsley leaves.

Chilli Leaf Kimchi (from Korea)

Soak 3 cups chilli leaves with baby green chillies still attached in salt water for 3 days. Cut one small Japanese radish into thin pieces and sprinkle with salt. Cut 3-4 green onions into ¾ inch pieces and coat with 1 tsp. ginger powder. Chop ½ cup pickled baby shrimp. Rinse the chilli leaves and radish pieces and drain well. Mix with other ingredients and sprinkle 1 Tb. chilli powder over mixture. Season to taste with salt.

Cajun Lentil Stew
(from the Searchable Online Archive of Recipes (SOAR) at: http://soar.berkeley.edu/recipes/stews/indexall.html)

- 1 tsp. olive oil
- 1 green bell pepper, diced
- 2 stalks celery, diced
- 1 (16-ounce) bag brown lentils
- 10 cups water
- 1/2 tsp., garlic powder
- 1 tsp. salt
- 6 ounces beef sausage, diced
- 1 medium onion, diced
- 2 green onions, minced
- 2 tsp. Cajun seasoning blend
- 1 (14.5-ounce) can diced tomatoes
- 1/2 tsp. thyme
-

In a large kettle, heat the olive oil over medium heat. Add the sausage, green pepper, onion, celery and green onion and cook over medium-low heat for 10 to 12 minutes. Vegetables should "sweat," not brown. Adjust heat lower if vegetables start to brown. Add the lentils, Cajun seasoning blend, water, diced tomatoes, garlic powder and thyme leaves. Stir well. Bring to a boil, reduce heat to a simmer and cover. Cook for 1 1/2 hours or until lentils are soft. Add more water if necessary. Stir in salt. Serve hot. Makes 12 servings. Nutritional information per serving: 234 calories, 4.6 grams fat, 35 grams carbohydrates, 9milligrams cholesterol, 583 milligrams sodium.

Malaysian Rempah (from Graeme Caselton's Chile-Head
Web site at: http://easyweb.easynet.co.uk/~gcaselton/chile/cooking.html)

- 2 tablespoon ginger, fresh, finely chopped
- 4 blades lemon grass, finely chopped
- 1 teaspoon black peppercorns, crushed
- 2 dozen peanuts, cashews or almonds, chopped
- 40 Thai red chillies, chopped
- 6 shallots, finely chopped
- 4 cloves garlic, finely chopped
- 1 teaspoon palm or brown sugar
- 1 teaspoon turmeric, ground
- 3 teaspoon spoons salt

Use a pestle and mortar or food processor to grind all the ingredients to a smooth paste.

PEPPER TRIVIA

This new survey will report information and curiosity on pepper world, kindly supplied by Terry Berke.

Chilli peppers have made it to the elite "stamp hall of fame"! A picture of a red chilli wreath was among 4 wreaths chosen by the U.S. Postal Service to grace the face of a 32 cent stamp. The "Contemporary Wreaths" collection was issued by the postal service for the 1998 holiday season. *(Source: Winter 1999 issue of The Chile Pepper Institute Newsletter)*

Hungarian scientist Albert Szent-Gyorgyi won the 1937 Nobel Prize for isolating ascorbic acid, better known as vitamin C, in peppers. *(Source: Chili Lore, in the June 1999 issue of Sawasdee magazine*)

Farmers in Japan are using red chilli powder bombs to keep monkeys from pilfering their produce. The bombs, which propel the powder into the eyes and noses of the monkeys when they pass in front of sensors, replace electrified fences and wires, which the monkeys outwitted while stealing a half-million dollars worth of produce. (*Source: Sept-Oct. 1998 issue of Fiery Foods Magazine*)

Chip Hearn of Dewey Beach, Delaware owns the world's largest hot (chilli) sauce collection, with >5,100 different bottles. It is housed in the Starboard Restaurant in Dewey Beach, where at any given time you can taste between 60 and 350 of them. (*Source: Nov.-Dec. 1998 issue of Fiery Foods Magazine*)

A radio station in Las Cruces, New Mexico reported that a 14-year-old girl was expelled from school after giving Dave's Insanity Sauce (an extremely hot sauce) to her friends. More than a dozen kids were sent home due to "chilli damage". (*Source: Jan.-Feb. 1999 issue of Fiery Foods Magazine*)

Scientists at Kyoto University in Japan found that intravenous injections of capsaicin caused mice to continue swimming for longer periods of time than non-injected mice. Shooting up capsaicin, a chilli-head's dream come true..... Next thing you know, there'll be capsaicin-abuse treatment centres for IV-capsaicin-users, featuring seminars such as "Bland food is nice food".

In 1852, a young bride left New York to live on her husband's cotton plantation in North Carolina. She wrote to her parents: "Red pepper is much used to flavour meat with the famous barbecue of the South and the dish which I believe they esteem above all dishes is roasted pig dressed with red pepper and vinegar." (*Source: May-June 1999 issue of Fiery Foods and Barbecue Business magazine*)

The first jalapenos in space were carried in a little bag by the famous chilli-head astronaut Bill "The Flame Eater" Lenoir, when he was launched into orbit in 1982. *(Source: Chili Lore, in the June 1999 issue of Sawasdee magazine)*

A 25 g (~1 oz.) serving of fresh, red chilli pepper contains 100% of the RDA of Vitamin C, and 25% of the RDA of Vitamin A, as well as dietary fibber. Chilli peppers are fat-free, cholesterol-free, and low in calories. If you don't like spicy peppers, a single fresh, green bell pepper (~200 g) contains a whopping 400% of the RDA of Vitamin C, and 10% of the RDA of Vitamin A. If you eat a single red bell pepper, the Vitamin C content is still 400% of the RDA, but the Vitamin A content shoots up to 100% of the RDA. (*Source: USDA Nutrient Database at http://www.nal.usda.gov/fnic/*)

New York authorities once put chilli powder in subway token slots to try to stop juvenile delinquents from sucking out the tokens. *(Source: Chili Lore, in the June 1999 issue of Sawasdee magazine*)

Chilli peppers "warmeth the stomacke and helpeth greatly the digestion of meates". *(Source: John Gerard's Herball, 1597)*

Twenty-five people with cast-iron stomachs lined up Feb. 21, 2000 for an annual jalapeno-eating contest in Larendo, Texas. With drinks close at hand, they vied for the top pepper eater. The contest, sponsored by jalapeno producer, La Costena, was part of Larendo's yearly President's Day celebrations. The winner, Jed Donahue, ate 5 pounds of grapes the night before to stretch out his stomach. Jed has won the contest five out of the last seven years. This year, he took the contest by consuming a grand total of 105 peppers. The winner received a year's supply of Maalox. *(Source: CNN web site, Feb. 22, 2000)*

ORDER FORM FOR "CAPSICUM AND EGGPLANT NEWSLETTER"
No. 20, 2001
(to be published in the summer of 2001)

If you want to receive promptly the next issue of "Capsicum and Eggplant Newsletter", please fill in this form and return it together with a copy of the payment order to:

DI.VA.P.R.A.
Agricultural Genetics
Via Leonardo da Vinci, 44
10095 GRUGLIASCO TO - Italy
Fax +39 011 6502754 (+39 011 6708826 from January 2001)
Email: capsicum@agraria.unito.it

---✂----------

To "Capsicum and Eggplant" Editorial Board

Please, when available, send me a copy of "Capsicum and Eggplant Newsletter" No. 20 (2001). I am sending the subscription rate directly to EUCARPIA Secretariat (P.O.Box 315, 6700 AH Wageningen, The Netherlands).

Name

.....

Dept/Inst.

.....

.....

.....

Address

.....

.....

City ..... Country .....

Date ..... Signature .....

VOUCHER TO BE RETURNED TO THE EUCARPIA SECRETARIAT (P.O.Box 315, 6700 AH Wageningen, The Netherlands) IN CASE YOU PAY THE SUBSCRIPTION FEE BY CREDIT CARD

-----✂----------

To: EUCARPIA Secretariat

Object: subscription for "Capsicum and Eggplant Newsletter"

Volume(s) No. ..... - Year(s) .....

From:

.....

.....

.....

.....

Invoice No. ..... Amount .....

Charge my credit card of

❑ American Express ❑ Diners Club

❑ Eurocard ❑ Visa

Card number ..... Expiring date .....

Issuing bank .....

Date ..... Signature .....

ANALYTICAL INDEX

Pepper *(Capsicum annuum)*

Eggplant *(Solanum melongena)*

MAILING LIST

ALBANIA
Institute of Vegetables and Potato Crops, TIRANA.
Vegetables and Potato Research Institute Dr Mevlud Hallidri, Rr Skender Kosturi, TIRANA.

ALGERIA
Dept d'Agronomy Génèrale Institute National Agronomique, EL HARRACH-ALGER.
Institut National de la Recherche Agronomique, BP 15, Jardin d'Essais du Hamma, EL ANNASSER, ALGIERS.
Institut pour le Développement des Cultures Maraichères Centre Primaire, Domaine Mellah, STAVOUELI.

ANGOLA
Instituto de Investigaçâo Agronómica, CP 406, HUAMBO.

ANTIGUA
C.A.R.D.I P.O Box 766, Friars Hill, ST JOHN'S.

ARGENTINA
Catedra de Fitotecnia Fac Ciencias Agrarias, (4700) CATAMARCA.
Centro de Investigación de Frutas y Hortalizas, CC 15, 5505 CHACRAS DE CORIA, MENDOZA.
Estaciòn Experimental La Consulta I.N.T.A., Casilla de Correo 8/5567, La Consulta MENDOZA.
INTA Ing J.C.Zembo, Rivadavia 1439, 1033 BUENOS AIRES.

AUSTRALIA
Department of Primary Industries Dr Allen M Hibberd, G.P.O Box 46, BRISBANEQUEENSLAND.
Department of Primary Industries Plant Pathology Branch, Meiers Road, INDOOROOPILLY Queensland 4068.
Department of Primary Industries Serials Librarian Central Library, G.P.O Box 2215, BRISBANE-Queensland 4001.
Department of Primary Industries Bundaberg Research Station Mail Service 108, Ashfield Road, BUNDABERG-Queensland 4670.
Department of Primary Industries Horticultural Research Station , P.O.Box 538, BOWEN-Queensland 4805.
Department of Primary Industries Redlands Horticultural Research Stat A.M.Hibberd, P.O.Box 327, CLEVELAND-Queensland 4163.
State Library of Queensland Serials Unit Acquisition Branch, P.O.Box 488, SOUTH BRISBANE 4101.

AUSTRIA
Gemusesamenzucht Wanas Leitzersbrunnerfeld 21, 2003 IECTZESDORF.
Institute for Applied Pharmakognosie Universität Wien, Währingerstrasse 25, 1090 WIEN.
Institute for Applied Microbiology University for Agriculture and Forestry, Nussdorfer Lande 11, 1190 WIEN.

BANGLADESH
Bangladesh Agricultural Development Corporation, DHAKA.
BARI, GPO Box 2235, JOYDEBPUR, GAZIPUR.

BARBADOS
Caribbean Agricultural Research & Development Organization (CARDI) Cave Hill Campus, P.O Box 64, BRIDGETOWN.

BELGIUM
East-West Seed Bangladesh Ltd Dr Martine Dijkhuizen c/o Devarrewaere, 21 Dageraadlaan, 1652 ALSEMBERG.
Horticultural Unity University of Sciences Agronomy Dr Néji Tarchopun, Way of Deportee 2, 5030 BRUSSELS.
Plant Genetic Systems N.V Dr Arlette Reynaerts, J Plateaustraat 22, B9000 GENT.

BELIZE
Department of Agriculture Central Farm, CAYO DISTRICT.

BENIN
Direction de la Recherche Agronomique, BP 884, COTONOU.

BERMUDA
Department of Agriculture, Fisheries and Parks, P.O Box HM 834, HAMILTON HM CX.

BHUTAN
Horticulture Section Department of Agriculture Ministry of Agriculture, THIMPHU.

BOLIVIA
Centro Fitogenetico Pairumani , A.A 128, COCHABAMBA.
Instituto Boliviano de Technologia Agropecuaria (IBTA) Casilla Postal 5783, Avenida Camacho 1471, LA PAZ.

BOTSWANA

Agricultural Research Station, Private Bag 0033, GABORONE.
Director SACCAR, P O Box 00108, GABARONE.
The Principal Botswana College of Agriculture Ministry of Agriculture, Private Bag 0027, GABORONE.

BRASIL

Agroflora Sementes S/A Dept Research Della Vecchia Paulo Tarcisio, Caixa Postal 427, BRAGANCA PAULISTA,SP-12.900.000.
Dept de Fitotecnica Universidade Federal de Viçosa, 36.570 VICOSA M.G..
Dept de Genética ESALQ, Caixa Postal 83, 13.400 PIRACICABASÃO PAULO.
EMBRAPA Centro Nacional de Pesquisa de Hortalicas, C.P 07.0218, 70.359-970 BRASILIA DF.
Inst Agronomico de Campinas , Cx Postal 28, 13028 CAMPINAS SP.
Instituto Agronomico do Paranà IAPAR Area de DocumentaçaoADC, Caixa Postal 481, 86001-970 LONDRINA-PARANA'.
Universidade de Sao Paulo Campus "Luiz de Queirox" Divisão de Bibilioteca e Documentação, Av Padua Dias 11C.P.9, 13418-900 PIRACICABASÃO PAULO.

BRUNEI

Agronomy Department Agricultural Res and Development Div Agriculture Department, Ministry of Industry and Primary Res., BANDAR SERI BEGAWAN 2059.

BULGARIA

Agricultural University of Plovdiv Horticulture Department N Panayotov, PLOVID.
Bulgarian Academy of Sciences Institute of Genetics "Acad D Kostov", 1113 SOFIA.
Institute of Introduction and Plant Resources, SADOVO 4122.
Institute of Plant Physiology of Bulgarian Academy of Sciences, Academican Bouchevstr 6, SOFIA.
Institute of Plant Protection , KOSTINBROD 97113.
Kolarov V. Higher Institute of Agriculture, PLOVDIV.
Maritsa Vegetable Crops Research Institute Biblioteka, Ul Brezovsko shosse n.32PK 10, 4003 PLOVDIV.
Sortovi Semena AD Gorna Oryahovitsa Dr Todor B Christov, 125 Tzarigradsko Shousse bl 1, 1113 SOFIA.

BURKINA FASO

Institut de Recherche Agronomiques et Zootecniques, BP 596, OUAGADOUGOU.
IRAT , B.P 910, BOBO DIOULASSO.

CAMEROON

Institut de la Recherche Agronomique, BP 2123, YAOUNDÈ.
Programme "Cultures Maraîchères" IRA Foumbot, B.P 465, BAFOUSSAM.

CANADA

Agriculture Canada Library Attn Exchanges, OTTAWAK1A OC5.
Agriculture Canada Research Station, P.O.Box 1000, AGASSIZ-B.C..
Greygo Distributors Frank Peter, Ridge Road, HARROW ONTARIO NORIGO.
Padata , 627 Aquarius Rd RR 2, VICTORIAB.C V9B 5B4.
Stokes Seeds Limited Research Center E.A.Kerr, 39 James St.-P.O.Box 10, ST CATHARINES-Ont L2R 6R6.

CAPE VERDE

Instituto Nacional de Fomento Agrario, PRAIA.
Instituto Nacional de Investigacâo Agraria, Caixa Postal 115, PRAIA.
INTA , C.P 84, PRAIA.
President de l'INIDA M Horacio de S Soares, .

CENTRAL AFRICAN REPUBLIC

Centre d'Etudes Agronomique d'Afrique Centrale, BP 78, M'BAIKI.

CHAD

Direction de la Recherche et des Techiniques Agronomiques Departement Horticole, Ministère de l'Agriculture, NDJAMENA.

CHILE

Biblioteca Central Instituto de Investigaciones Agropecuarias (INIA), Casilla 439, Correo 3, SANTIAGO.
Casseres Ernesto , La Pastora 181 Dep 140, SANTIAGO 10.
I.N.I.ACentro Regional La Platina Dept Produccion Vegetal Dr Gabriel Saavedra, P.O.Box 439-3, SANTIAGO.
Universidad Austral de Chile Inst de Producion Vegetal Facultad de Ciencias Agrarias, Casilla 567, VALDIVIA.

CHINA P.R.

Academy of Agricultural Sciences Hunan Vegetable Institute Dr Jianhua Liu, Ma Po Ling, CHANGSHAHUNAN 410125.
Beijing Vegetable Research Institute, BEIJING.
Chinese Academy of Agric Sciences Inst of Vegetables and Flowers, 30 Baishiqiaou Road, XIJIAOBEIJING 100081.
Chongqing Agricultural Res Institute Shibing TianZhonghua Lu, Zhou Ma YangBa Nan, CHONGQING 400055.
Dept of Horticulture Northwestern Agric University, YANGLINGShaanxi 712100.
Harbin Agricultural Institute Dr Zhang Jingtao, 288 Cheng Xiang Road, HARBIN 150070.
Institut of Horticulture Zhejiang Academy of Agricultural Sciences, 198 Shigiao Road, HANGZHOU 310 021.

Institute of Horticulture Academy of Liaoning Agr Sci., Shen Yang, 110161 Dong Ling Ma Guan Qiao.
Vegetable and Flower Institute, BEIJING.

COLOMBIA

Centro International de Agricultura Tropical (CIAT), Apartado Aéreo 67-13, CALI, VALLE DEL CAUCA.
I.C.A , A.A 51764, MEDELLIN.
I.C.A Programa Hortalizas A.A.233, PALMIRA.
Instituto Colombiano Agropecuario ICA, Calle 37 No 8-43Apartado Aereo 7984, SANTAFE DE BOGOTAD.C..
Universidad Nacional de Colombia Sede Palmira, Apartado Aereo 21079, CALI.

CONGO

Conseil National de la Recherche Scientifique et Technique, BP 2499, BRAZZAVILLE.

COSTA RICA

Centro Agronomico Tropical de Investigacion y Ensenanza (CATIE), Apartado 74, TURRIALBA 71 70.
Inter-American Institute for Cooperation on Agriculture (IICA), Apartado 55, 2200 CORONADO, SAN JOSÉ.
Orton Memorial Library IICA-CIDIA, TURRIALBA.
Sede Universitaria Regional del Atlàntico Universidad de Costa Rica, Apdo 119, TURRIALBA.
Unidad de Recursos Genéticos , CATIE, TURRIALBA 7170.
Vegetable Research Program Ministry of Agriculture, SAN JOSE'.

CROATIA

Faculty of Agriculture, Svetosimunska 25, 41000 ZAGREB.
Podravka, Starcevica 32, 43300 COPRIVNICA.
Povrtlarski Centar Zagreb, Kaciceva 9, 41000 ZAGREB.

CUBA

Centro de Informacion y Documentacion Agropecuario , Gaveta Postal 4149, LA HABANA 4.
Dept de Proteccion de Plantas INIFAT calle 1 esquina 2, (Santiago de Las Vegas), CIUDAD DE LA HABANA.
Horticultural Research Institute Liliana Dimitrova Ministry of Agric Res Network, km 33-½ Carretera de Bejucal a Quivican, LA SALUD-LA HABANA.
Inst de Investigaciones Fundamentales en Agricultura Tropical Ministry of Agriculture Research Network, Calle 1 esq a 2 (Santiago de L Vegas), CIUDAD HABANA.
Instituto Nacional de Ciencias Agricolas Gaveta Postal No 1, San José de las Lajas, LA HABANA.
IRTA, HAVANA.
Universidad de Matanzas "Cienfuegos" Dir de Informaciòn Cientifico Tecnica Selecciòn, Adquisiciòn y Canje, Autopista Varadero km 3,5, MATANZAS.

CYPRUS

Agricultural Research Institute Ministry of Agriculture and Natural Resources, ATHALASSA, NICOSIA.

CZECH REPUBLIC

Academy of Sciences of the Czech Republic, Narodni trida 3, 111 42 PRAHA 1.
Dept of Genetic Resources Div of Genetics and Plant Breeding Inst of Plant Production, Ruzyné 507, 161 06 PRAGUE 6.
Inst of Experimental Botany Academy of Science of the Czech Republic, Sokolovskà 6, 772 00 OLOMUC.
Research Inst of Vegetable Growing and Breeeding , Slechtitelu, 772 36 OLOMOUC 7.

DOMINICAN REPUBLIC

Instituto Superior de Agricultura, Apdo 166, SANTIAGO.

ECUADOR

Instituto Nacional de Investigaciones Agropecuarias, San Javier 295 y Orellana, Casilla 2600, QUITO, PICHINCHA.

EGYPT

Assiut University Agricultural Faculty Department of Horticulture Dr Mohamed Fouad, ASSIUT 71526.
Faculty of Agriculture , P.O.Box 84, KAFR-EL-SHEIKH.
Faculty of Agriculture University of Mansoura, University Post Office 35516, SHARIA EL-GOMHOURIA, MANSOURA.
Horticultural Research Institute Agricultural Research Center (ARC) Ministry of Agriculture and Food Security, GIZA, ORMAN, CAIRO.

EL SALVADOR

Centro Nacional de Technologia Agropecuaria, Final la Avenida Norte, SAN SALVADOR.
Centro Nacional de Tecnologia Agropecuaria , Km 33-½ carretera a Santa Ana, SAN ANDRES-LA LIBERTAD.
Universidad de El Salvador Ciudad Universitaria, Final 25 Avenida Norte, SAN SALVADOR.

ERITREA

Department of Agricultural Research and Extension ServMin of Agriculture Att Mr Tkleab Mesghena, BP 4627, ASMARA.

ETHIOPIA

Bako Agricultural Research Center , P.O.Box 3, BAKOWEST SHOWA.

FAO Representative in Ethiopia for ETH/87/001, P.O Box 5536, ADDIS ABABA.
Institute of Agricoltural Research (IAR) Nazareth Research Station, P.O Box 103, NAZARETH.
Institute of Agricultural Research (IAR) Horticulture Department, P.O.Box 2003, ADDIS ABEBA.
Plant Genetic Resources Center , P.O.Box 30726, ADDIS ABEBA.

FIJI

Sigatoka Research Station, P.O Box 24, SIGATOKA.

FRANCE

Agrogene Vincent Wickaert, 620, rue Blaise Pascal, 77550 MOISSY CRAMAYEL.
Asgrow-France Ets B.P n.5, Saint Martin le Beau, 37270 MONTLOUIS-SUR-LOIRE.
CIRAD-IRAT-Documentation B.P.5035 Av.Val de Montferrand, 34032 MONTPELLIER.
Clause Semences, 1, Av Lucien Clause, 91221 BRETIGNY SUR ORGE.
Clause Semences Claude Basterreix-Vergez Mas St Pierre, La Galine, 13210 ST REMY DE PROVENCE.
Daunay Marie-Christine INRA Genetics and Breeding of Fruits and Vegetables, B.P 94, 84143 MONTFAVET CEDEX.
Ecole Nat Sup d'Horticulture , 4 rue Hardy, 78009 VERSAILLES.
GEVES-SEV Les Vigneres, B.P 1, 84300 CAVAILLON.
Graines Gautier, B.P n.1, 13630 EYRAGUES.
Hortisem Jacques Hallard, 2240 Chemin du Tilleul, 13160 CHATEAURENARD.
INRA Plant Pathology, B.P 94, 84143 MONTFAVET-CEDEX.
INRA Genetics and Breeding of Fruits and Vegetables Anne Marie Daubeze, B.P 94, 84143 MONTFAVET-CEDEX.
INRA Laboratoire de Biologie des Invertebres Caroline Caporalino-Djion, 123 Boul Du CapB.P 2078, 06606 ANTIBES CEDEX.
INRA Library Genetics and Breeding of Fruits and Vegetables, B.P 94, 84143 MONTFAVET-CEDEX.
Institut de Biologie Moléculaire des Plantes du CNRS Bibliotheque, 12, rue du Général Zimmer, 67084 STRASBOURG CEDEX.
Laboratoire de Morphogénès Végétale Université de Paris Sud Cécile Collonnier, Bat 360, 91405 ORSAY CEDEX.
Laboratoire de Phytomorphologie Expérimentale Université de Provence, 3 Place V Hugo, 13331 MARSEILLE CEDEX 3.
Laboratoire du Phytotron C.N.R.S., 91190 GIF-SUR-YVETTE.
Novartis Seeds s.a Jean Luis Nicolet, Domaine du Moulin, 84260 SARRIANS.
ORSTOM 2051 Av du Val de Mont Ferrand, B.P 5045, 34032 MONTPELLIER.
Palloix Alain INRAGenetics and Breeding of Fruits and Vegetables, B.P 94, 84143 MONTFAVET-CEDEX.
Rijk Zwaan France Marc Villevieille, La Vernède, 30390 ARAMON.
Sakata Seeds France De Mijolla Olivier Yukihiro Kobayashi, Domaine du Sablas Rue du Moulin, 30620 UCHAUD.
Seminis Vegetable Seeds Recherche France Claude Robledo, Mas du Rouzel Chemin des Canaux, 30900 NIMES.
Takii Recherche France Robert Legnani Kazuhuki Tanaka, Quartier de la Malgue, 13630 EYRAGUES.
Technisem Claude Duranton, 7, Av Du Garigliano ZAC des Gatines, 91601 SAVIGNY SUR ORGE.
Tezier Centre de Recerche Documentation (Christine Rascle) Domaine de Maninet, Route de Beaumont, 26000 VALENCE.
Vilmorin Ets Florence Picard, Route du Manair, 49250 LA MENITRE.
Vilmorin Institut de Recherches Jean W Hennart Monique Jacquet Centre de la Costière, Ledenon, 30210 REMOULINS.

GABON

Centre d'Introduction, d'Amélioration et de Multiplication (CIAM) Ministère de l'Agriculture, LIBREVILLE.

GERMANY

Breun Karin Galgenhofer Str 39, W-8522 HERZOGENAURACH.
Fedral Center for Breeding Research on Cultivated Plants Institute for Resistance Genetics, Graf-Seinsheim-Str 23, 85461 GRUNBACH.
Pflanzengenetik und Kulturpflanzenforschung Institut Wissenschaftliche Bibliothek, Corrensstrasse 3, 06466 GATERSLEBEN.
Plant Physiology Inst Technical University of Munich, 8050 FREISING-WEIHENSTEPHAN.
Universität Bonn Zentralbibliothek-Landbauwissensch Zeitschriften Zugangstelle, Postfach 2460, 53014 BONN.
University of Hohenheim Inst of Plant Breeding, Seed Sciences and Population Genetics, Dr Angela G Shilling, D-70593 STUTTGART.

GHANA

University of Ghana Faculty of Agriculture Department of Crop Science, LEGON.

GREAT BRITAIN

Acquisitions Unit (DSC-AO) British Library Boston Spa, WETHERBYW YORKS LS23 7BQ.
C.A.B International Plant Breeding Abstract Wallingdorf, P.O Box 100, OXON OX10 8DE.
Dept of Agricultural Botany Plant Sciences Laboratories University of Reading, READING RG6 2AS.
Horticulture Research International Library, Wellesbourne, WARWICKSHIRE CV35 9EF.
Lester Richard University of Birmingham School of Biological Sciences, P.O.Box 361, B15 2TT BIRMINGHAM.
Library and Information Services Section N.R.I., Central Av Chatham Maritime, KENT ME4 4TB.
Schering Agrochemicals Ltd , Chesterford Park Research Stat., SALLRON WALDEN-Essex CB10 1XL.
School of Biological Sciences Birmingham University, Edgbaston P.O.Box 363, BIRMINGHAM B15 2TT.
Scottish Crop Research Inst Invergowrie , DUNDEE DD2 5DA.

GREECE

Agricultural Research Center of Macedonia and Thrace, P.O.Box 312, 570-01 THESSALONIKI.
Greek Gene Bank P.O Box 312, 57001 THESSALONIKI.
Inst of Vegetable Crops , HERAKLION-CRETE 711 10.

GRENADA

C.A.R.D.I., P.O Box 270, ST GEORGES.

GUADELOUPE (FRENCH W INDIES)

INRA-CRAAG-URPV Denis La Fortune, BP 1232, 97184 POINTE-A-PITRE CEDEX.

GUAM

College of Agriculture University of Guam, UOG Station, 96923 MANGILAO.

GUATEMALA

Academia de Ciencias Médicas, Fisicas y Naturales de Guatemala Apartado Postal 569, Calle 1-25, Zona 1, GUATEMALA CITY.
La Facultad de Agronomia de la Universidad Rafael Landivar, .
La Facultad de Ciencias Medicas de la Universidad de San Carlos, SAN CARLOS.
Universidad de S Carlos de Guatemala Centro de Documentacion e Informacion Agricola, Apartado Postal No 1545, GUATEMALA.

GUINEA BISSAU

Centre Pilote des Actions Maraîcheres (CEPAM) Ministère de l'Agriculture, DALABA.
Service Agricole Autonome de Bissau (SAAB) Ministère de l'Agriculture, BISSAU.

GUYANA

C.A.R.D.I 44 Brickdam, Stabroek, GEORGETOWN.
Guyana School of Agriculture, Mon Repos, EAST COAST DEMERARA.
IICA, Antilles Zone, P.O Box 10-1089, QUEENSTOWN, GEORGETOWN.

HAITI

Centre de Recherche et de Documentation AgricolesCRDA, .
Ferme expérimentale "Damien" Ministère de l'Agriculture, PORT-AU-PRINCE.

HONDURAS

Escuela Agricola Panamericana , P.O Box 93, TEGUCICALPA.
Federacion de Productores y Esportadors Agropecuarios y Agroindustriales de HondurasFPX, Apartado Postal 1442, SAN PEDRO SULA.
Fundaciôñ Hondurena de Investigación Agricola, P.O Box 2067, SAN PEDRO SULA, CORTÉS.

HUNGARY

Agricultural Biotechnology Center Institute for Plant Sciences Judit Mityko, P.O.Box 411, 2101 GODOLLO.
Agricultural Research Inst of the Hungarian Academy of Sciences, Marx tér 2, 2462 MARTONVASAR.
Agricultural University Department of Genetics and Plant Breeding, 2103 GODOLLO.
Andrasfalvy Andras, Tigris u 33, 1016 BUDAPEST.
Csillery Gabor Budakert Ltd., Bartòk Béla ut 41, H -1114 BUDAPEST.
Enterprise for Extension and Research in Fruit Growing and Ornamentals Dept Ornamentals, Park u 2, H-1223 BUDAPEST.
Institute for Fruit and Ornamental Growing , FERTOD H-9431.
Institute of Vegetable Growing University of Horticulture, Villanyi ut 35-43, 1118 BUDAPEST.
Library Seed Production and Trading Company, P.O.Box 41, 6601 SZENTES.
Library Vegetable Crops Research Institute, P.O.Box 116, 6001 KECSKEMET.
Moor Andrea Vegetable Crops Research Institute, P.O.Box 95, 1775 BUDAPEST.
National Institute for Agricultural Quality Control, Keleti Kàroly ut 24, 1024 BUDAPEST.
Novartis Seeds Kft, Hungaria Krt 69, 1146 BUDAPEST.
Plant Breeding Center Vetomag Trading House Co Ltd., P.O.B 41, 6601 SZENTES.
Plant Health and Soil Protection Station, Rarosi u 102P.O.Box 99, HODMEZOVASARHELY.
Plant Protection Institute Hungarian Academy of Sciences, P.O.Box 102, 1525 BUDAPEST.
Red Pepper Research Development LTD Research Station Kalocsa, Obermayar tér 9, KALOCSA 6300.
Research Centre for Agrobotany N.I.A.V.I.T , 2766 TAPIOSZELE.
Research Station of.Agricultural University, P.O.Box 3, 4014 PALLAG-DEBRECEN.
Szegedi Paprika Foodprocessing and Trading Company, Szovetkezeti ut 1, 6725 SZEGED.
University of Horticulture and Food Industry Department of Management and Marketing, P.O.Box 53, 1502 BUDAPEST.
University of Agricultural Sciences Faculty of Agricultural Sciences Institute for Plant Protection, P.O.Box 71, 8361 KESZTHELY.
University of Horticulture and Food Industry Department of Plant Pathology, P.O.Box 53, 1502 BUDAPEST.
Vegetable Crops Research Institute Research Station Szeged, Kulterulet 7, 6728 SZEGED.
Vegetable Crops Research Institute Research Station Budapest, P.O.Box 95, 1775 BUDAPEST.

ILE DE LA REUNION

IRAT-CIRAD-Reunion , 97487 Saint-Denis Cedex, REUNION.

INDIA

Agricultural College and Research Inst Department of Horticulture V Ponnuswami, (Thoothukudi Dist Tamil Nadu), KILLIKULAM VALLANADU 628 252.
Ankur Seeds Pvt Ltd Agric Research Laboratories, 27 New Cotton Market Lay-out, NAGPUR 440 018MAHARASHTRA.
AVT Research Foundation Dr D.C Sastri P.B.No 1685, 28/961 B.PANAMPILLY NAGAR, PERUMANOOR P.O.-COCHIN 682 015.
Bejo Sheetal Seeds Pvt Ltd Mr A.D.Nirkhee, P.O.Box 77A-2 Old Midc, JALNA 431 203MAHARASHTRA.
Bhardwaj Vinay Gut No 24, Chitegaon, Paithan Road, AURANGABAD 431 005.
Biotechnology Research Center Department of Agricultural Botany Punjabrao Agricultural Univ., AKOLA 444 104 MAHARASHTRA ST..
Burdwan University , BURDWAN 713 104.

Central Experimental Station , Wakawali, DAPOLI 415 711 (Dist. Ratnagiri-Maharashtra).
Ches Hinoo House , Shukla Colony, RANCHI Biharstate.
Chillies Export House Ltd., 35, M.C Chidambara Nadar Street, VIRUDHUNAGAR626001.
College of Agriculture Department of Plant Pathology Dr M S Bhale, J N Agricultural University, JABALPUR 482 004, M.P.
College of Agriculture Orissa University of Agriculture and Technology, BHUBANESWAR 751 003, ORISSA.
Cotton Research Units CRS Punjabrao Krishi Vidyapeeth, AKOLA444 104 (Maharashtra).
Dept of Agriculture, Mothirakkanni, KERALATHRISSUR DT 680721.
Dept of Botany Andhra University, WALTAIR 530 003.
Dept of Plant Pathology Agricultural College and Research Institute, MADURAI 625 104TAMILNADU.
Dept of Botany Cytogenetics Laboratory Nagarjuna University, NAGARJUNA NAGAR 522 510, Guntur Dist (A.P.).
Dept of Botany Dharmpeth Science College, Near Ambazari Garden, NAGPUR 440 010.
Dept of Botany Kakatiya University Mutation Breeding, and Tissue Culture Lab., WARANGAL 506 009 A.P.
Dept of Botany University of Rajasthan, JAIPUR302 004.
Dept of Horticulture Banaras Indu University, VARANASI 221 005.
Dept of Horticulture College of Agriculture, Rajendranagar, HYDERABAD 500 030 A.P..
Dept of Plant Pathology J.N.Agricultural University Zonal Agric Research Station, Chandangoan, CHHINDWARA 480 002 (MP).
Dept of Plant Pathology Punjab Agricultural University, LUDHIANA Punjab 141 004.
Dept of Vegetable Crops Landscaping and Floriculture Punjab Agricultural University, LUDHIANA141 004.
Dept of Vegetable Science and Floriculture College of Agriculture, Himachal Pradesch Horticultural University, PALAMPUR176 062.
Div of Mycology and Plant Pathology I.A.R.I., NEW DELHI 110 012.
Div of Plant Genetic Resources Indian Inst of Hortic Res 255 Upper Palace Orchards, 8th Main 18th CrossSadasivanagar, BANGALORE 560 080 (Karnataka).
Div of Vegetable Crops Indian Inst of Horticultural Res., Hessaraghatta Lake P.O., BANGALORE 560 089.
Gujarat Agricultural Univesity Department of Plant Breeding Dr S.A.Patel, Anand Campus, ANANDG.S 388 110.
Haryana Agricultural University Department of Plant Pathology, HISAR125004.
I.A.R.I Library, NEW DELHI110 012.
I.C.A.R , Krishi Bhavan, NEW DELHI 110 001.
ICAR Vivekananda Parvatiya Krishi Shri Dhar, Anusandhan Sansthan, ALMORA 263601 (U.P.).
Indian Agricultural Research Institute, Regional Station, KATRAINKullu ValleyHP 175 129.
Indian Institute of Spice Research Cardamon Research Center D Prasath, Appangala MADIKERI 571 210, KODAGU DTKARNATAKA.
Indian Institute of Spices Research I.C.A.R Post Bag No 1701-Marikunnu P.O., CALICUT 673012, KERALA.
Indian Institute Vegetable Research Sanjeet Kumar, P.O.Box 5002, VARANASI 221 005.
Indo-American Hybrid Seeds Research and Development 214 Palika Bhavan R.K Puram, Sector XIII, NEW DELHI 110 066.
Kerala Agricultural University Dept of Olericulture College of Horticulture, P.O Vellanikkara 680 654, THRISSURKERALA.
Library Mahatma Phule Agricultural University, RAHURIPIN 413 722, Dist.Ahmednagar [M.S].
Library Punjabrao Krishi Vidyapeeth, AKOLA444 104 (Maharashtra).
Library Tamil Nadu Agricultural University, COIMBATORE 641 003.
Library Tamil Nadu Agricultural University Horticulture College and Research Inst., Madurai Dist.Tamil Nadu, PERIYAKULAM 626 501.
Library University of Horticulture and Forestry, SOLAN (P.O.: NAUNI)173 230 H.P..
Maharashtra Hybrid Seeds Co Ltd Resham Bhavan 4th floor, 78 Veer Nariman Road, MUMBAI 400 020.
Mahatma Phule Krishi Vidyapeeth Horticulture department S.D Warade, Dist Ahmednagar, RAHURI 413 722.
Mangalore University Department of Applied Botany, MANGALAGANGOTHRI574 199 (D.K.).
Mukada Seeds Boman Baug Kher Pada, GHOLVADDist Thane (W.RLY.).
Namdhari SeedsUday Singh 119, 9th Main Arasappa Complex Ideal Homes Township, Rajarajeshwari Nagar, BANGALORE 560 039.
Nath Seeds Ltd Mr S.U.Baig Nath House, Nath Road, Post Box 318, AURANGABAD (M.S.) 431005.
National Bureau of Plant Genetic Resourcse, Pusa Campus, NEW DELHI 110012.
Nehru Library Haryana Agricultural University, HISSAR 125 004.
Nirmal Seeds Ltd., Bhadgaon Road, PACHORA 424201 (DIST JALGAON).
Pioneer Overseas Corporation Dr N Anand 61/A 14th cross Ist Block, R.T Nagar, BANGALORE 560 032.
Proagro-Pgs India Ltd No 498, 1° Floor, 5th Cross, V.V.Nagar, H.M.T.Layout, Ganganagar Ext., BANGALORE 560 032.
Proagro-Pgs India Ltd Dr M Vinod Kumar Dhumaspur Road, Badshahpur, GURGAON 122001.
Regional Agric Research Station , Lam GUNTUR 522 034.
Regional Fruit Research Station , Cuddapah District A.P., ANANTHARAJUPET 516 105.
Sarpan Agri-Horticultural Res Centre SAHRC Dr N.B.Gaddagimath NH-4 BypassBelgaum Road, Opp Air Tech, DHARWAD5 (KARNATAKA).
Self Employment Training Inst Pudupudur S.R.K.V Post, (Via) Perlanalckenpalayam, COIMBATORE 641 020 (Tamil Nadu).
Sher-e-Kashmir University of Agricultural Sciences and Technology Division of Olericulture and Floriculture, Shalimar Campus, SRINAGAR KASHMIR 191 121.
Sungro Seeds Ltd, 207, Aradhana Bhawan, AZADPURDEHLI-110033.
Tamil Nadu Agricultural Univ Agricultural Research Station , South Arcot District, TAMILNADUPALUR 607 113.
Tamil Nadu Agricultural Univ Horticultural Research Station , Vijayanagaram, OOTY 643 001.
Terra-Agro Technologies Ltd John S Daniel Site No 258, 90, Elayamuthur Village, UDUMALPET TALUKCOIMBATORE DT..
Tetali Rajyalakshmi c/o K G Raja Rao Department of Botany, Andhra University, VISAKHAPATNAM 530 003.
University of Agricultural Sciences Dharwad Chilli Research Center R.C.Jagadeesha, Tq RanebennurKarnataka State, A.R.S., HANUMANAMATTI 581135.
V Ramsundar 7.Karia Kara Vilai, East of Clock Tower, NAGERCOIL 629001.

INDONESIA

Central Research Inst for Horticulture (CRIH) Head office, Jl Ragunan 19, PASAR MINGGU, JAKARTA.
Indonesia Moslem Library, Jalan Sempur Dalam No 1, BOGOR KP 16154.
LEHRI Library Project ATA 395 Kotak Pos 1427, BANDUNG 40 014.
LEHRI Research Institute for Horticulture Jln Tangkuban Perahu 517, LEMBANG 6247BANDUNG 40391, WEST JAVA.
Plant Molecular Biology Lab Department of Agronomy Faculty of Agriculture, I P BJI Raya Pajajaran, BOGOR.
PT East West Seed Indonesia, Po Box 1, CAMPAKAPURWAKARTA 41181.

IRAN

College of Agriculture, KARAJTEHRAN.
Kowkab Publishers Journal Department, P.O.Box 14835-157, TEHRAN.

IRAQ

College of Agriculture University of Baghdad, JADIRIYABAGHDAD.

ISRAEL

Dept of Plant Pathology The Volcani Center, P.O.Box 6, BET DAGAN 50250.
Dept Plant Genetics Inst of Field and Garden Crops The Volcani Center, P.O.B 6, BET DAGAN 50250.
Div Virology The Volcani Center, P.O.Box 6, BET DAGAN 50250.
Hazera Quality Seeds Research Division Dr Eyal Vardi, Mivhor Farm, DN LACHISH DAROM 79353.
Shifriss Chen The Volcani Center Department of Plant Genetics, P.O.Box 6, BET DAGAN 50250.
Zeraim Seed Growers Co Ltd., P.O.Box 103, 70750 GEDERA.

ITALY

Agrotec, Lungotevere Michelangelo 9, 00192 ROMA RM.
Asgrow Italia Jean M Poulos, Strada Latina 1C.P 110, 04014 PONTINIA LT.
Azienda Agricola MFN di Mario Faraone Mennella & C., Casella Postale 158, 80100 NAPOLI NA.
Clause Italia, Strada Madonnina 13, 10078 VENARIA REALE TO.
Consorzio Vitrocoop Centrale ortofrutticola, Via Masiera I 1191, 47027 CESENA FO.
DI.VA.P.R.A Genetica Agraria, Via Leonardo da Vinci 44, 10095 GRUGLIASCO TO.
DI.VA.P.R.A Patologia Vegetale, Via Leonardo da Vinci, 44, 10095 GRUGLIASCO TO.
Dipartimento di Agronomia e Genetica Vegetale Facoltà di Agraria, Via Università, 80055 PORTICI NA.
Dipartimento di Agronomia, Selvicoltura e Gestione del Territorio Orticoltura, Via Leonardo da Vinci 44, 10095 GRUGLIASCO TO.
ENEA Biblioteca c/o CRE Casaccia, 00060 S MARIA DI GALERIA RM.
Esasem S.p.A Gianni Gatto Alessandro Belardinelli, Via San Biagio 25, 37052 CASALEONE VR.
IPGRI Library, Via delle Sette Chiese 142, 00145 ROMA RM.
Istituto del Germoplasma , Via Amendola 165/A, 70126 BARI BA.
Istituto di Miglioramento Genetico Facoltà di Agraria Università Tuscia, 01100 VITERBO VT.
Istituto di Nematologia Agr Appl C.N.R., Via Amendola 165/A, 70126 BARI BA.
Istituto di Patologia Vegetale , Via Filippo Re 8, 40126 BOLOGNA BO.
Istituto di Patologia Vegetale Facoltà di Agraria, Via Università 100, 80055 PORTICI NA.
Istituto di Patologia Vegetale Facoltà di Agraria Prof M.Marte, B.go XX Giugno, 74, 06100 PERUGIA PG.
Istituto Sperimentale per l'Orticoltura, C.P 48, 84098 PONTECAGNANO SA.
Istituto Sperimentale per l'Orticoltura Sezione Operativa , Via Salaria 1, 63030 MONSAMPOLO D TRONTO AP.
Istituto Sperimentale per l'Orticoltura Sezione Operativa , Via Paullese 28, 20075 MONTANASO LOMBARDO MI.
Laboratorio Fitovirologia Applicata C.N.R , Strada delle Cacce, 73, 10135 TORINO TO.
Metapontum Agrobios, S.S Jonica 106 Km 488.2, 75010 METAPONTO MT.
Nunhems Sementi s.r.l Centro Ricerche Loes Van Leeuwen, Via Ghiarone 2, 40019 SANT'AGATA BOLOGNESE BO.
Olter Sementi , C.so Venezia 93, 14100 ASTI AT.
Oris Dr F.Vecchio, Via Vittorio Veneto 81, 20090 SALERANO SUL LAMBRO MI.
Peto Italianana s.r.l Centro Ricerche Carlo Vagnozzi Vittorio Stravato, Via Canneto di Rodi, 04010 BORGO SABOTINO LT.
S.A.I.S S.p.A Centro Ricerche e Miglioramento Genetico, Via Ravennate 214, 47023 CESENA FO.
Semencoop S.c.r.l, Via Calcinaro 2425, 47020 MARTORANO DI CESENA FO.
Stazione Sperimentale Industrie e Conserve Alimentari, Via Nazionale 121, 84012 ANGRI SA.

IVORY COAST

Compagnie Ivoirienne pour le Développement des Cultures Vivrières (CIDV), BOUAKÈ.
Faculty of Science , 04 B.P 322, ABIDJAN 04.
Institut des Savanes, Département des Cultures Vivrières, BP 635, BOUAKÉ.

JAMAICA

Bodles Agricultural Research Station, Old Harbour P.O., ST CATHERINE.
National Agriculture Research Institute Ministry of Agriculture, KINGSTOM.
TCP/BZE/8821, NPC c/o FAO Repr In jamaica, P.O.Box 1136, KINGSTON.

JAPAN

Academy Kita-Osaka Co Ltd Yonezawa Bldg Dai 6 Esaka 3F, 7-26 Hiroshiba Cho, Suita OSAKA 564.
Agriculture Forestry and Fisheries Research Council , Kosumigoseki Chiyoda, TOKYO.
Aoki Yosho Ltd 1.58-14 Matsubara, Setagaya-ku, TOKYO 156.
Applied Plant Research Laboratory Japan Tobacco Inc Manabu Hagimori, 1900 Idei., Oyama, Tochigi 323-0808, OYAMA.
College of Bioresources Sciences Nihon University, 3-34-1 ShimounaSetagaya-ku, TOKYO 154.
Dept Biotechnology and Plant Breeding Shiro Isshiki Faculty of Agriculture, Saga University, SAGA 840-8502.
Dept of Breeding Vegetable & Ornamental Crops Research Station, M.A.F.F., KUSAVAAGEMIE 514-23.
Dept of Greenhouse Cultivation V.O.C.R , TAKETOYOCHISTAAICHI.
Faculty of Agriculture Kagawa University, Miki-machiKida-gun, KAGAWAKEN 761-07.
Faculty of Agriculture Nagoya University Chikusa, NAGOYA 464.
Japan International Research Center of Agricultural Sciences, O Washi 1-2, TSUKUBA 305 IBARAKI.
Kihara Inst for Biological Res Yokohama City Univ , Kanagawa-ken 232, YOKOHAMA-SHI.
Kimio Ito Vegetable Breeding Nagano Chushin Agricultural, Experiment Station, Shiojiri NAGANO 399-64.
Kochi Agricultural Research Center M Matsumoto, M Okada, H sawada, 1100, Hataeda (Kochi Pref.), NANKOKU CITY.

Lab Vegetable and Ornamental Hortic Faculty of Agriculture Kyoto Univ. Susumu Yazawa, Oiwache-choKitashivakawa, KYOTO 606.
Laboratory of Plant Genetics Department of Agriculture Dr Yukata Hirata, Tokyo Univ Of Agric and Techn., FUCHUTOKYO 183.
Morioka Branch V.O.C.R.S., Shimokuriyagawa, MORIOKA 020-01.
National Inst of Agrobiological Resources, Tsukuba Science City, YATABE IBARAKI.
National Research Inst of Veget., Ornamental Plants and Tea (NIVOT) Lab of Breeding Solan Vegetables, T Yoshida360 Kusawa, ANOMIE 514-2392.
Nihon Horticultural Production Institute, 207 Kamishiki, MATSUDO-SHI CHIBA-KEN 271.
Nippon Del Monte Corp Research and Development, 3748 Shimizu-cho, NUMATA, GUMMA 378.
Ohta Yasuo, Kasuga 2-5-1-301, TSUKUBASHI 305.
Plant Biotechnology Institute Ibaraki Agricultural Centre Dr Hiroshi Ezura, Ago 3165-1, Iwana, Nishi-Ibaraki, 319-0292 IBARAKI.
Plant Cell Technology Lab Chiba University Horticulture Faculty Dr Keiko Ishikawa, 648, Matsudo, MATSUDO-SHICHIBA 271-8501.
Sakata Seed Corp Kakegawa Breeding Station Dr K Miyoshi, 1743-2 Yoshioka, KAKEGAWASHIZUOKA 436-01.
Sakata Seed Corp Plant Biotechnology Center Toshio Shiga, 358 Uchikoshi, SODEGAURA, CHIBA, 299-0217.
Sakata Seed Corp. R & D DivisionYosumi Okada 2 -71 Nakamachidai, Tsuzuki-ku, YOKOHAMA 224-0041.
Shizuoka Agricultural Experimental Station , 678-1 Tomioka -Toyota Iwata, SHIZUOKA.
The Nippon Shinyaku Institute for Botanical Research Oyake Sakanotsuji-cho 39, Yamashina-ku, KYOTO 607.
Yukura Yasuo 46.7 3-Chome, Miyasaka Setagaya-Ku, TOKYO.

JORDAN

Department of Agricultural and Scientific Research and Extension, P.O Box 226, AMMAN.
Ministry of Agriculture National Centre for Agricultural Research and Technology Transfer, P.O.Box 639, BAQA'A 19381.

KENYA

Department of Crop Science University of Nairobi, NAIROBI.
National Horticultural Research Station, P.O Box 220, THIKA.

KIRIBATI

Agricultural Division P.O.Box 267, Tanaea, Bikenibeu, TARAWA.

KOREA DEMOCRATIC REPUBLIC

Pilot Greenhose Farm, PYONGYANG.
Pyongyang Vegetable Research Center, PYONGYANG.

KOREA, REPUBLIC OF

Choong Ang Seed Co Ltd Dr Il-Woong Yu, 12-3 Seongjeong-Dong, CHEONAN CITYCHOONG NAM 330-170.
Department of Agriculture and Life Sc College of Agriculture and Life Sciences Seoul National Univ., Dr B.D.Kim, SUWON 441-744.
Department of Horticulture College of Agriculture Seoul National University, Seodum-dong, SUWEON 170.
Department of Horticulture Kyungpook National University Dr Byung-Soo Kim, 1370 Sankyuk-Dong BukKu, TAEGU 702-701.
Div of Vegetable Breeding Horticultural Experiment Station, 540 Tap-Dong, SUWON 441-440.
Horticultural Experiment Station , 20 Gandong-dong Buk-gu, PUSAN 57111.
Hungnong Seed Co Overseas Sales Department Joongbu Breeding Research Station, 1338-20 Seocho-Dong, Seocho-ku, SEOUL.
Nong-Woo Seeds Plant Breeding Research Institute 387-2 Sasa-2Ri, Panwol -, HWASONG 445-820.
Novartis Seed Korea Research and Development Station Yong Jik Lee, 168 Notap 4 Janghowonlchon, KYUNGKI.
Osan Breeding Institute Choong-Ang Seeds Co Ltd., 14 Bangkyo Dongtan, HWASUNG KYOUNGGI 445-810.
Seoul Seed International Co Ltd Chongill B/D 736-17 Yeoksam-dong, Kangnam-gu, SEOUL.

KUWAIT

Director, Ext Relations Dept Public Auth for Agric Aff and Fish Res Attn Mr Amir A Marafi, P.O Box 21422, SAFAT 13075.

LEBANON

Faculty of Agricultural and Food Sciences, P.O.Box 236, Bliss Street, BEIRUT.
Institut de Recherche Agronomique du Liban (IRAL), .

LESOTHO

Lesotho Agricultural College, P.O.Box 829, MASERU 100.

LIBERIA

CARI Central Agricultural Research Institute, P.O.Box 3929, MONROVIA, SUAKOKO.
CARI Central Agricultural Research Institute, P.O.Box 32, GBARNGA-BONG COUNTY.

LIBYA

Agricultural Research Station, P.O.Box 2480, TRIPOLI.
National Bureau for Agricultural Consultations and Studies , P.O.Box 2761, TRIPOLI.

MADAGASCAR

Centre National de la Recherche Appliquée au Développement Rural, BP 1690, ANTANANARIVO (101).

MALAWI

Bunda College of Agriculture University of Malawi, P.O.Box 219, LILONGWE.
Bvumbwe Agricultural Research Station, P.O.Box 5748, LIMBE.

The Officer-in-Charge Chitedze Agricultural Research Station, Box 158, LILONGWE.
The Principal Natural Resources College, Box 143, LILONGWE.

MALAYSIA

Dept of Agronomy and Horticulture University of Agriculture Malaysia Dr Sayed M.Z Hasan, University Pertanian Malaysia, 43400 SERDANGSELANGOR.
Dept of Genetics & Cellular Biology University of Malaya , KUALA LUMPUR 22-11.
MARDI , P.O.Box 12301G.P.O 50774, KUALA LUMPUR.
MARDI Tanah Rata 39007, Cameron HighlandsPAHANG.
MARDI Research Station JALAN KEBUN, Bag Berkunci 202, Unipertana, SERDANG-SELANGOR.

MALI

Institut d'Economie Rurale Ministère de l'Agriculture, BAMAKO.

MALTA

Department of Science University of Malta University Campus, MSIDA.

MARTINIQUE

I.R.A.T.-C.I.R.A.D , B.P 427, FORT DE FRANCE.

MAURITANIA

Centre Nat de Recherche Agronomique et de Développement de l'Agriculture Ministère de l'Agriculture Dept de l'Horticulture, NOUAKCHOTT.

MAURITIUS

Ministry of Agriculture and Natural Resources Agricultural Service, PORT LOUIS.

MEXICO

Centro de Botànica Colegio de Postgraduados, 56230 CHAPINGO-Estado de Mexico.
Centro de Investigaciones Agricolas del Nord INIA-SARH, Apartado Postal 81, 3300 CD DELICIASCHIH..
CINVESTAV Unidad Biotecn e Ing Genet Plantas Octavio Martinez de la Vega, Apartado Postal 629, 36500 IRAPUATO, GTO.
Experimental Station Celaya INIFAP, Apartado Postal 112, CELAYA-GTO 38000.
Genetic Center College of Postgraduate, 56230 MONTECILLO.
IBPGR Oficina para Latinoamerica c/o CIMMYT, Apartado Postal 6-641, MEXICO 06600 D.F..
INIFAPSAGAR Octavio Pozo Campodonico, Apartado Postal C-1Suc Paropuerta, 89100 TAMPICO.
Instituto Nacional de Investigaciones Forestales y Agropecuarias (INIFAP) Dr Juan Hernandez Hernandez, Aquiles Serdan 802, 93400 PAPANTLAVERACRUZ.
Instituto Nacional de Investigaciones Forestales, Agricolas y Pecuarias (INIFAP)Ing J K Lopez, Serapio Rendon 83Col San Rafael, 06470 MEXICO, D.F..
Laborde Josè A, Guanajuato 117, CELAYA-GTO 38040.
Library C.I.F.A.P Campo Exper del Sur de Tamaulipas Apartado Postal C-1, Km 55 Carretera Tampico Mante, TAMPICO.
Universidad Autonoma Chapingo Biblioteca Central, km 38,5 Carretera Mexico-Texcoco, 56230 CHAPINGO.

MOROCCO

Complexe Horticole Institut Agronomique et Vétérinaire Hassan II, BP 438, AGADIR.
Direction de la Production Vegetale Ministere de l'Agriculture et de la Reforme Agrarire, RABAT.
Division de la Documentation et de l'InformationDirection de la Pianification et des Affaires Economiq., Minist de l'Agric et de la Reforme Agr., RABAT.
Division de Recherches et Experimentations Forestiers Bibliothèque, Av Omar Iben El KhattabB.P 763, RABATAGDAL.
Ecole Nationale d'Agriculture, MEKNES.
Ecole Nationale Forestiere des Ingenieurs, SALE.
Institut de Technologie Horticole, MEKNES.
Institut National de la Recherche Agronomique INRA, RABAT.
Société du Développement Agricole (SODEA), RABAT.

MOZAMBIQUE

Facultad de Agricultura Universidade Eduardo Mondlane, P.O.Box 257, MAPUTO.

NEPAL

National Agricultural Research and Services Centre Department of Agricultural Development Ministry of Agriculture, KATHMANDU.
Nepal Agricultural Research Council Plant Pathology Division R.D Timila, P.O.Box 1126, LALITPUR.

NEVIS

CARDI Att Monica Gordon, P.O.Box 442, CHARLESTOWN.

NEW ZELAND

J Wattie Canneries Ltd , King Street-P.O.Box 439, HASTINGS.
The Librarian (serials) Massey University, PALMERSTON NORTH.

NICARAGUA
Istituto Superior Ciencias Agropecuarias REGEN, Km 12.5 Carretera Norte, MANAGUA.

NIGER
Institut National de la Recherche Agronomique au Niger (INRAN), BP 149, NIAMEY.

NIGERIA
Department of Crop Production College of Agricultural Sciences Ogun State University, AGO-IWOYE.
Department of Crop Science University of Nigeria, NSUKKA.
Institute for Agricultural Research Ahmadu Bello University Dept Crop Protection (Dr.M.D.Alegbejo), P.M.B 1044, ZARIA.
National Horticultural Research Inst Idi-Ishin Jericho Reservation Area, P.M.B 5432, IBADAN.

NORWAY
Dept of Vegetable Crops the Agricultural University of Norway, Box 22, 1432 AAS-NLH.

PAKISTAN
Pakistan Agricultural Research Council, P.O.Box 1031, ISLAMABAD.
Vegetable Research Institute , FAISALABAD 38950.

PAPUA NEW GUINEA
Department of Agriculture Food Management Branch Food Processing Preservation Unit, University of Technology, LAE, MOROBE PROVINCE.
Department of Agriculture and Livestok Headquarters Sprint Garden Road, P.O.Box 417, KONEDOBU.
Klaas Johan Osinga Fresh Produce Development Co Ltd., P.O.Box 958, GOROKA 441E.H.P..

PERU
Dept de Horticultura Universidad Nacional Agraria, Apartado 456, LA MOLINA-LIMA.
Experiment Station La Molina, Apartado 2791, LA MOLINALIMA.
Holle Miguel CIP, Apartado 1558, LIMA 100.
Instituto Nacional de Investigación Promoción Agropecuaria (INIPA) Sinchi Roca 2727Lince, Apartado 2791, LIMA 14.
Quea Julio A, Tarapacá 230Urb Tarapacá, TACNA.
Universidad Nacional de San Agustin Biblioteca de Biomedicas, Apartado 2726, AREQUIPA.

PHILIPPINES
College of Agriculture Inst of Plant Breeding Univ of the Philippines at Los Banos, College, LAGUNA 3720.
East-West Seed Company Inc Research Station Dr Trinette Van Selling, P.O.Box 2384 MCPO, 1263 MAKATI CITY.

POLAND
Academy of Agriculture Inst of Genetics and Plant Breeding, Wojska Polsiego 71, 60-625 POZNAN.
Department of Plant Genetics, Breeding and Biotechnology SGGW Dr Aleksadra Korzeniewska, Nowoursynowska 166, 02-787 WARSAWA.
Deparment of Genetics A.Mickiewicz University, Dabrowskiego Street 165, 60-594 POZNAN.
Department of Genetics and Plant Breeding University of Agriculture, Zgorzelecka Street 16, 60-198 POZNAN.
Inst of Plant Genetics Polish Academy of Sciences, Ul Strzeszynska 34, 60-479 POZNAN.
Iwarz-Pnos Ltd E HorodeckaC Tkacz, Reguly ul Wiejska 1, 05-816 MICHALOWICE.
Michalik Brabara University of Agriculture Dept of Genetics and Plant Breeding, Al 29 Listopada 54, 31-425 CRACOW.
Plantico Hort Breeding and Seed Production Lucyna Koscielniak, Swietostaw, 87-853 KRUSZYN.
Polan Krakowska Hodowla I Nasiennictwo Ogrodnicze Dr Izabela Zudarska, Ul L Rydla 53-55, 30-130 KRAKOW.
Research Institute of Vegetable Crops, Ulica 22 Lipca 1/3, 96-100 SKIERNIEWICE.
University of Technology and Agriculture Dept of Genetic and Plant Breeding Prof Pawel Nowaczyk, Ul Bernardynska 6, 85-029 BYDGOSZCZ.

PORTUGAL
I.N.I.A Estaçao Agronomica Nacional, Quinta do Marques, OEIRAS.

PUERTO RICO
Universioty de Puerto Rico Rec de Mayaguez Colegio de Ciencias Agricolas Estacion Exp Agr Subest de Isabela, Apartado 506, ISABELA 00662.
University of Puerto Rico College of Agricultural Sciences, Mayaguez Campus, College Station, MAYAGUEZ 00708.

ROMANIA
Research Inst for Vegetable and Flower Growth, 8268 VIDRA JUD GIURGIU.

RUSSIA
Agrogroup Semco Olga Svetlana Timina, Prospect Mira, VVZ, 129223 MOSCOW.
Bolshoy Haritoniewsky , Perenlok Dom 21, MOSKVA B-78.
Dept of International Book Exchange Central Scientific Agricultural Library, Orlikow Street 3, 107804 GSP-MOSCOW B-139.
Institute of Nutrition Russian Academy of Medical Sciences, Ustinskiy pr 2/14, 109240 MOSCOW.
Majkop Research Station of Vavilov Institute of Plant Indutry, 352772 MAJKOP REGIONSUNTUK.

N.I.Vavilon All Union Inst of Plant Industry, Herzen Street 44, 190 000 S PIETROBOURG.
Research Inst on Vegetable Crops, Breeding and Seed Production Solanaceous Crops Breeding Lab., Odintsov dis., p/o Lesnoy godorok, 143080 MOSCOW REGION.

RWANDA

Institut des Sciencies Agronomiques du Rwanda (ISAR), BP 138, BUTARE.

SAMOA

Dept of Agriculture Ministry of Agriculture, APIA.

SAO TOME AND PRINCIPE

Ministério da Agricultura Estaçáo Experimental, CP 47, SAO TOMÉ.

SAUDI ARABIA

Department of Horticulture Ministry of Agriculture, RIYADH.

SENEGAL

Centre pour le Développment de l'Horticulture (ISRA), Bp 2619, DAKAR.
CORAF Vegetable Research Network Attn Alain Mbaye, c/o ISRABP 3120, DAKAR.

SEYCHELLES

Direction Générale de la Production Agricole Ministère de l'Agriculture, GRAND'ANSE, MAHE.
Grand'Anse Expérimental Centre, P.O.Box 166, GRAND'ANSE, MAHE.

SINGAPORE

Institute of Molecular Agrobiology Laboratory of Plant Biotechnology Research Link, The National University of Singapore, SINGAPORE 117604.

SLOVAK REPUBLIC

Research and Breeding Inst for Vegetable and Special Plants, 94701 HURBANOVO.
Research and Breeding Institute for Vegetable and Special Plants, Andovská 6, 94001 NOVE ZEMKY.
Research Breeding Station Novofruct s.e., 94043 NOVE ZAMKY.
Vyskumny a slaschtitelsky ustav zeleniny-VRBANOVO , Slachtitelska stanica, 93041 KVETOSLAVOV.

SLOVENIA

Agricultural Institute of Slovenia Dr Mihaela Cerne, Hacquetova 2, 61109 LJUBLJANA.

SOLOMON ISLANDS

Dodo Creek Research Station, P.O.Box G13, HONIARA.

SPAIN

Asgrow Seed Company , Apartado 175, 04700 EL EJIDO (ALMERIA).
C.S.I.C Estacion Experimental La Mayora, ALGARROBO-COSTA MALAGA.
Centro de Investigaciones Agrarias , P.O.Box 1056, 26080 LOGRONO.
Centro Investigacion y Desarrollo Agroalimentario Biblioteca, Apartado oficial, 30150 LA ALBERCAMURCIA.
Clause Iberica S.A , Apartado 162, PATERNA (Valencia).
Dept de Bioquimica y Biologia Molecular Universidad de Almeria, La Canada de San Urbano, 04120 ALMERIA.
Dept de Biologia Animal y Vegetal F Merino de Caceres Universidad de La Coruña, Campus da Zapataria s/n, 15701 LA CORUÑA.
Diputacion General de Aragon Servicio de Investigacion Agroaliment Seccion Documentacion y Bibliotheca, Apartado 727, 50080 ZARAGOZA.
Escuela de Capacitaciòn Agraria, Apartado 71, DON BENITO (BADAJOZ).
Gil Ortega Ramiro D.G.AS.I.A., Apartado 727, 50080 ZARAGOZA.
I.N.I.A Dr.F.Ponz, Apartado 8111, 28080 MADRID.
Instituto Nacional Investigaciones Agrarias Cit Centro Inv y Tecn Biblioteca, Ctra de la Coruna, km 7, 28040 MADRID.
Polytechnical University of Valencia Biotechnology Department (Genetics) Dr F Nuez Vinals, Camino de Vera, 14, 46022 VALENCIA.
Polytechnical University of Valencia Plant Protection Department Pathology, Camino de Vera 14, 46020 VALENCIA.
Ramiro Arnedo S.A José Luis Peiro Abril, Carretera de Malaga, 18, 04740 EL PARADOR (ALMERIA).
Semillas Fito, Selva de Mar 111, 08019 BARCELONA.
Semillas Fitò , Crtra N-2, BELLPUIG (Lèrida).
Semillas Pioneer S.A J Riado Abad, Paraje Tres Aljibes 16, 04710 EL EJIDO (ALMERIA).
Sluis & Groot Semillas , Apdo de Carreos 57, EL EJIDO-ALMERIA.
Western Seed Espana Ir Henriette C J Aarden Apartado de Correos 22, Carrizal Ingenio, 35240 LAS PALMAS GRAN CANARIA.

SRI LANKA

Agricultural Research Station , MAHAILLUPPALLAMA.
Central Agricultural Research Institute, P.O.Box 11, GANNORUVA, PERADENIYA.
Food Technology Section Ceylon Inst of Scientific and Industrial Research, P.O.Box 787, COLOMBO.
Government's Department of Agriculture, PERADENIYA.

ST LUCIA
C.A.R.D.I., P.O Box 971, CASTRIES.

SUDAN
Agricultural Research Corporation Horticulture Germplasm Unit, P.O.Box 126, WAD MEDANI.
Department of Horticulture Faculty of Agriculture University of Khartoum, SHAMBAT, KHARTOUM.
Gezira University Faculty of Agricultural Sciences Plant Pathology Department, P.O.Box 20, WAD MEDANI.
University of Gezira Faculty of Agricultural Sciences Dept of Horticulture, P.O.Box 20, WAD MEDANI.
University of Khartoum Faculty of Agriculture Amel Abdeen Elsayed, P.O.Box 32, SHAMBAT 13314.

SUISSE
Nestec S.A , Av Nestlé 55, CH-1800 VEVEY.

SURINAM
Surinam Agricultural Experiment Station Cultuurtuinlaan, P.O Box 160, PARAMARIBO.

SWAZILAND
Agricultural Research Division, P.O.Box 4, MALKERNS.
University of Swaziland, Private Bag 4, KWALUSENI.

SYRIA
Faculty of Agriculture Damascus University, University Street, DAMASCUS.
Faculty of Agriculture University of Aleppo, ALEPPO.

TAIWAN R.O.C.
Black Lowell L The Asian Vegetable Research and Development Center, P.O.Box 42, SHANHUA, TAINAN 741.
DAIS , 350 Lin-Sed Road Sec 1, TAINAN.
Dept of Horticulture Nat Chung Hsing Univ., 250 Kuokuang Road, TAICHUNG 40227.
Dept of Horticulture Nat Taiwan University, TAIPEI.
Fengshan Tropical Hort Exp Stat., FENGSHAN KAOHSIUNG 83017.
Information and Documentation The Asian Vegetable Research and Development Center, P.O.Box 42, SHANHUA TAINAN 741.
Library Taiwan Agric Research Inst., 189 Chung-cheng Road, WAN-FENG WU-FENG TAICHUNG 41301.
National Chiayi Inst of Agriculture, CHIAYI.
Taiwan Seed Improvement and Propagation Station 46 Hsing-Chung st., Ta-nan village Shin-shieh, TAICHUNG.
Wang Jan-Fen The Asian Vegetable and Research Development Center, P.O.Box 42, SHANHUATAINAN.

TANZANIA
Horticultural Training and Research Institute Tengeru, P.O.Box 1253, ARUSHA.
Sokoine University of Agriculture, P.O Box 9192, DAR ES SALAM.

THAILAND
APTA Phaya Thai Court, Soi GolitPhaya Thai Road, BANGKOK 10400.
AVRDC Thailand Outreach Program Kasetsart University, P.O.Box 91010, (Kasetsart) BANGKOK 10903.
Chia Tai Company Limited , 299-301 Songsawad Road, BANGKOK 10100.
Div of Horticulture Dept of Agriculture, Bagkhen BANGKOK.
East-West Seed Co.Ltd Research Station Farm Lert Phan Mr S J de Joop, 7 Moo 9, Maefaek Mai Amphur Sansai, CHIANG MAI 50290.
Faculty of Agriculture Chiang Mai University, 130 Huay Kaew Road, CHIANG MAI 50002.
Horticulture Research Institute Dept of Agriculture Ms Patchara Punjasamarnwong, Chatuchak, BANGKOK 10900.
Horticulture Research Institute Headquarters, Dept of Agriculture, Ministry of Agriculture and Cooperatives, DOA Building Bangkhen, BANGKOK 10900.
Thep Watana Seed Co Ltd., 293-293/1-2 Surawong Rd Bangruk, BANGKOK 10500.

THE NETHERLANDS
Bejo Zaden b.v B Schrijver, P.O.Box 50, 1749 ZH WARMENHUIZEN.
Bel Agro Handelmaatschappij b.v., P.O.Box 3913, 1001 AS AMSTERDAM.
CPRO-DLO R.E Voorrips A.P.M den Nijs, P.O.Box 16, 6700 AA WAGENINGEN.
De Ruiter Zonen Dr D Vreugdenhil, Naaldwijkseweg 400, 2691 RA 'S GRAVENZANDE.
Enza Zaden b.v., P.O.Box 7, 1600 AA ENKHUIZEN.
EUCARPIA Secretariat, P.O.Box 315, 6700 AH WAGENINGEN.
Gebr Bakker Zaadteelt Zaadhandel, Oostelijke Randweg 12, 1723 LM NOORDSCHARWOUDE.
Glasshouse Crops Research and Experiment Station Library, P.O.Box 8, 2670 AA NAALDWIJK.
Keygene n.v S VargaR van Wijk, P.O Box 216, 6700 AE WAGENINGEN.
Kniphorst International Booksellers, Postbus 67, 6700 AB WAGENINGEN.
Landbouwuniversiteit 99458 Bibliotheek, Postbus 9100, 6700 HA WAGENINGEN.
Nickerson Zwaan b.v , Gebroken Neeldijk 74-P.O.Box 19, 2990 AA BANRENDRECHT.
Novartis Seeds b.v Vegetables and Flowers, P.O.Box 2Westernde 62, 1600 AA ENKHUIZEN.
Nunhems Zaden BV , P.O.Box 4005, 6080 AA HAELEN.
Rijk Zwaan Zaadteelt en Zaadhandel B.V., P.O.Box 40, 2678 ZG DE LIER.
Royal Sluis , P.O.Box 22, 1600 AA ENKHUIZEN.
S & G Seeds b.v Library, P.O.Box 26, 1600 AA ENKHUIZEN.

Sakata Seed Europe B.V Dr Y Kobayashi, Kruizemuntweg 27, 1435 DD RIJSENHOUT.
Seminis Vegetable Seed b.v Jurko Leij, P.O.Box 93, 2675 ZH HONSELERSDIJK.
Sluis en Groot Seeds B.V., Blaker 7, 2678 LW DE LIER.
Swets & Zeitlinger B.V Backsets Department, P.O.Box 810, 2160 SZ LISSE.
University of Nijmegen Botanical Garden Gerard M Van der Weerden, Toernooiveld 1, 6525 ED NIJMEGEN.
Van der Zaden B.V Beethovenstraat 42, 5102 XB DONGEN.

TOGO

Département de l'Agriculture Ministère de l'Agriculture, YAOUNDÉ.

TRANSNISTRIA MOLDAVIAN REPUBLIK

Inst of Ecological Genetics of the Academy of Sciences, Lesnaya 20, KISHINEV-277018.
Transnistria Institute of Agriculture Olga O Timina, Mira str 50, 278000 TIRASPOL.

TRINIDAD AND TOBAGO

Caribbean Agricultural Research and Development Institute (CARDI) University Campus, ST AUGUSTINE.
GCP/RLA/108/ITA FAO, Chaguaramas c/o FAO Representative's Office, 134-138 Frederick StreetP.O.Box 822, PORT OF SPAIN.

TUNISIA

Cooperative Centrale de Semences et Plants Selectionnes, 45, Av Farhat Hached, 1001 TUNIS.
Department of Biological Sciences Faculty of Sciences Library Research II, Campus Universitaire, 1060 TUNIS.
Ecole Superieure d'Horticulture , CHOTT-MARIEM-SOUSSE.
Horticultural Institute of Chatt-Mariem, SOUSSE.
INRAT Ali Ltifi, Route de Tunis, 9019 BEJA.
INRAT Laboratoire de Cryptogamie, Rue Hedi Karray, 2049 ARIANA.
INRAT Laboratoire de Virologie, Rue Hédi Karray, 2049 ARIANA.
Inst National Agronomique de Tunisie Lab Cultures Maraichéres et Florales , 43 Avenue Charles Nicolles, 1082-TUNIS MAHRAJENE.
Lab de Génétique et Biologie Molec Faculté des Sciences de Tunis Campus Universitaire, La Belvedere, 1060 TUNIS.
Station d'Appui de la Medjerda , 2010 MANOUBA.

TURKEY

Aegean Regional Agricultural Research Inst., P.O.Box 9, MENEMEN-IZMIR.
Ankara University Faculty of Agriculture Department of Horticulture, ANKARA-Diskapi.
Atatõrk Horticultural Research Yalova Inst., ISTAMBUL.
Department of Horticulture Fac Agriculture Univ Of Cukurova, Bahçeç Bitkileri Bölümü, 01330 ADANA.
Department of Plant Pathology Fac Agriculture Univ Of Cukurova, Bahçeç Bitkileri Bölümü, 01330 ADANA.
Ege Universitesi Ziraat Fakültesi Bitki Koruma Bölümü, BORNOVA 35100-IZMIR.
Uludag Univ Faculty of Agric Dept of Horticulture, BURSA.
Vegetable Research Institute, PK 130, 07110 ANTALYA.

U.S.A.

Albert R Mann Library Serials Unit Acquisition Division/1ALM1682, Cornell University, ITHACA NEW YORK 14853-4301.
Andrews Jean, 1805 Polo Road, AUSTIN TX 78703.
Asgrow E.P.G , 7000 Portage Road, KALAMAZOO Michigan 49001.
Asgrow Seed Company Dr.R.Heisey, 500 Lucy Brown Lane, SAN JUAN BAUTISTA CA 95045.
Campbell Research and Development Dawn F Adams, 28605 County Road 104, DAVIS CA 95616.
Cass River Seed Bradley Boese, 4328 Sheridan Road, SAGINAW MICHIGAN 48601.
Central Valley seeds, Inc., 485 Victor Way Suite 10, SALINAS CA 93907.
Chili-Queen , 6336 Oracle Rd Suite 326.319, TUCSON ARIZONA 85704.
College of Agricultural Sciences University of Delaware Department of Plant Sciences, NEWARK Delaware 19717-1303.
Danson Seed Co Michael Nadel, 10851 Wodbine Street, LOS ANGELES, CA 90034.
Department of Crop Sciences University of IllinoisAW 101, Turner Hall Dr Houston A Hobbs, 1102 S Goodwin Av., URBANA IL 61801.
Department of Entomology, Plant Pathology and Weed Science, New Mexico State University, LAS CRUCES NM 88003.
Dept of Biology Indiana University, BLOOMINGTON IN 47405.
Dept of Botany Miami University, OXFORD Ohio 45056.
Dept of Horticultural Sciences New York Agricultural Expt Stat Prof R.W.Robinson, P.O.Box 462, GENEVA-New York 14456-0462.
Dept of Horticulture Louisiana Agricultural Exp Stat., 137 Agronomy-Horticulture Building, BATON ROUGE LA 70803-2120.
Dept of Horticulture Michigan State University, EAST LANSING Michigan 48824.
Dept of Vegetable Crops Cornell University Plant Science Building, ITHACA N.Y 14853-0327.
Dept of Vegetable Crops University of California, DAVI SCalifornia 95616.
Dept Plant Breeding & Biometry Cornell University, 312 Bradfield Hall, ITHACA N.Y 14853-1902.
Dept Plant Pathol and Crop Physiol Louisiana Agric Exper Station Louisiana State University, 302 Life Science Building, BATON ROUGE Louisiana 70803.
Desert Botanical Garden Richter Library, 1201 North Galvin Parkway, PHOENIX ARIZONA 85008.
Extension-Research Center , P.O.Box 189, ATTAPULGUS-Georgia 31715.
Genetics Department North Carolina State University, Box 7614, RALEIGH-NC 27695.
Harris Moran Seed Company Chester Kurowski, 100 Breen Road, SAN JUAN BAUTISTA CA 95045.
IFAS University of Florida, ARES BELLE GLADE Florida 33430.
IFAS University of Florida, 345 South Congress Avenue, DELRAY BEACH-Florida 33444.
IFAS University of Florida Agronomy Department, Building 164, GAINESVILLE Florida 32611-0621.
IFAS, University of Florida Prof Robert E Stall Plant Pathology Dept., P.O.Box 6801453 Fifield Hall, GAINESVILLE Florida 32611-0513.
Kalsec Inc Library Ken Wheaton, P.O.Box 505113713 West Main Str., KALAMAZOO MICHIGAN 49005-0511.
Library Cornell University New York Agricultural Experiment Station, Jordan Hall, GENEVA-New York 14456.

National Seed Storage Laboratory U.S Dept Agriculture Colorado State University, FORT COLLINS-Colorado 80523.
New Mexico State Univ. Dept of Agronomy and Horticulture Dr.P.W.Bosland, Box 30003 Dept 3Q, LAS CRUCES-New Mexico 88003.
New York Botanical Garden LuEsther T Mertz Library Serials & Exchange, BRONX-N.Y 104585126.
Novartis Seed Co Dr Steven Czaplewski, 10290 Greenway Rd., NAPLES FLORIDA 34114.
Pepper Research Inc S.R.Subramanya, P.O.Box 1068, LOXAHATHCHEE, FL 33740-1068.
Rogers Food Co./Chili Products Dr P.A Gniffke 39502 Cypress Ave., P.O Drawer H, GREENFIELD-CA 93927.
Rogers Seed Co., P.O.Box 4188, BOISE IDAHO 83711-4188.
Sakata Seed America, 105, Boronda Road, SALINAS CA 93907.
Sakata Seed America, Inc William McCarthy, P.O.Box 1118, LEHIGH ACRESFL 33970-1118.
Seminis Vegetable Seeds Research Dr Paula McGahan, 37437 State Highway 16, WOODLAND CA 95695.
Seminis Vegetable Seeds Inc Dale S Kammerlohr, P.O.Box 249, FELDA FLORIDA 33930-0249.
Suburban Experiment Station University of Massachussets, 240 Beaver Street, WALTHAM-Ma 02254.
Texas Agr Exp Station The Texas University, 2415 East Hwy 83, WESLACO Texas 78596-8399.
The Chile Pepper Institute New Mexico State University, Box 30003Dept 3Q, LAS CRUCES NM 88003.
The Pepper Gal National Hot Pepper Association Dr Elisabeth A Payton, 400 N.W 20th Street, FORT LAUDERDALE FL 33311.
The Pillsbury Company Technology Center Technology Knowledge Center, 330 Univ. Avenue SE, MINNEAPOLIS MN 55414-2198.
United Genetics Seeds Co Dr Ken Owens, 8000 Fairview Road, HOLLISTERCA 95023.
Universidad Nacional de Palmira Biblioteca SEINTEC, P O Box 830661, BIRMINGHAM AL 35283-0661.
University of Tennessee Dr Brad Reddick, Rm 205 Plant Science Bldg., KNOXVILLE TN 37996.
USDA National Agricultural Library Current Serial Records Rm 002, BELTSVILLE Maryland 20705.
USDAARS Plant Genetic Resources Robert L Jarret, 1109 Experiment Street, GRIFFIN-GA 30223-1797.
USDAARSPPMQ Dale Marshall Russell Research Center, 130 Whippoorwill Circle, ATHENS GA 30605-3440.
USDA-Agr Mark Serv Plant Variety Protection Office NAL Bldg.-Room 500J.Strachan, 10301 Baltimore Blvd., BELTSVILLE Maryland 20705-2351.

UGANDA

Library Kawanda Agricultural Research Station, P.O Box 7065, KAMPALA.

UNION OF MYANMAR

Library Institute of Agriculture, Yezin, PYINMANA.

UNITED ARAB EMIRATES

Agricultural Research Centre Digdaga, P.O.Box 176, RAS AL KHAIMAH.

URUGUAY

Centro de Investigaciones Agricolas "Alberto Boerger" (CIAAB), LA ESTANZUELA, COLONIA.
Consejo Nacional de Investigaciones Cientificas y Técnicas (CONICYT) Reconquista 535 p 7, P.O.Box 1869, MONTEVIDEO.

VENEZUELA

Fusagri, P.O Box 162, Cagua, 2122 ARAGUA.
Universidad de Oriente, Jusepin, ESTADO MONAGAS.

VIETNAM

Vietnam Institute of Agricultural Science and Technology, Thanh Tri District, HANOI.

YUGOSLAVIA

Vegetable Research Institute Palanka, Ul Karadjordjeva 73, 11420 SMEDEREVSKA PALANKA.
Vitamin Spice Pepper Breeding Station, Ul Partizanska 24, 24420 HORGOS.

ZAIRE

Institut National pour l'Etude et la Recherche Agronomique (INERA), BP 1513, KISANGANI.

ZAMBIA

University of Zambia, P.O Box 32379, LUSAKA.

ZIMBABWE

Department of Agricultural, Technical and Extension Services (AGRITEX) Ministry of Lands, Agriculture and Rural Resettlement, HARARE.
Department of Research and Specialist Services (R & SS) Ministry of Lands, Agriculture and Rural Resettlement, and Rural Resettlement, HARARE.