Adv. Hort. Sci., 11 (1997): 193-201

Review paper

Development of eggplant varietal resistance to insects and diseases via plant breeding

G.L. Rotino*, E. Perri*, N. Acciarri, F. Sunseri[1]***, S. Arpaia*****
* *Istituto Sperimentale per l'Orticoltura, MiPA, 26836 Montanaso Lombardo, Italy.*
** *Istituto Sperimentale per l'Orticoltura, MiPA, 63030 Monsampolo del Tronto, Italy.*
*** *Metapontum Agrobios, 75010 Metaponto, Italy.*

Key words: biotechnology, biotic stress, genetic resistance, *Solanum melongena.*

Abstract: Eggplant plantings are constantly attacked by a number of serious pests (e.g. the fruit and shoot borer, the Colorado potato beetle, soil-borne fungi). In spite of the heavy losses they may cause, breeding for resistance in this crop has been very limited because of lack of desirable traits in the eggplant genome or sexual incompatibility with resistant, wild related species. The present paper reviews the source of resistant genes available in both eggplant gene pool and wild *Solanum* relatives. Considering the genetic determinism of resistant traits, the possible strategies for eggplant breeding are discussed with emphasis on approaches based on the integration of classical breeding methods (crosses and selection) with biotechnological ones (anther culture, genetic transformation, protoplast fusion and marker-assisted selection).

1. Introduction

Solanum melongena L. (2n = 24) is also known as eggplant, aubergine, brinjal or Guinea squash. It is mainly cultivated in tropical Asian and Mediterranean countries. The annual worldwide production of eggplant was about 9 million metric tons in 1995 and it has increased in the last fifteen years by about 2.5 million metric tons (FAO, 1995). The largest producer is China with 60% of total world production followed by Turkey, India, Japan and Mediterranean countries such as Egypt, Italy, Spain, etc. Eggplant is an important and popular vegetable in the diet of the inhabitants of these countries.

Most of the produce is freshly marketed but the use of frozen pre-cooked eggplant is spreading, mainly in developed countries. The fruits and leaves display other medicinal uses. Eggplant is a slow-growing perennial solanaceous crop in tropical countries, while in temperate zones it behaves as an annual. However, its growing season can be extended under protected cultivation. The plant grows to a height of 50 to 150 cm and bears fruits of very different size, shape and skin colour. It is a day-neutral plant and it starts flowering at the 6th to 10th leaf stage lasting for a long period. It is considered an autogamous species, however the frequency of natural cross-pollination is estimated to vary from 0.2 to 48%.

Eggplant breeding is mainly focused on F_1 hybrid cultivars, which nearly replace the open pollinated varieties, particularly in intensive growing areas. The major objectives of breeding are the development of high-quality and pest-resistant varieties. In the countries where intensive and successive cropping is practised, the main goal of breeding programs is to develop varieties resistant to soil-born diseases (*Verticillium* and *Fusarium* wilt, bacterial wilt and nematode infections). Eggplant plantings are severely damaged also by insects (e.g. *Leucinodes orbonalis* Guenee, *Leptinotarsa decemlineata* - Say -, *Trialeurodes vaporariorum* - Westw -), mites and fruit rot. Since eggplant is highly responsive to *in vitro* manipulation (Hinata, 1986), biotechnological approaches as *in vitro* doubled-haploids production (Rotino, 1996), culture and fusion of protoplasts (Sihachakr *et al.*, 1994), and genetic transformation (Rotino and Gleddie, 1990) may well help to solve several of its agronomic problems.

[1] Present address: Dip. Biologia, Difesa e Biotecnologia Agroforestali Università degli Studi della Basilicata, 85100 Potenza.

Received for publication 4 March 1997.

2. Breeding for resistance and crop improvement

Resistance source within eggplant germplasm

The breeding procedures usually followed are: pedigree, backcross, bulk methods, recurrent selection and single seed descent (Kalloo, 1993).

In spite of the huge morphological variability, there is a lack of resistance traits in the *Solanum melongena* gene pool. Thus, the release of eggplant cultivars resistant or tolerant to the main diseases and pests has been very limited. A certain degree of genetic variability related to resistance to several pests has been found and germplasm was reported as a suitable source (Table 1). Nevertheless, most of this genetic material gave unsatisfactory or contrasting results when employed in breeding programs.

Several reasons, such as resistance restricted to a specific pathogen strain(s) or isolate(s), polygenic and complex resistance traits, and unreliable tests for assessing the resistance may explain the relatively poor results gathered so far. Nevertheless, efforts have permitted tolerance improvement to some diseases (e.g. even in the absence of an effective resistance trait, lines showing a reasonable field tolerance to *Verticillium* spp. have been selected).

With regard to insects resistance, studies have been carried out by Indian scientists to exploit genetic variation aimed at the selection of genotypes with improved tolerance or resistance to the fruit and shoot borer, *L. orbonalis* (Dahnkhar and Sharma, 1986) which is the most destructive pest in Asia. Many field screenings of different genotypes infested by this insect made it possible to correlate some plant characters with improved tolerance to this pest.

Morphological traits that have been associated with increased tolerance to insect attack are tightly arranged seeds in the mesocarp (Lal, 1991), more lignified and compact hypodermal sclerenchyma, and broader and more compact vascular bundles (Isahaque, 1984). Plant chemicals potentially involved in tolerance to this pyralid were also identified: lower sugar and protein content (Isahaque, 1984), and higher level of peroxidase and polyphenoloxidase and higher level of glycoalkaloids (Bajaj *et al.,* 1989). The latter are well-known compounds involved also in resistance to *L. decemlineata* in several solanaceae (Flanders *et al.,* 1992).

However, Tewari and Moorthy (1985) reported that the variation in tolerance, under field conditions among different genotypes, was lost in artificial infestation with a high pest population density and all genotypes were equally susceptible. The tolerance seemed inherited as a polygenic trait with a high additive effect supported by more than one recessive gene (Dahnkhar *et al.,* 1977; 1980).

A partial resistance to *T. vaporariorum* based on antibiosis and antixenosis was also noted among seven eggplant genotypes in greenhouse and laboratory tests, the differences in hairiness and colour among genotypes had no relation to the resistance (Malausa *et al.,* 1988).

In germplasm field screenings, variation was noted also in relation to the response to natural infestations of jassid (*Amrasca biguttula* - Ishida -) (Khaire and Lawande, 1986). Unlike the previous case, the presence of trichomes was considered to be associated with increased levels of resistance (Schreiner, 1990) while other morphological characters such as leaf lamina and midrib thickness were positively correlated with the insect infestation (Subbaratnam *et al.,* 1983).

Trichomes are also involved in resistance to insects in potato and other wild *Solanum* species. The combined action of mechanical obstruction and the production of phenolic compounds (Avé and Tingey, 1986) and sucrose esters of carboxylic acids (Neal *et al.,* 1990) sensibly reduce attack by aphids, leafhoppers, flea beetles and Colorado Potato Beetle (Flanders *et al.,* 1992).

A certain degree of variation in the susceptibility to

Table 1 - Eggplant germplasm reported as resistant to its main pests

Pest	Source	Reference
Insects		
Jassid *(Amrasca biguttula)*	S488-2; S34; S258 'Manjari Gota'	Pawar *et al.*, 1987
	Green-fruited local populations	Schereiner 1990
Aphis gossypii	AC 49A	Sambandam and Chelliah. 1983
Glasshouse whitefly *(Trialeurodes vaporariorum)*	'Shinkuro'	Malausa *et al.*, 1988
Shoot and fruit borer *(Leucinodes orbonalis)*	F_3 progenies *S. melongena x S. incanum*	Rao, 1981
	'Pusa Purple Cluster' AM 62	Nathani, 1983
	SM 17-4	Singh and Sidhu, 1988
Diseases		
F. oxysporum and *Phomopsis vexans*	F_4 plants *S. melongena x S. indicum*	Rao and Kumar, 1980
Fusarium wilt	K 61, K 7, Ghana Local	Abdullaeva and Shifman, 1988
Verticillium dahliae	PI 1649, PI 174362	Lockwood and Markarian, 1961
Verticillium albo-atrum	'Florida Market', 'Hanis Hybrid 7763'	O'Brien, 1983
Cercospora solani	UdupiGulla, GO-3	Madalageri *et al.*, 1988
Pseudomonas solanacearum	SM6-1, PPC, ARU2C	Sheela *et al.*, 1984
	SM 6-1, SP, SM 6-7, SP	Ushamani and Peter, 1987
Nematodes		
M. incognita race 1 and 2	'Gulla'	Ravichandra *et al.*, 1988

the Coleopteran *L. decemlineata* (Fiume, 1987) and *Epilachna vigintioctopunctata* F. (Sambadan *et al.*, 1976; Raju *et al.*, 1987) was reported for some eggplant accessions.

Partial resistance to *Tetranychus cinnabarinus* (Boisduval) based on antibiosis, was found to be positively correlated with the density of leaf hairs (Misra *et al.*, 1990) or to an antixenosis mechanism (Schalk *et al.*, 1975).

Resistance source in wild species and distant hybridization

Many attempts have been made to introgress resistance genes displayed by wild *Solanum* species by means of sexual hybridization (Kalloo, 1993). The first step in a program aimed at the introgression of useful traits from wild relatives into the eggplant gene pool is their evaluation for disease and pest resistance. The second step is selecting and fixing useful resistance levels in segregating progenies. In addition, different accessions of the wild species may give different results with respect to resistance to the same pathogen.

Several *Solanaceous* species have been identified as possible sources of resistance to the main pests of eggplant (Table 2), however the genetics of the resistance is not completely known. Source of resistance to the most serious soil-born diseases (*Verticillium*, *Fusarium* and nematodes) have been identified in *S. sisymbrifolium* and *S. torvum*. *S. khasianum* was found resistant to the shoot and fruit borer (*L. orbonalis*).

In spite of numerous studies and the huge work undertaken by some research groups, the contribution of wild relatives to eggplant breeding has been, so far, very limited. Principal reasons for the unsatisfactory results obtained may be concerned with a certain confusion in taxonomic classification within the *Solanum* genus that makes a reasonable prediction of the suitable wild species to be employed for crossing very difficult for breeders (Daunay and Lester, 1988; Daunay *et al.*, 1995).

Table 2 - Wild *solanum* species reported as resistant to the main pests of eggplant

Pest	Source	Reference
Insects		
Shoot and fruit borer	*S. integrifolium, S. sisymbrifolium*	Chelliah and Srinivasan, 1983
(Leucinodes orbonalis)	*S. xantocarpon, S. khasianum*	Khan *et al.*, 1978
	S. hispidum	Sharma *et al.*, 1980
Glasshouse whitefly *(Trialeurodes vaporariorum)*	*S. macrocarpon*	Malausa *et al.*, 1988
Aphis gossypii	*S. sisymbriofolium, S. mammosum*	Sambandam and Chelliah, 1983
Colorado Potato Beetle *(Leptinotarsa decemlineata)*	*S. pinnatisectum, S. polyadenium, S. jamesii, S. trifidum, S. capsici-baccatum, S. tarijense, S. chacoense, S. berthaultii, S. chompatophilum*	Flanders *et al.*, 1992
Mites		
Two-spotted spider mite	*S. macrocarpon*	Schaff *et al.*, 1982
(Tetranychus urticae)	*S. integrifolium*	Dikii and Voronina, 1985
Carmine spidermite	*S. mammosum*	Schalk *et al.*, 1975
(T. cinnaborinus)	*S. pseudocapsicum*	"
	S. sisymbrifolium	"
Diseases		
Fusarium wilt	*S. indicum, S. integrifolium, S. incanum*	Yamakawa and Mochizuki, 1979
	S. sisymbrifolium	Cappelli *et al.*, 1995
Verticillium dahliae	*S. torvum, S. caripense, S. persicum, S. scabrun*	Sakata *et al.*, 1989
	S. sodomaeum	Anonymous, 1979
	S. sisymbrifolium, S. torvum	Alconero *et al.*, 1988
Verticillium dahaliae, V. albo-atrum	*S. sisymbrifolium*	Fassuliotis and Dukes, 1972
Phomopsis fruit rot *(P. vexans)*	*S. gilo, S. intergrifolium*	Ahmad, 1987
Cercospora solani	*S. macrocarpon*	Madalageri, 1988
Bacterial wilt *(Pseudomonas solanacearum)*	*S. integrifolium, S. torvum,*	Yamakawa, 1982;
	S. integrifolium	Sheela *et al.*, 1984
Nematodes		
Meloidogyne incognita	*S. sisymbrifolium*	Fassuliotis, 1973
	S. khasianum, S. torvum	
	S. toxicarium	Ali *et al.*, 1992
	S. sisymbrifolium, S. torvum	Di Vito *et al.*, 1992
Meloidogyne incognita, M. arenaria	*S. torvum, S. sisymbrifolium*	Daunay and Dalmasso, 1985
Meloidogyne incognita, M. javanica	*S. sisymbrifolium*	Fassuliotis and Dukes, 1972
Meloidogyne spp.	*S. torvum, S. aethiopicum*	Hébert, 1985
M. javanica	*S. torvum*	Di Vito *et al.*, 1992
M. hapla	*S. sisymbriofolium*	Di Vito *et al.*, 1992
Phytoplasmas	*S. hispidum*	Rao, 1980
Little leaf	*S. integrifolium*	Khan *et al.*, 1978
Virus	*S. hispidum*	Rao, 1980
Eggplant mosaic virus		

Successful distant hybridization between *S. melongena* and wild relatives are reported in Table 3. Most of the interspecific hybrids obtained were sterile or not crossable with eggplant, thus this material was useless to start a breeding program. Nishio *et al.* (1984) classified 11 *Solanum* spp. into three groups on the basis of their interspecific compatibility: 1. *S. melongena, S. incanum, S. macrocarpon*; 2. *S. integrifolium, S. gilo, S. nodiflorum*; 3. *S. indicum, S. mammosum, S. torvum, S. sisymbrifolium, S. toxicarium.* Crosses are possible only within and between the first and second groups.

The INRA at Monfavet (France) started a project to evaluate the crossability of a collection of wild relatives in order to steer breeders towards the use of genetic variability within the species crossable with eggplant. The strategy of this work is reversed compared to previous approaches about distant hybridization in eggplant, in fact the evaluation for resistance to pathogens is restricted to the wild species crossable with eggplant. By using this procedure 15 interspecific hybrids have been obtained among 21 *solanum* tested so far (Daunay *et al.*, 1995).

In Japan, where grafting is a normal practice for most eggplant cultivation, intensive resistance breeding is carried out to confer multiple resistance in the rootstocks (Yamakawa, 1982). Wild relatives (*S. integrifolium, S. torvum,* etc.) or selected fertile sexual or somatic interspecific hybrids are employed as rootstock. Grafting on suitable rootstock is also developing in the Mediterranean countries under protected cultivation.

3. Biotechnological approaches

Incorporation of doubled-haploid in breeding for disease resistance

Eggplant anther culture technique is currently incorporated in commercial breeding programs in France, Italy and other countries. Compared to successive selfing, the main advantage of anther culture is that it saves time in obtaining pure lines. Two years after anther culture it is possible to include eggplant doubled-haploid (DH) lines in field trials, which represents less than half the time required by sexual reproduction. Anther-derived DH lines may be released as self-pollinated cultivars or used as parents of F_1 hybrids. For breeding purposes a large number of homozygous plants is needed and it is important that DH lines be a representative sample of the genetic variation obtained from the sexual recombination of donor plant. Other factors that have to be taken into account are the heterozygosity level of the anther donor (F_1, F_2 or advanced selected progenies) and the genetic inheritance of the desirable traits. Genetic variation has been observed among DH lines derived from both inbred cultivar and heterozygous donors (Rotino, 1996).

Although good recombinant DH lines may be recovered from F_1 hybrids, it has to be considered that most of the DH lines do not present useful characters for practical breeding. Therefore, it is advisable to apply anther culture technique in a segregating plant population previously selected for disease resistance and other agronomic traits. In these plants, there is a higher probability of finding favourable gene combinations since the parental chromosomes have already undergone at least two recombination cycles.

Production of DH lines can be effectively applied when a relatively small number of genes are involved in the resistance trait or when the desirable alleles are recessive and not closely linked. A very useful application of anther culture technique is to extract DH lines from advanced cycles of a recurrent selection scheme. Resistance to insects seems to be partial and its inheritance polygenic; the use of anther culture could thus significantly improve the selection efficacy because it may allow to fix favourable gene combinations at the homozygous level.

Table 3 - Sexual hybrids between eggplant and wild *solanum* spp.

S. melongena x S. indicum	F_4 progeny obtained	Rao and Kumar, 1980
S. sodomeum x S. melongena	Fertile F_1	Tudor and Tomescu, 1995
S. melongena x S. macrocarpon	Partially fertile F_1s	Schaff *et al.*, 1982
	Sterile F_1	Rajasekaran, 1961
S. melongena x S. khasianum	F_1 obtained by embryo rescue	Sharma *et al.*, 1980
	F_2 obtained	
S. aethiopicum x S. melongena	F_1 obtained by embryo culture	Ano *et al.*, 1991
S. melongena x S. insanum	F_1 obtained	Ali and Fujieda, 1990
S. melongena x S. gilo	F_1 obtained	Ali and Fujieda, 1990
	Sterile F_1	Nasrallah and Hopp, 1963
S. integrifolium x S. melongena	Sterile F_1s	Kirti and Rao, 1982
	F_1 obtained	Ali and Fujieda, 1990
S. gilo x S. melongena	Sterile F_1s	Omidiji, 1981; Rao and Baksh, 1981
S. melongena x S. hispidum	Sterile F_1s	Rao, 1980
S. melongena x S. torvum	Sterile F_1s	McCammon and Honma, 1983
S. melongena x S. insanum / S. incanum / S. integrifolium / S. gilo	Functional seeds	Rao, 1979

Somatic hybridization

Protoplast fusion and somatic hybrids regeneration has been attempted in an effort to overcome sexual barriers between eggplant and its wild relatives. From the first successful production of somatic hybrids between eggplant and *S. sisymbrifolium* (Gleddie *et al.*, 1986), several other somatic interspecific hybrids have been obtained. Out of 13 successful protoplast fusion experiments, somatic hybrid plants were regenerated in 11 cases but fertile hybrid plants were obtained only in combination with three wild species (Table 4). The useful resistance traits to *Pseudomonas*, spider mites, *Fusarium* and *Verticillium* derived from wild species were maintained in the regenerated somatic hybrids. Moreover, further information about backcrosses with eggplant are limited.

This technique permits the obtainment of somatic hybrids in which recombination of both nuclear and cytoplasmic DNA occurs, thus it represents a powerful tool to enlarge the genetic variability in eggplant. An improvement of the somatic hybrids regeneration efficiency and the use of better selection schemes may allow the regeneration of a large number of symmetric and asymmetric somatic hybrids which should give a higher probability to find backcrossable plants. In addition, anther culture of somatic hybrids can be a suitable tool to bring back to the diploid status the amphidiploid hybrids or their backcrosses with eggplant.

Genetic transformation

Protocols for introducing foreign agronomically useful genes into the eggplant genome via *Agrobacterium tumefaciens* are available (Rotino and Gleddie, 1990). *Bacillus thuringiensis* wild type genes active against *L. decemlineata* were obtained but the low expression level of the transgene did not permit satisfactory insect control (Rotino *et al.*, 1992; Chen *et al.*, 1995). Recently transgenic eggplant resistant to Colorado Potato Beetle have been obtained using mutagenized Bt *cryIII* genes (Arpaia *et al.*, 1997b; Hamilton *et al.*, 1997). Anti-lepidopteran Bt genes *cryI* and *cryII* could then be used to verify the sensitivity of the fruit and shoot borer to the toxin and its possible control in the field. Other primary gene products (e.g. proteinase inhibitors, lectins) which are toxic to insects may be employed alone or in various combination.

The availability of engineered resistant eggplant based on a single dominant gene, will pose the problem of durability of resistance obtained by genetic manipula-

Table 4 - Results of somatic hybridization between eggplant and *solanum* spp.

Fusion partners	Results of fusions	Hybrid characteristics	Reference
S. melongena cv. Imperial Black Beauty + *S. sisymbrifolium*	26 somatic hybrid plants; Aneuploids close to 48	Sterile. Mites and root-knot nematode resis	Gleddie *et al.*, 1986
S. melongena cv. Dourga + *S. khasianum*	83 somatic hybrid plants; Most tetraploids (48) and few aneuploids (46-48)	Sterile	Sihachakr *et al.*, 1988
S. melongena cv. Black Beauty + S. torvum	10 somatic hybrid plants; Tetraploids and aneuploids (46-48)	Sterile *Verticillium,* resist. Spider mites partially resist.	Guri and Sink, 1988a
S. melongena cv. Black Beauty + *S. nigrum*	2 somatic hybrid plants	Sterile. Atrazine resist.	Guri and Sink, 1988b
S. melongena cv. Dourga + *S. torvum*	19 somatic hybrid plants; Most tetraploids (46-48)	Sterile, *Verticillium* filtrate and nematode resist.	Sihachakr *et al.*, 1989a
S. melongena cv. Dourga + *S. nigrum*	1 somatic hybrid plant Aneuploid	Sterile. Atrazine resist.	Sihachakr *et al.*, 1989b
S. melongena cv. Shironasu + *S. intergrifolium*	16 somatic hybrid plants; Tetraploid	Fertile. Offsprings *Pseudomonas* resist.	Kameya *et al.*, 1990
S. melongena cv. Shironasu + *Nicotiana tabacum* (chlorophyll-deficient, streptomycin and kanamycin-resistant	Green shoots from 2 somatic hybrid colonies	-	Toki *et al.*, 1990
S. melongena cv Black Beauty + (sexual hybrid tomato x *Lycopersicon pennellii*)	2 hybrid calli with leaf-like primordia	-	Guri *et al.*, 1991
S. melongena cv. Dourga + *S. aethiopicum*	35 somatic hyvrid plants 32 tetraploids, 1 hexaploid, 2 mixoploids	Fertile. *Pseudomonas* and *Fusarium* resist.	Daunay *et al.*, 1993
S. melongena cv. Senryou + *S. sanitwongsei*	1 somatic hybrid plants Tetraploids	Fertile. *Pseudomonas* resist.	Asao *et al.*, 1994
S. melongena cv Black Beauty + sexual cross *L. esculentum* and *L. pennellii*	4 somatic hybrid plants 45-60 chromosome	Sterile	Liu *et al.*, 1995
Solanum melongena breeding lines + *S. integrifolium*	More than 100 hybrid plants. Mostly tetraploid	Fertile. Backcrossed. *Fusarium* resist.	Rotino *et al.*, 1995

tion. Resistance to CryIIIA toxin in laboratory strain of *L. decemlineata* was inducted by continuing exposure to the toxin (Whalon *et al.,* 1993) and the presence of resistance alleles in relatively high frequencies for some beetle populations in the field has been reported (Whalon and Rahardja, personal communication).

Resistance management is an effort to prevent or delay adaptation in insects, thus it should be considered as the management of a genetic resource represented by the insect susceptibility genes or alleles. Computer simulations have been widely used to investigate the possible outcome of an insect-host coevolution under different levels of selection pressure (Gould, 1986; Mallet and Porter, 1992; Alstad and Andow, 1995). The results are also different in dependence of the host and insect ecology and genetics. A specific model is also available to investigate the most relevant features of the Colorado Potato Beetle-eggplant interactions (Arpaia *et al.,* 1996). Indications retrieved by the latter model indicate that a mixed planting of transgenic and non transgenic clones could allow the preservation of a longlasting efficacy of the germplasm.

Therefore, methods of resistance preservation should be incorporated within the philosophy of Integrated Pest Management (IPM). These methods fit well with the IPM goal of implementing strategies to hold pest population below density that could cause economic injury by using natural, biological and cultural tools as first line to control pests and diseases. Field observations have also indicated that in some cases a synergistic action of Bt-transgenic plants and natural enemies is possible and will make it to maintain a longlasting efficacy of the resistant lines (Arpaia *et al.,* 1997a).

Within the IPM context, the strategies proposed for better management of plant resistance genes are: i) diversification of mortality source; ii) reduction of selection pressure for each mortality mechanism; iii) refuges or immigration to supply susceptible individuals; iv) estimation and/or prediction of progress toward insect resistance (McGaughey and Whalon, 1992). Extensive field studies are certainly needed to support the indications retrieved by simulation models in order to better target the field deployment of insect-resistant transgenic eggplants.

Engineering insect resistance based on secondary compounds involved in the resistance (e.g. glycoalkaloids) will be more difficult because a more complex biochemical pathway should be known and altered.

Marker-assisted selection

Molecular markers can be used to facilitate the localization of genomic traits that show continuous variation in expression and are more complex than simple mendelian characters in inheritance (quantitative trait loci or QTLs). Unfortunately, the development in eggplant of Marker-Assisted Selection is far from becoming a reality since, at the present, it lacks a genetic map. Allozyme and Random amplified polymorphic DNA variation in eggplant was recently reported (Karihaloo and Gottlieb, 1995; Karihaloo *et al.,* 1995). RAPD and allozyme analyses were performed on 52 accessions, comprising 27 cultivars of *Solanum melongena* and 25 lines of the related weedy form "*insanum*". The results show a very high degree of similarity between the accessions tested (I=0.947 by RAPD analysis); overall, the "*insanum*" accessions were more diverse than those of *S. melongena* (Karihaloo *et al.,* 1995). These preliminary results indicate a low degree of polymorphism in eggplant by using the above mentioned markers. In the near future, considering the advantage from the synthenic relationship with the well-studied *Solanaceous* species potato and tomato, it could be possibile to obtain genetic information on segregating (F_2, Recombinant Inbred Lines or DH) populations by using markers such as RFLP, AFLP and microsatellites.

Molecular markers were recently used to locate genes for resistance *to L. decemlineata* in hybrid *Solanum tuberosum* x *Solanum berthaultii* potato progenies (Yencho *et al.,* 1996). Two and three QTLs influencing resistance were identified in reciprocal backcrosses with *S. berthaultii* and potato, respectively. These QTLs generally coincided with the loci associated with glandular trichomes, confirming their role in the mechanism of resistance. However, a constant association of QTL on chromosome 1 not linked with trichomes was noted, suggesting that other factors were contributing to insect resistance in those progenies.

4. Perspectives

Breeding for resistance in eggplant has received limited research efforts, considering the heavy losses that pests may cause to the cultivation of this crop. Moreover, the possibility of pest adaptation to resistance genes should bring a re-orientation of breeding for pest resistance.

The crucial point for development of a durable crop protection strategy is the interdisciplinary cooperation between breeders, entomologists, plant pathologists and agronomists. Field evaluation of breeding materials has to be performed taking into consideration the entire agroecosystem, trying to reduce to a minimum chemical interference.

Exploitation of resistance genes

Searching for partial resistance within the eggplant gene pool may be particularly important, as evidenced by the genetic variation observed that is involved with the response to major pests. In addition, established biotechnological techniques, mainly based on tissue culture and gene transfer, can enlarge the availability of resistance genes from wild relatives or unrelated organisms.

The availability of a genetic map to start marker-assisted selection also in eggplant would be an important effort to identify QTLs conferring tolerance/resistance to the major diseases (*Verticillium* and *Fusarium* wilt, bacterial wilt and nematode infections).

Finally, the improvement of techniques to obtain fertile somatic interspecific hybrids should enable the use of genes derived from wild species (and maintained in the regenerated somatic hybrids), increasing the quota of recovery in backcross populations.

Development of efficient and reliable test procedures to assess the resistance

Plant resistance to insects is often expressed in terms of its negative effects on individual development and/or population biology. If a first screening may be performed, for simplicity and economy, on a single criterion (e.g. mortality), more comprehensive surveys are needed to assess the cumulative impact on insect populations. Parameters such as fertility and fecundity, or adverse impact on insect behaviour should be included in the investigations. Collection of all the data necessary for life tables or population growth curves may be justified, too. Investigations should also include the effects of infestations on plants on a progressive larger scale (plant tissues, organs, single plants, greenhouse and field trials). The ultimate goal of insect resistance is obviously crop yield and quality, which should then represent the final characters to examine at in field experiments.

Collect field data to validate simulation models and predict insect population growth

This will be a helpful instrument both during the selection of the most effective genotypes in specific plant-insect interaction and in field trials to address the study by looking at the entire agroecosystem in a way that will eventually optimize the germplasm resources and place them in an appropriate IPM perspective.

References

ABDULLAEVA K.H.T., SHIFMAN I.A., 1988 - *Resistance of eggplant to* Fusarium *wilt.* - Selektsiya i Semenovodstvo, Moscow, 1: 29-31.

AHMAD Q., 1987 - *Sources of resistance in brinjal to* Phomopsis *fruit rot.* - Indian Phytopathol., 40: 98-100.

ALCONERO R., ROBINSON R.W., DICKLOW B., SHAIL J., 1988 - Verticillium *wilt resistance in eggplant, related* Solanum *species and interspecific hybrids.* - HortScience, 23(2): 388-390.

ALI M., FUJIEDA K., 1990 - *Cross compatibility between eggplant* (Solanum melongena *L.*) *and wild relatives.* - J. Japan. Soc. Hort. Sci., 58(4): 977-984.

ALI M., MATSUZOE N., OKUBO H., FUJIEDA K., 1992 - *Resistance of non-tuberosus solanum to root-knot nematode.* - J. Japan. Soc. Hort. Sci., 60(4): 921-926.

ALSTAD D.N., ANDOW D.A., 1995 - *Managing of the evolution of insect resistance to transgenic plants.* - Science, 268: 1894-1896

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.

ANONYMOUS, 1979 - *Annual report vegetable crops breeding station Avignon-Montfavet, France, 1977-1978.* - Avignon, Montfavet, France, pp. 117-120.

ARPAIA S., CHIRIATTI K., GIORIO G., 1996 - *Predicting durability of Colorado Potato Beetle resistant eggplant germplasm.* - Proc. XX Int. Cong. Entomol. Florence, Italy, 25-31 August, pp. 715.

ARPAIA S., GOULD F., KENNEDY G.G., 1997a - *Potential impact of* Coleomegilla maculata *DeGeer (*Coleoptera: Coccinellidae*) predation on adaptation of* Leptinotarsa decemlineata *Say* (Coleoptera: Chrysomelidae*) to Bt-transgenic potatoes.* - Entomol. Exp. Appl., 82(1): 91-100.

ARPAIA S., MENNELLA G., ONOFARO V., PERRI E., SUNSERI F., ROTINO G.L. 1997b - *Production of transgenic eggplant (*Solanum melongena *L.) resistant to Colorado Potato Beetle (*Leptinotarsa decemlineata - *Say -).* - Theor. Appl. Genet., 95(3): 329-334.

ASAO H., ARAI S., HIRAI M., 1994 - *Characteristics of a somatic hybrid between* Solanum melongena *L. and* Solanum sanitwongsei *Craib.* - Breeding Science, 44: 301-305.

AVÉ D.A., TINGEY W.M., 1986 - *Phenolic constituents of glandular trichomes on* Solanum berthaultii *and* S. polyadenum. - Amer. Pot. Journal., 63: 473-480.

BAJAJ K.L., SINGH D., KAUR G., 1989 - *Biochemical basis of relative field resistance of eggplant (*Solanum melongena *L.) to the fruit and shoot borer* (Leucinodes orbonalis *Guen.*). - Vegetable Science, 16(2):145-149

CAPPELLI C., STRAVATO V.M., ROTINO G.L., BUONAURIO R., 1995 - *Sources of resistance among* Solanum *spp. to an italian isolate of* Fusarium oxysporum *f. sp.* melongenae. - Eucarpia, IXth Meeting on Genetics and Breeding on Capsicum and Eggplant, Budapest (Hungary): 221-224.

CHELLIAH S., SRINIVASAN K., 1983 - *Resistance in bhindi, brinjal and tomato to major insect and mite pests.* - National Seminar on Breeding Crop Plants for Resistance to Pest and Disease, May 25-27, Coimbatore, India, Tamil Nadu Agricultural University, pp. 47-49.

CHEN Q., JELENKOVIC G., CHIN C., BILLINGS S., EBERHARDT J., GOFFREDA J.C., 1995 - *Transfer and transcriptional expression of Coleopteran* cryIIIB *endotoxin gene of* Bacillus thuringiensis *in eggplant.* - J. Amer. Soc. Hort. Sci., 120(6): 921-927.

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., DALMASSO A., 1985 - *Multiplication of* Meloidogyne javanica, M. incognita *and* M. arenaria *on several* Solanum *species.* - Revue de Nématol., 8(1): 31-34.

DAUNAY M.C., LESTER R.N., 1988 - *The usefulness of taxonomy for* Solanaceae *breeders, with special reference to the genus* solanum *and to* Solanum melongena *L. (eggplant).* - Capsicum Newsletter, (7): 70-79.

DAUNAY M.C., LESTER R.N., DALMON A., FERRI M., 1995 - *Wild genetic resources for eggplant* (Solanum melongena) *breeding.* - Eucarpia, IXth Meeting on Genetics and Breeding on Capsicum and Eggplant, Budapest (Hungary), pp. 26-29.

DHANKHAR B.S., GUPTA V.P., SINGH K., 1977 - *Screening and variability studies for relative susceptibility to shoot and fruit borer (*Leucinodes orbonalis *Gn.) in normal and ratoon crop of brinjal (*Solanum melongena *L.).* - Haryana Journal of Horticultural Sciences, 6(1/2): 50-58.

DHANKHAR B.S., MEHROTRA N., SINGH K., 1980 - *Heterosis in relation to yield components and shoot/fruit borer (*Leucinodes orbonalis *Gn.) in brinjal (*Solanum melongena *L.)* - Genetica Agraria, 34(3/4): 215-220.

DHANKHAR B.S., SHARMA N.K., 1986 - *Variability in relation to shoot and fruit borer* (Leucinodes arbonalis *Guen.) infestation in brinjal (*Solanum melongena *L.).* - Haryana Journal of Horticultural Sciences, 15(3/4): 243-248.

DI VITO M., ZACCHEO G., CATALANO F., 1992 - *Source for resistance to root-knot nematodes (*Meloidogyne *spp.) in eggplant.* - VIIIth Meeting "Genetics and Breeding on Capsicum and Eggplant", Rome, September 7-10, pp. 301-303.

DIKII S.P., VORONINA M.V., 1985 - *Using the eggplant gene bank in breeding.* - Trudy po Prikladnoi Botanike, Genetike i Selektsii, 81: 71-75.

FAO, 1995 - *Production Yearbook.* Vol. 48. - FAO Statistics series No. 125

FASSULIOTIS G., 1973 - *Susceptibility of eggplant,* S. melongena *to root knot nematode (*Meloidogyne incognita*).* - Plant Disease Rep., 57: 606-608.

FASSULIOTIS G., DUKES P.D., 1972 - *Disease reactions of* Solanum melongena *and* S. sisymbrifolium *to* Meloidogyne incognita *and* Verticillium albo-atrum. - J. Nematol., 4: 222.

FIUME F., 1987 - *Saggi di resistenza in campo alla Dorifora* (Leptinotarsa decemlineata *Say*) *in melanzana.* - Agricoltura e Ricerca (Special issue) - *Problemi e prospettive della melanzana*, pp. 39-46.

FLANDERS K.L., HAWKES J.G., RADCLIFFE E.B., LAUER F.I., 1992 - *Insect resistance in potatoes: sources, evolutionary relationships, morphological and chemical defences, and ecogeographical associations.* - Euphytica, 61: 83-111.

GLEDDIE S., KELLER W.A., SETTERFIELD G., 1986 - *Production and characterization of somatic hybrids between* Solanum melongena *and* S. sisymbrifolium *Lam.* - Theor. Appl. Genet., 71: 613-621.

GOULD F., 1986 - *Simulation models for predicting durability of insect resistant germplasm: deterministic diploid two-locus model.* - Environ. Entomol., 15: 1-10

GURI A., DUNBAR L.J., SINK K.C., 1991 - *Somatic hybridization between selected* Lycopersicon *and* Solanum *species.* - Plant Cell Rep., 10: 76-80.

GURI A., SINK K.C., 1988a - *Interspecific somatic hybrid plants between eggplant (*Solanum melongena*) and* Solanum torvum. - Theor. Appl. Genet., 76: 490-496.

GURI A., SINK K.C., 1988b - *Organelle composition in somatic hybrids between an atrazine resistant biotype of* Solanum nigrum *and* Solanum melongena. - Plant Sci., 58: 51-58.

HAMILTON G.C., JELENKOVIC G.J., LASHOMB J.H., GHIDIU G., BILLINGS S., PATT J.M., 1997 - *Effectiveness of transgenic eggplant (*Solanum melongena *L.) against the Colorado potato beetle.* - Adv. in Hort. Sci., 11(4): 189-192.

HÉBERT Y., 1985 - *Rèsistance comparée de 9 espèces du genre* Solanum *au flétrissement bactérien (*Pseudomonas solanacearum*) et au nématode* Meloidogyne incognita. *Intérêt pour l'amélioration de l'aubergine (*Solanum melongena *L.) en zone tropicale humide.* - Agronomie, 5(1): 27-32.

HINATA K., 1986 - *Eggplant (*Solanum melongena *L.),* pp. 363-370. - In: BAJAJ Y.P.S. (ed.), *Biotechnology in agriculture and forestry*, Vol. 2, Springer-Verlag, Berlin.

ISAHAQUE N.M.M., 1984 - *Comparative susceptibility of some varieties of eggplant to shoot- and fruit- borer in Assam.* - Indian Journal of Agricultural Sciences, 54(9): 751-756.

KALLOO G., 1993 - *Eggplant,* Solanum melongena *L.*, pp. 587-604. - In: KALLOO G., and B.O. BERGH (eds.) *Genetic improvement of vegetable crops.* Pergamon Press, Oxford.

KAMEYA T., MIYAZAWA N., TOKI S., 1990 - *Production of somatic hybrids between* Solanum melongena *L. and* S. integrifolium *Poir.* - Japan. J. Breed., 40: 429-434.

KARIHALOO J.L., BRAUNER S., GOTTLIEB L.B., 1995 - *Random amplified polymorphic DNA variation in the eggplant,* Solanum melongena *L.* (Solanaceae). - Theor. Appl. Genet., 90: 767-770.

KARIHALOO J.L., GOTTLIEB L.B., 1995 - *Allozyme variation in the eggplant,* Solanum melongena *L.* (Solanaceae). - Theor. Appl. Genet., 90: 578-583.

KHAIRE V.A., LAWANDE K.E., 1986 - *Screening of promising germplasm of brinjal against shoot and fruit borer (*Leucinodes orbonalis *G.), aphid (*Myzus persicae *S.) and jassid (*Amrasca biguttula biguttula *Ishida).* - Current Research Reporter, Mahatma Phule Agricultural University, 2(1): 112-115.

KHAN R., RAO G.R., BAKSH S., 1978 - *Cytogenetics of* Solanum integrifolium *and its possible use in eggplant breeding.* - Indian J. Genet. Plant Breed., 38(3): 343-347.

KIRTI P.B., RAO B.G.S., 1982 - *Cytological studies on F1 hybrids of* Solanum integrifolium *with* S. melongena *and* S. melongena *var.* insanum. - Genetica, 59: 127-131.

LAL O.P., 1991 - *Varietal resistance in the eggplant,* Solanum melongena *against the shoot and fruit borer,* Leucinodes orbonalis *Guen.* (Lepidoptera: Pyralidae). - Zeitschrift für Pflanzenkrankheiten und Pflanzenschutz, 98(4): 405-410.

LIU K.B., LI Y.M., SINK K.C., 1995 - *Asymmetric somatic hybrid plants between an interspecific* Lycopersicon *hybrid and* Solanum melongena. - Plant Cell Rep., 14: 652-656.

LOCKWOOD J.L., MARKARIAN D., 1961 - *Breeding eggplants for resistance to* Verticillium *wilt.* - Quart. Bull. Mich. Agric. Exp. Sta., 44: 15-19.

MADALAGERI B.B., DHARMATTI P.R., MADALAGERI M.B., PADAGANUR G.M., 1988 - *Reaction of eggplant genotypes to* Cercospora solani *and* Leucinodes orbonalis. - Plant Pathol. Newsl., 6: 26-30.

MALAUSA J.C., DAUNAY M.C., BOURGOIN T., 1988 - *Recherches préliminaires sur la résistance de l'aubergine à l'aleurode des serres,* Trialeurodes vaporariorum *Westwood,* (Homoptera, Aleyrodidae). - Agronomie, 8(8): 693-699.

MALLET J., PORTER P., 1992 - *Preventing adaptation to insect-resistant crops: are seed mixtures or refugia the best strategy?* - Proc. R. Soc. London, B 250: 165-169.

McCAMMON K.R., HONMA S., 1983 - *Morphological and cytogenetic analyses of an interspecific hybrid eggplant,* Solanum melongena *x* Solanum torvum. - HortScience, 18: 894-895.

McGAUGHEY W.H., WHALON M.E., 1992 - *Managing insect resistance to* Bacillus thuringiensis *toxins.* - Science, 128: 1451-1455.

MISRA K.K., SARKAR P.K., DAS T.K., SOMCHOUDHURY A.K., 1990 - *Incidence of* Tetranychus cinnabarinus *(Boisd.)* (Acari: Tetranychidae) *on some selected accessions of brinjal with special reference to the physical basis of resistance.* - Indian Agriculturist, 34(3): 177-185.

NASRALLAH M.E., HOPP R.J., 1963 - *Interspecific crosses between* Solanum melongena *L. (eggplant) and related* Solanum *species.* - Proc. Am. Soc. Hortic. Sci., 83: 571-574.

NATHANI R.K., 1983 - *Studies on varietal susceptibility and chemical control of brinjal shoot and fruit borer (*Leucinodes orbonalis *Guenee).* - Thesis Abstracts, 9(1): 51.

NEAL J.J., TINGEY W.M., STEFFENS J.C., 1990 - *Sucrose esters of carboxylic acids in glandular trichomes of* Solanum berthaultii *deter settling and probing by green peach aphid.* - Journal of Chemical Ecology, 16: 487-497.

NISHIO T., MOCHIZUKI H., YAMAKAWA K., 1984 - *Interspecific crosses between eggplant and related species.* - Bull. Veg. Ornam. Crops. Res. Sta., A12: 57-61.

O'BRIEN M.J., 1983 - *Evaluation of eggplant accessions and cultivars for resistance to* Verticilium *wilt.* - Plant Disease, 67: 763-766.

OMIDIJI M.O., 1981 - *Cytogenetic studies on the F_1 hybrid between the African eggplant,* Solanum gilo *Raddi, and* Solanum melongena *L.* - Hortic. Res., 21: 75-82.

PAWAR D.B., MOTE U.N., KALE P.N., AJRI D.S., 1987 - *Promising resistant sources for jassid and fruit borer in brinjal.* - Curr. Res. Rep., Mahatma Phule Agric. Univ., 3: 81-87.

RAJASEKARAN S., 1961 - *Cytogenetic studies in* Solanum melongena *L.,* S. melongena *var.* bulsarensis *Argikar and their hybrid and study of colchicine induced polyploidy in* S. melongena *L.* - M. Sc.(Ag.) dissertation, University of Poona, India.

RAJU B., REDDY G.P.V., MURTHY M.M.K., PRASAD V.D., 1987 - *Biochemical factors in varietal resistance of eggplant for the spotted leaf-beetle and shoot and fruit-borer.* - Indian Journal of Agricultural Sciences, 57(3); 142-146.

RAO G.R., 1980 - *Cytogenetic relationship and barriers to gene exchange between* Solanum melongena *L. and* Solanum hispidum *Pers.* - Caryologia, 33: 429-433.

RAO G.R., 1981 - *Investigations on cytogenetics and development of improved pest-resistant eggplant germplasm.* - Proc. Ind. Acad. Sci. (Plant Science), 90(1): 59-69.

RAO G.R., BAKSH S., 1981 - *Relationship between* Solanum melongena *L. and* Solanum integrifolium *Poir.* - Ind. J. Genetics & Plant Breed., 41(1): 46-53.

RAO G.R., KUMAR A., 1980 - *Some observations on interspecific hybrids of* Solanum melongena *L.* - Proc. Indian Acad. Sci., 89: 117-121.

RAO N., 1979 - *The barriers to hybridization between* Solanum melongena *and some other species of* solanum, pp. 605-614. - In: HAWKES J.G., R.N. LESTER, and A.D. SKELDING (eds.) *The biology and taxonomy of the* Solanaceae, Academic Press, New York.

RAVICHANDRA N.G., KRISHNAPPA K., SETTY K.G.H., 1988 - *Evaluation of brinjal (*Solanum melongena *L.) germplasm resistance against* Meloidogyne javanica *and race-1, race-2 and race-3 of* M. incognita. - Indian F. Nematol., 18: 165-168.

ROTINO G.L., 1996 - *Haploidy in Eggplant*, pp. 115-141. - In: JAIN S.M., S.K. SOPORY, and R.E. VEILLEUX (eds.) *In vitro Haploid Production in Higher Plants*, Vol. 3, Kluwer Academic Publishers, The Netherlands.

ROTINO G.L., ARPAIA S., IANNACONE R., IANNAMICO V., MENNELLA G., ONOFARO V., PERRONE D., SUNSERI F., XIKE Q., SPONGA F., 1992 - Agrobacterium *mediated transformation of* Solanum *spp. using a Bt gene effective against coleopteran.* - Proc VIIIth Meeting on genetics and breeding of *Capsicum* and eggplant. Rome (Italy). Capsicum newsletter, special issue, pp. 295-300.

ROTINO G.L., DORR I., PEDRAZZINI E., PERRI E., 1995 - *Fusione di protoplasti tra melanzana* (Solanum melongena *L.*) *e* Solanum *selvatici.* - Atti XXXIX Convegno Annuale S.I.G.A., Vasto Marina 27-30 September, p. 157.

ROTINO G.L., GLEDDIE S., 1990 - *Tranformation of eggplant (*S. melongena *L.) using a binary* Agrobacterium tumefaciens *vector.* - Plant Cell Reports, 9: 26-29.

SAKATA Y., NISHIO T., MON'MA S., 1989 - *Resistance of* Solanum *species to* Vertricillium *wilt and bacterial wilt.* - Eucarpia VIIth Meeting on Genetics and Breeding on Capsicum and Eggplant, Kragujevac (Yugoslavia), pp. 177-180.

SAMBANDAM C.N., CHELLIAH S., 1983 - *Breeding brinjal for resistance to* Aphis gossypii *G.* - National Seminar on Breeding Crop Plants for Resistance to Pests and Diseases, May 25-27, Coimbatore, India, Tamil Nadu Agric. Univ., pp. 15-18.

SAMBANDAM C.N., NATARAJAN K., CHELLIAH S., 1976 - *Studies on the mechanisms of resistance found in eggplants and certain wild* Solanum *species to* Epilachna vigintioctopunctata *F.* (Coccinellidae: Coleoptera). - Annamalai University Agricultural Research Annual, 6: 53-70.

SCHAFF D.A., JELENKOVIC G., BOYER C.D., POLLACK B.L., 1982 - *Hybridization and fertility of hybrid derivatives of* Solanum melongena *L. and* Solanum macrocarpon *L.* - Theor. Appl. Genet., 62: 149-153.

SCHALK J.M., STONER A.K., WEBB R.E., WINTERS H.F., 1975 - *Resistance in eggplant,* Solanum melongena *L., and nontuber-bearing* Solanum *species to carmine spider mite.* - J. of the Amer. Soc. for Hort. Sci., 100(5): 479-481.

SCHREINER I.H., 1990 - *Resistance and yield response to* Amrasca biguttula (Homoptera: Cicadellidae) *in eggplant* (Solanum melongena). - Philippine Entomologist, 8(1): 661-669.

SHARMA D.R., CHOWDHURY J.B., AHUJA U., DHANKHAR B.S., 1980 - *Interspecific hybridization in genus* Solanum. *A cross between* S. melongena *and* S. khasianum *through embryo culture.* - Z. Pflanzenzuecht, 85: 248-253.

SHEELA K.B., GOPALKRISHNAN P.K., PETER K.V., 1984 - *Resistance to bacterial wilt in a set of eggplant breeding lines.* - Indian F. Agric. Sci., 54: 457-460.

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 relatives*, pp. 255-278. - In: BAJAJ Y.P.S. (ed.), *Biotechnology in agriculture and forestry* vol. 27. Springer-Verlag, Berlin Heidelberg.

SIHACHAKR D., DUCREUX G., VEDEL F., ALLOT M., SAN L.H., SERVAES A., 1989b - *Somatic hybridization of eggplant (*Solanum melongena *L.) with* Solanum nigrum *L. by protoplast electrofusion.* - Int. Conf. The impact of biotechnology on agriculture, Amiens, 10-12 July 1989.

SIHACHAKR D., HAICOUR R., CHAPUT M.H., BARRIENTOS E., DUCREUX G., ROSSIGNOL L., 1989a - *Somatic hybrid plants produced by electrofusion between* Solanum melongena *L. and* Solanum torvum *Sw.* - Theor. Appl. Genet., 77:1-6.

SIHACHAKR D., HAICOUR R., SERRAF I., BARRIENTOS E., HERBRETEAU C., DUCREUX G., ROSSIGNOL L., SOUVANNAVONG V., 1988 - *Electrofusion for the production of somatic hybrid plants of* Solanum melongena *L. and* Solanum khasianum *C.V. Clark.* - Plant Sci., 57: 215-223.

SINGH D., SIDHU A.S., 1988 - *Management of pest complex in brinjal.* - Indian Journal of Entomoloy, 48(3): 305-311.

SUBBARATNAM G.V., BUTANI D.K., RAO B.H.K.M., 1983 - *Leaf characters of brinjal governing resistance to jassid,* Amrasca biguttula biguttula (*Ishida*). - Indian Journal of Entomology, 45(2): 171-173.

TEWARI G.C., MOORTHY P.N.K., 1985 - *Field response of eggplant varieties to infestation by shoot- and fruit-borer* - Indian Journal of Agricultural Sciences, 55(2): 82-84.

TOKI S., KAMEYA T., ABE T., 1990 - *Production of a triple mutant, chlorophyll-deficient, streptomycin- and kanamycin-resistant* Nicotiana tabacum, *and its use in intergeneric somatic hybrid formation with* Solanum melongena. - Theor. Appl. Genet., 80: 588-592.

TUDOR M., TOMESCU A., 1995 - *Studies on the crossing compatibility of the species* Solanum sodomeum *and* Solanum melongena *var. "Lucia".* - Eucarpia, IXth Meeting on Genetics and Breeding on Capsicum and Eggplant, Budapest (Hungary), pp. 39-41.

USHAMANI P., PETER K.V., 1987 - *Field resistance of brinjal to bacterial wilt.* - Agric. Res. F. Kerala, 25: 133-137.

WHALON M.E., MILLER D.L., HOLLINGHWORTH R.M., GRAFIUS E.J., MILLER J.R., 1993 - *Selection of a Colorado Potato Beetle* (Coleoptera: Chrysomelidae) *strain resistant to* Bacillus thuringiensis. - J. Econom. Entomol., 86(2): 226-233

YAMAKAWA K., 1982 - *Use of rootstocks in* Solanaceous *fruit-vegetable production in Japan.* - Japan Agric. Res. Quart., 15: 175-179.

YAMAKAWA K., MOCHIZUKI H., 1979 - *Nature and inheritance of* Fusarium *wilt resistance in eggplant cultivars and related wild* Solanum *species.* - Bull. Veg. and Ornam. Crops Res. Sta., 6:19-27.

YENCHO G.C., BONIERBALE M.W., TINGEY W.M., PLAISTED R.L., TANKSLEY S.D. 1996 - *Molecular markers locate genes for resistance to the Colorado Potato Beetle,* Leptinotarsa decemlineata, *in hybrid* Solanum tuberosum *x* Solanum berthaultii *potato progenies.* - Entomol. Exper. Appl., 81: 141-154.