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The Evaluation of Breeding Resistance against Brinjal Shoot and Fruit Borer Infestation

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A B S T R A C T

Brinjal is the important crop of all the solanaceous crops in the vegetable crops. BRINJAL is also known as Eggplant / Aubergine. Brinjal is cultivated at larger scale in India and they produce high quality vegetable crops under protected cultivation. Brinjal is highly demand in market value followed with other crops suchas tomato, onion, potato etc. The major problem in Brinjal that is the pest incidence by Brinjal shoot and fruit borer. The pest incidence is in which the pests feed on the particular crop,, leading to severe damage and yield loss is being occurred. When the crop have reached the economic threshold level at high level of incidence, the crop can be damaged. In brinjal, brinjal shoot and fruit borer *(Leucinodes orbonalis* green) is the serious and notorious pests in the brinjal Cultivation. This pest incidence is found mostly in shoot and fruit parts of the brinjal crop. The damage incidence mostly happens in fruiting stage of brinjal and most of the Pests feed on fruits, particularly seen in most of the horticultural crops. In incidence of BFSB, it accounts 85% yield loss should be estimated at brinjal growing countries particularly in Asian countries and it's marketing value also losses. In recent years, the researchers, scientists are developing their own new various strategies and experiments for tackling this kind of incidence; I have generated my idea by the help of studying various strategies which are done by experts and researchers. Breeding resistance is a great strategy for the researchers and scientists for developing the resistance of crops by transfer of the resistant trait from other crop containing resistant gene. By the end of this review, it is discussed about understanding the performance of breeding resistance through various approaches.

Introduction

Importance of Eggplant

Brinjal/ eggplant /Aubergine is the important staple vegetable crops of the solanaceous family followed with tomato, potato and chilli. They producing more yield and well crop diversity. The brinjal have 3 important Varieties based on the shape and size namely

Solanum melongena var esculentum – (Round egg plant)

Solanum melongena var serpentine- (Long egg plant)

Solanum melongena var depressum- (Dwarf egg plant)

The Green, purple, white Brinjal are valuable in marketing purpose and some white and green Brinjal show bitterness containing some alkaloids and shapes are also valuable for marketing purpose and demand. The brinjal have high nutritional value like phosphorus, potassium, calcium, magnesium, vitamins B6, minerals and all others. The Brinjal is also cultivated under Greenhouse and polyhouse condition at higher scale technology and protected from natural calamities and diseases and pest attack recently all over the world. These are used as trade, marketing purpose and seed processing at high valuable quantity among all the vegetables.

Brinjal shoot and fruit borer

The major problem of Brinjal Cultivation has been the pest problem. Here we will discuss about the major pest of Brinjal i.e., "Brinjal Shoot and fruit borer" (*Leucinodes orbonalis*). The pest belongs to the order *Lepidoptera* and family *pyraustidae*. The eggs are creamy white in colour and are laid singly on tender shoots, leaves, flowers and also developing fruits. Larva is stout and pink coloured with sparsely distributed hairs on the body and brown headed. Pupa is greyish and boat shaped cocoon. The adult is medium sized with white wings and red markings on forewings. The total life cycle of the pest lasts for about 20-50 days. This pest is most dangerous and highly monophagous insect particularly in Brinjal crop than other Solanaceae crop.

Impact on the yield

India, Bangladesh, Pakistan, Burma, Thailand have accounts 80 % of yield loss. This pest is the major problem in brinjal yield. The ETL level of this pest is 1 to 5% Fruit damage per plant. The symptoms produces shredding of buds, damage the flowers, the larvae are bored the holes on the shoots and it cause withering of the leaves and it reduced the yield also. Damage to the plant is caused mainly by the larvae, which bores through the terminal part of the mid rib of large leaves and tender shoots to cause "dead hearts". Later on it also enters into flower buds and fruits. In fruits it plugs the entry hole by its excreta. The infested terminal shoots and fruits ultimately drop out. The pest which is able to feed the crop for their food requirement, finally damage the crop and fruits become non-valuable for marketing purposes and food consumption also. Mostly 70 to 100% of damage occurs in the fruits. The loss is estimated nearby 85% of the BSFB.

Various strategies

The management practices which are followed have not been able to solve this pest and many are not relevant to control this pest. The scientists, researchers and other agents have made different strategies to control this pest by various principles like quality traits determination, various varieties based on escape, hybrids and tolerant varieties. In technology level, there have been some improvements in the breeding Programme at various institutes, research Centre and universities. Various researchers are developing various strategies by experimental designs, breeding resistance, introduction, genetic variability, heterosis breeding, micro-propagation technique like plant tissue culture, marker assisted selection, DNA process

related experiments which are conducted and record the data about variability of each derived genotypes. Heterosis breeding, minimize the effect of biotic attack which are mainly occurs by selection and hybridization techniques. These techniques which are used for developing the resistant Cultivars and hybrids along with various genetical manipulation from various experiments and varieties are released from every research Centre to society for distributing to the farmers. The resistant Cultivars which are helps to dominates the Cultivation under biotic stress condition and it gives the healthy yield also. The wild related species and Resistance Cultivars play an important role in Several breeding programme for developing the resistant variety by various number of traits under suitable breeding practices; it helps us to transfer the resistant traits from wild types to the Brinjal varieties for further generation and for producing quality yield for high marketable price and quality control. This is about the modern trends in Agricultural scientific research development which are followed for development of various varieties containing different traits for resistance to the stress condition and ability to produce the yield of crops.

Role of breeding

Breeding resistance have a great role in crop improvement due to manipulation of genetic constituents and development of defensive traits. This strategy helps to minimize the yield loss through a high degree of resistance gene and it is very efficient tool to perform this role.

Recently, many scientists and researchers are working in this field by different strategies like wild related species, phytochemicals hormone analysis, Distinct Hybridization, gene to gene hypothesis, in vitro culture through promotor, management strategy; these are implemented. In Heterosis breeding, the hybrids have to be evaluated ultimately by the mean performance for fruit borer. The two parents with lesser incidence resulting in a hybrid with least incidence might be due to complementation of genes for bringing down the incidence of fruit borer. Epistatic parts were engaged with the occurrence of the majority of the chemical characters in Brinjal fruits (Shinde, 2006). Both additive and non-additive gene impacts are exploited by utilizing various breeding tactics and back crosses with the genotypes having phenols, nitrogen, low sugar levels and silica levels in Brinjal fruits. Most characters were administered by both additive and non-additive gene impacts, proposing that a breeding technique including biparental mating and reciprocal recurrent selection would be the most reasonable. Additive gene activity has been accounted for to administer inheritance of yield contributing characters in Brinjal. Additive, predominance epistasis and gene impacts was vital for the vast majority of the characters in Brinjal shoots. It should require to be explored these genetic impacts through various breeding tactics. These strategies depend on the crop adaptability and the researcher's skills.

The Review of Literature

Pest Incidence

Anjali mathur *et al.,* (2012) has performed research on seasonal incidence and effect abiotic factors on population dynamics of major insect pests on Brinjal crop. They observed that the percent shoot damage was positively correlated with both maximum and minimum temperature, rainfall and wind speed where as it was negatively correlated with mean relative humidity.

Md Abdul Mannan *et al.,* (2015) has performed Brinjal shoot and fruit borer infestation in relation to the plant age and season. The experiment was carried out under field conditions in Bangladesh Agricultural university on the variety BARI BEGOON 8 where they had monitored weekly for the BFSB infestation after transplanting and concluded infestation was different in plant of different ages. They observed that the peak shoot infestation was 8.56% in the 10^{th} of transplanting and there was no infestation of BFSB found until 5^{th} week of transplanting.

Nitesh Maru *et al.,* (2018) has done research on incidence of shoot and fruit borer on Brinjal in relation to weather parameters in Allahabad region. Their results showed that the initial incidence of BSFB on shoot was occurred on the 40th standard week (1st week of October) and reached peak on 43rd standard week (last week of October), whereas initial incidence occurred on 42nd week. They also revealed that the BSFB incidence on shoot showed significant positive correlation with Maximum temperature and sun shine hours. They concluded that the management of Brinjal pest during *rabi* sown crop under central plain agro-climatic zone should therefore be promoted and tailored from September onwards using an integrated approach.

Estimation of Heterosis breeding

Kamalakkannan *et al.,* (2007) was performed about the producing tolerance of shoot and fruit borer by using the analysis of (11) Line and (3) tester crossing Technique for estimate the combining ability test, heterosis and nature of additive gene action. While crossing between WHITE BRINJAL(line)*ANNAMALAI(Tester) by resulting the observation between these two parents of standard heterosis is Up to 222.77 and it determines the Fruit yield.

Ravi Kumar *et al.*,(2017) have performed the Heterosis breeding in brinjal by using six parents were selected as based on the crop divergence and crossed in dialleledesign like [KS-224 × Swarms Mani] and [SBRB-6/12×SBRB-3/12]. Here the result was revealed about the percentage of 31 to 78% and 60.42% about Brinjal Shoot and fruit borer incidence have estimated.

Desmukh *et al.,* (2015) were performed the magnitude Heterosis breeding in brinjal through utilize 36 F1 hybrids along with 9 parents and 2 checks were evaluated using Randomized Block Design with three replication. The result also considered through heterobeltiosis for traits as (Ascond long× Selection-167)- 40.33% about the incidence of BFSB and the study also revealed about commercial exploitation of F1 in brinjal due to Heterosis breeding.

Mondal *et al.,* (2021), have performed the estimation of Heterosis, Combining ability of brinjal varieties through six varieties are crossed in diallelic fashion and here in maximum significant of gca mainly Garia for 7 character following with BCB-40 and BCB-50 and punjab sadabhar for 6 character. The result also revealed During crossing these two varieties it gives the (22.07)% of BFSB incidence between (garia×punjab sadabhar) and [BCB-40×BCB-50] gives 18% incidence of BFSB.

Hybridization breeding

Gyanendra *et al.,* (2002)have performed the interspecific hybridization between Varieties and wild species by following hybrid varieties like Puss kranti, *S.incanum*, *S.indicum*, *S.gilo*, Annamalai and Aushey ; (3 hybrids : 3 wild species) are crossed with each other varieties and the result also revealed about crossing with (Aushey ×Pusa kranti) have very Suceptible to BFSB Infestation and they got the frequency (16.73, 22.60 and 14.40) when *S.gilo* crossing with 3 interspecific hybrids (pusa kranti, Annamalai and Aushey) get univalent frequency respectively.

Veeraragavathatham *et al.,* (2010) have utilized the Wild relative of brinjal that is Soda apple (*Solanum viarum*) is used for hybridization breeding programme with brinjal variety EP-65 for develop a resistant genes of the Cultivars against Brinjal Shoot and fruit borer (*Leucinodes orbonalis*); he was going to transfer the gene from wild type to the variety of the brinjal for combine the resistant trait ; Hybridization were made on F1 plants were raised subsequently in every generation was done by selfing to obtain F9 plants. The Molecular study of RAPD primers also revealed the introgression of the genes from donor parent *Solanum viarum* to brinjal. The result was revealed that he was named the two inbreed progenies like HD 1 and HD 2 were identified based on their high marketable yield (4.07 kg plant-1 and 3.46 kg per plant) and the less

infection 9n shoot borer (7.69 % 9.09%t) and fruit borer (6.67% and 6.85 %).

Pugalendhi *et al.,* (2011) have performed the interspecific hybridization between Varieties and wild related species [EP 65 × *Solanum viarum*] through BC3 F4, BC3F5 and BC3 F6 generation simultaneously.

These are evaluated as per the performance of Genetical parameters along with borer Infestation were also studied. In BC3 F5 to F8 have high marketable price of yield have been recorded in result and studied correlation of bio chemicals like phenols, high solasodine, polyphenol oxidase, reduce the TSS and sugar content for breeding programme.

Vethamoni *et al.,* (2016) have performed about to record the growth and yield attributes between line ×Tester nearly 60 hybrids developed Among, 6 hybrids are shown very efficient in all kind of morphological characteristics and resistance against BSFB also. Among the hybrids L15×T2 was created the record of maximum no of fruits (54.8) and minimum borer Infestation also (12%). Among all the hybrids, L15×T2 have shown the most significant hybrid for dominate the minimum BSFB Infestation and high yield capacity along with all the hybrids.

Joseph *et al.,* (2021) have studied about the Defensive mechanism of wild type of Brinjal like *Solanum virginianum* with the varieties of brinjal namely "Ponni and surya" for developing the breeding resistance of brinjal against Brinjal Shoot and fruit borer (*Leucinodes orbonalis*) ; The *Solanum virginianum* not have any anthocyanin content compared to varieties of brinjal like "Surya and Ponni". But they have moderate pubescence can be observed in stem in *Solanum virginianum.* During crossing between wild species and variety and after it can be observed as between two varieties Ponni and surya; Ponni variety is more susceptible (54- 45%) compared to Surya (15-54%) was observed.

Bio chemical basis of resistance

Alam *et al.,* (2010) have performed the Breeding resistance of brinjal against BFSB through estimation of Bio chemical analysis of polyphenoloxidase, phenylalanine Ammonium Lyase, lignin and lower amount of reducing sugar. Here the result also revealed about the negative correlation was found between percent Infestation of BFSB with ppo, pal and lignin content; whereas, in positive correlation is reducing sugar content.

Jadhav *et al.,* (2015) was performed about the Breeding Resistance of shoot and fruit borer in Brinjal by using his cry1F gene driven by CaMV35S promotor by developing four brinjal namely "Manjarigota", "Ruchira", "Poona selection" and "Krishna kathi" ; Agrobacterium concentration of 0.2 at optical density600 (OD600) was found to be optimum and grown under Tissue culture techniques and resulting transformation efficiency was obtained in each 4 Cultivars, Ruchira (19.8%), Krishna kathi (11.78%), Manjarigota (5.41%) and Poona selection (3.97%%).

Nagappan *et al.,* (2016) have carried out 30 green brinjal genotypes for experimentally find the influence of bio physical and biochemical analysis of brinjal for check the Infestation of BFSB. Here there are recorded the data on specific gravity and the basis of positive and negative correlation between these biochemical analysis of brinjal crop in pedicel (r=0.057), calyx (r=0.057), and polyphenoloxidase (r=-68), solasodine (r=-0.43) and phenol (r=-0.49). The result also revealed about the genotype ABSR-2 have recorded it's maximum yield, high marketable yield, minimum shoot Infestation, phenol, PPO, PAL, solasodine, low reducing sugar.

Mustafa *et al.,* (2018) was performed for evaluate the Breeding resistance of brinjal against Brinjal shoot and fruit borer (*Leucinodes orbonalis*) by using his exploitation of genetic constitutions land it tends to improve and develop some quality traits and synthetic traits and he got a result from apart from

chemicals and any other unsafe method which are utilized for control the Brinjal shoot and fruit borer, but it is necessary to grow the pest resistant cultivars.

Singh *et al.,* (2021) have studied about the characterization of eggplant genotypes for different resistance mechanisms against *Leucinodes orbonalis* (Brinjal Shoot and fruit borer) by using 42 genotypes of eggplant and analyzed is biochemical compounds like total phenols, polyphenol oxidase, peroxidases, phenylalanine ammonium Lyase and solasodine had significantly negative correlation with the per cent fruit infestation by *L. orbonalis* while the reducing sugars and non-reducing sugars showed a significantly positive correlation.

Ramakrishnan *et al.,* (2021) have performed the molecular genotypic diversity of Population of Brinjal Shoot and fruit borer (*Leucinodes orbonalis*) by using different strategies for management practices. The present investigation have performed using RAPD (Random Amplified Polymorphic DNA) primer is used as a molecular marker. This marker is mostly using at Tamil Nadu state South India.

Biotechnology basis of resistance

Jadhav *et al.,* (2015) was performed about the Breeding Resistance of shoot and fruit borer in Brinjal by using his cry1F gene driven by CaMV35S promotor by developing four brinjal namely "Manjarigota", "Ruchira", "Poona selection" and "Krishna kathi" ; Agrobacterium concentration of 0.2 at optical density600 (OD600) was found to be optimum and grown under Tissue culture techniques and resulting transformation efficiency was obtained in each 4 Cultivars, Ruchira (19.8%), Krishna kathi (11.78%), Manjarigota (5.41%) and Poona selection (3.97%%).

Muthusamy Prabhu *et al.,* (2009) has made research in the biochemical basis of shoot and fruit borer resistance in interspecific progenies of Brinjal. The different levels of biochemical constituents namely peroxidase, poly phenol oxidase, total phenols, and solasodine contents were observed in genotypes derived from inter-specific crosses and their parents.

The biochemical basis of host plant resistance for shoot and fruit borer of Brinjal was investigated using selected genotypes from the back crosses involving cultivated Brinjal varieties and *Solanum viarum*. A higher level of polyphenoloxidase activity was observed in interspecific cross F6 EP65 x *S. viarum*. This study showed that the biochemical parameters responsible for the resistance but showed as well the development of superior genotypes with resistance to shoot and fruit borer.

Tanu sethi *et al.,* (2016) conducted studies on in-vitro rearing of Brinjal shoot and fruit borer on artificial diet. They have concluded that the BSFB takes 26.25 days to complete life cycle on artificial diet as compared to 25.42 days on natural Brinjal fruits (var. Pusa Kranti). Thus, the artificial diet is useful for economic production of insects and quality under aseptic conditions on the basis of rearing at 27 0 C, 60-75% rh and 13 hr photophase for more than 56 generations without fortification with field populations. They have discussed about the methods being useful for studies on various aspects of BSFB management including insect resistance management in insect protective transgenic Brinjal.

Muhammad Abdullah shaukat *et al.,* (2018) has discussed on evaluation of resistance in Brinjal shoot and fruit borer infestation. Round shaped Brinjal are more susceptible to BSFB as compared to long Brinjal. The information of nature and relative extent of gene exploit (additive and non-additive) is of key importance in scheming appropriate and well-organized breeding plan for enhancement of resistance and crop yield.

Synthetic traits, for example, ash, crude fibre, silica, sugars, mineral ingredients, total phenol contents of fruit and shoot of Brinjal are examined to be included towards the shoot and fruit borer resistance in Brinjal.

Brinjal Shoot and fruit borer is highly monophagous insect in brinjal; it produces damage very severely particular in fruit and shoot parts. The larvae is the damage stage of the pest and it makes the holes on the stem and plant will withering and wilt, lack of Nutrient supply on roots and shoots and it is damage outbreak in fruit yield causing affect in eating quality, bore holes in fruits and rotting in flesh; Nearly 67% of damage occurs in shoot infestation and 78% of damage occurs in fruit infestation and affect in yield also; I have learned that different strategies and practice which are performed in the field under climatic Condition. I have practiced some hybridization in my brinjal field; still brinjal plants are moderate growth after transplanting; after 60 to 70 DAS, the flowering stage is start to flowers are blooming and I have performed hybridization in my field at only one cross for strengthen my experience since today. Finally I got 1 develop fruit from hybridized plant done by myself other than remaining plants are starts to flowering but Fruit set is not occurs earlier.

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