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Relationship between biochemical resistance attributing factors and shoot and fruit borer infestation by *Leucinodes orbonalis* (Guenee) in brinjal genotypes

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Abstract
Biochemical constituents in shoot and fruit of sixty brinjal genotypes and their role in offering resistance against shoot and fruit borer infestation caused by *Leucinodes orbonalis* Guenee was studied at college of Horticulture, Venkataramannagudem during kharif 2017-18 in augmented block design. Phenol content in shoot and fruit showed negative and highly significant correlation with shoot and fruit borer infestation (r = - 0.9587, r = -0.9717), highly significant and negative correlation with peroxidase (r = -0.9645, r = -0. 9586), highly significant and negative correlation with PAL (r = -0.9692, r = -0.9719). Highly significant and positive correlation was observed between phenol content of shoot and fruit with peroxidase (r = 9937, r = 0.9628) and PAL (r = 0.9776, r = 0.9758). Peroxidase and PAL also showed highly significant and positive correlation (r = 0.9911, r = 0.9643). Phenol in shoot and fruit had negative direct effect (-0.5815, -0.4070) on per cent shoot and fruit infestation. Its indirect effects via peroxidase (0.5832) in shoot are positive and in fruit are (-0.1728) negative; via PAL in shoot and fruit are (-0.9603, -0.3919) negative. Peroxidase in shoot had positive direct effect (0.5869) on per cent shoot infestation and in fruit had negative direct effect (-0.1794) on per cent fruit infestation. Its indirect effects via phenol (-0.5778, -0.3919) and PAL (-0.9735, -0.3873) are negative. PAL in shoot had negative direct effect (-0.9823, -0.4016) on per cent shoot and fruit infestation. Its indirect effects via phenol (-0.5685, -0.3972) and peroxidase (-0.5816, -0.1730) in shoot and fruit are negative. Phenol, peroxidase and PAL in shoot and fruit showed highly significant negative correlation with shoot and fruit borer infestation.

Keywords: Brinjal genotypes, biochemical factors, correlation, path analysis

Introduction

Vegetables play an important role in human diet throughout the world. Brinjal (*Solanum melongena* L.) is a popular vegetable and one of the major principle vegetable crops widely grown in both temperate and tropical regions of the globe mainly for its tender fruit as vegetable (Rai *et al.*, 1995) [22]. It is popular among people of all social strata and hence it is rightly called as 'Vegetable of masses 'and can be grown throughout the year in Indian subcontinent. Year round availability, easy cultivation, moderate to high yield and consumption in variety of ways has made brinjal the king of vegetables in India.

Among the major pests infesting the crop, shoot and fruit borer is the most limiting factor distributed all over India, causing heavy yield loss up to 70 per cent (Jat and Pareek, 2003) [10] and with particular to Andhra Pradesh, it is causing up to 70% loss in marketable fruit yield (Sasikala *et al.*, 1999) [25]. Chemical control is widely used means of managing the pest. Repeated use of broad spectrum synthetic chemicals results in environmental contamination, pesticide residue in the produce and destruction of beneficial insects.

Different management approaches like cultural, host plant resistance, biological, chemical etc. are integrated to minimize the damage of the pest on the crop. The most important and effective way to manage an insect pest is the use of host plant resistance mechanism. IPM system along with host plant resistance is yielding promising and encouraging results and hence, development of insect resistant varieties is a potential objective of the crop scientists. Biochemical factors of the host plant have been reported to play a vital role on resistance to various insect and disease pests (Panda and Khush, 1995) [17] and relatively resistant varieties contained higher amount of secondary metabolites inherently (Dhaliwal and Dilawari, 1993) [4]. On the other hand, susceptibility of a host plant might be due to enrichment of essential and necessary food materials, especially carbohydrate and proteins have been reported by Sadasivam and Manickam (1992) and Dhaliwal and Dilawari (1993) [4].

Development of high yielding as well as shoot and fruit borer tolerance cultivar of brinjal requires knowledge of existing genetic variation and also the extent of association among plant biochemical constituents and their relationship with resistance against shoot and fruit borer (Senapati and Senapati 2006) [27].

Correlation and path co-efficient analysis are the important biometrical technique to determine the characters contributing in host plant resistance. The characters that are positively correlated with levels of infestation are of considerably important to plant breeder for selection purpose. Correlation coefficient analysis assesses the mutual relationship between biochemical constituents of the plant and establishes the components upon which selection is to be done for improvement in development of resistant/tolerant variety. Path co-efficient analysis reveals the direct and indirect effect of various components thus providing understanding of the direct and indirect contribution of each character towards resistance.

In the light of above scenario, the present study was undertaken with the specific objective to investigate the relationship between biochemical constituents of shoot and fruit in brinjal genotypes and level of shoot and fruit borer infestation.

Material and Methods

The present experiment was conducted at college of Horticulture, Venkataramannagudem during kharif 2017-18. Sixty genotypes and three check cultivars of brinjal were screened against shoot and fruit borer in augmented block design. The seedlings were transplanted in the main field at 35-40 DAS in a single row of 5m length with a spacing of 70 x 60 cm. The checks were planted in a randomized manner after every eight test genotypes in each block. Recommended agronomic package of practices were adopted for raising the crop excluding the plant protection measures.

Five plants were tagged at random and observed for the incidence of shoot and fruit borer at fortnight interval starting from fifteenth day after transplantation to till final harvest. The shoot infestation was recorded by counting the healthy as well as infested shoots (withered tender shoots) from randomly tagged plants of each genotype and checks. Mean per cent shoot infestation of each genotype was calculated. Data on fruit infestation was recorded from the randomly tagged plants of each genotype at each harvest. The per cent fruit infestation was worked out on number basis. Based on per cent fruit infestation, genotypes were grouped as per the scale given by Mishra *et al.* (1988) [14]. For the estimation of biochemical constituents, shoot samples from the apical shoots of selected plants of each genotype were collected when the plants are at 45 days age. The leaves were clipped off and remaining shoot portion was taken for the estimation of biochemical constituents. Similarly samples of edible size healthy brinjal fruits of the same physiological age were picked when the plants were at 90 days age. Phenol was estimated from shoot and fruit samples by Bray and Thorpe (1954) [2] method, Peroxidase activity by Schimidt *et al.* (1982) [26] method and Phenylalanine Ammonialyase was determined according to the procedure laid down by Dickerson *et al.* (1984) [6].

Genotypic and phenotypic correlation coefficients were estimated according to the formula given by Johnson *et al.* (1955) [11]. The significance of the phenotypic and genotypic correlation coefficients was tested as given by Snedecor and Cochran (1967) [31]. Path coefficient analysis suggested by Wright (1921) [34] was used to calculate the direct and indirect contribution of various traits responsible to shoot and fruit infestation.

Results and Discussion

Correlation between Biochemical factors of shoot and per cent shoot infestation in brinjal genotypes

Infestation by the pest in genotypes depends upon various independent characters therefore, it is essential to know the relationship between the characters. Correlation analysis is used to find out the mutual association between level of infestation and the related characters. The estimate of correlation provides an effective way for isolation of individual genotypes with desirable characters for resistance.

The nature and magnitude of the association between fruit infestation and its component traits are necessary for adequate selection in advance generations of crop improvement. Nature of population under consideration and the magnitude of correlation coefficient could often be influenced by choice of the individual upon which the observations are made.

Correlations between character pairs are due to the linkage of genes or pleiotropy of genes. Therefore, selection of one trait influences the other linked or pleiotropically affected traits. Considerable importance has been attached to correlation studies in the crop improvement as they are helpful in making an effective selection.

In the present study, correlations between three biochemical constituents in shoot and fruit were worked out in all possible combinations at phenotypic and genotypic levels as shown in Table 1. In general, the magnitude of genotypic correlation coefficient was higher than the corresponding values of the phenotypic correlation coefficient. This indicated a strong genetic association between the traits and the phenotypic expression which was suppressed due to environmental influence.

The per cent shoot infestation showed negative and highly significant correlation with phenol content in shoot (r = -0.9587), highly significant and negative correlation with peroxidase content in shoot (r = -0.9645) (4.16), highly significant and negative correlation with PAL content in shoot (r = -0.9692. Highly significant and positive correlation was observed between phenol content of shoot with peroxidase (r =9937) and PAL (r = 0.9776). Peroxidase and PAL also showed highly significant and positive correlation (r = 0.9911).

Path coefficient analysis between Biochemical factors of shoot and per cent shoot infestation in brinjal genotypes

Path coefficient is standardized partial regression coefficient which splits the correlation coefficient into the measures of the direct and indirect effects of a set of independent variables on the dependent variable. This analysis provides a method for separating out the direct and indirect effect of causal factors which affect the shoot infestation.

The path coefficients between different biochemical factors of shoot and fruit were further partitioned into direct and indirect effects and are presented in Table 2.

The results indicated that, phenol in shoot had negative direct effect (-0.5815) on per cent shoot infestation. Its indirect effects via peroxidase (0.5832) is positive and via PAL (-0.9603) is negative. Peroxidase in shoot had positive direct effect (0.5869) on per cent shoot infestation. Its indirect effects via phenol (-0.5778) and PAL (-0.9735) are negative. PAL in shoot had negative direct effect (-0.9823) on per cent shoot infestation. Its indirect effects via phenol (-0.5685) and peroxidase (-0.5816) are negative.

The path coefficient analysis on the present study revealed that the highest magnitude of negative direct effect on per cent shoot infestation was exerted by Phenylalanine ammonialyase followed by peroxidase and phenol. It indicates that selection of a genotype based on biochemical factors such phenol. Peroxidase and PAL would result in an appreciable improvement in reduction of per cent shoot infestation. This indicated that the biochemical factors of shoot should be taken as an important parameter during the selection of a resistant or tolerant genotype.

Table 1: Genotypic and phenotypic correlation between biochemical factors of shoot and shoot infestation caused by *L. orbonalis*

	Phenol	Peroxidase	PAL	Per cent shoot infestation
Phenol	1.0000	0.9937 **	0.9776 **	-0.9587**
Peroxidase		1.0000	0.9911 **	-0.9645**
PAL			1.0000	-0.9692**
Per cent shoot infestation	-0.9587**	-0.9645**	-0.9692**	1.0000

Table 2: Genotypic and phenotypic path coefficient analysis between biochemical factors of shoot and shoot infestation caused by *L. orbonalis*

	Phenol	Peroxidase	PAL	Per cent shoot infestation
Phenol	-0.5815	-0.5778	-0.5685	-0.9587
Peroxidase	0.5832	0.5869	0.5816	-0.9645
PAL	-0.9603	-0.9735	-0.9823	-0.9692
Per cent shoot infestation	-0.9587	-0.9645	-0.9692	1.0000

Residual effect = 0.2378

Correlation between Biochemical factors of fruit and per cent fruit infestation in brinjal genotypes

In the present study, correlations between three biochemical constituents and fruit infestation was worked out in all possible combinations at phenotypic and genotypic levels as shown in Table 3.

The per cent fruit infestation showed negative and highly significant correlation with phenol content in fruit (r = -0.9717), highly significant and negative correlation with peroxidase content (r = -0. 9586) and highly significant and negative correlation with PAL content (r = -0.9719). Significant and highly positive correlation was observed between phenol content of fruit with peroxidase (r = 0.9628) and PAL (r = 0.9758). Peroxidase and PAL also showed highly significant and positive correlation (r = 0.9643).

Table 3: Genotypic and phenotypic correlation between biochemical factors of fruit and fruit infestation caused by *L. orbonalis*

	Phenol	Peroxidase	PAL	Per cent fruit Infestation
Phenol	1.0000			
Peroxidase	0.9628**	1.0000		
PAL	0.9758**	0.9643**	1.0000	
Per cent fruit infestation	-0.9717**	-0.9586**	-0.9719**	1.0000

Path coefficient analysis between Biochemical factors of fruit and per cent fruit infestation in brinjal genotypes

The correlation coefficients between different biochemical factors of fruit were further partitioned into direct and indirect effects and are presented in Table 4.

The results indicated that, phenol in fruit had negative direct effect (-0.4070) on per cent fruit infestation. Its indirect effects via peroxidase (r = -0.1728) and PAL (-0.3919) were negative. Peroxidase in fruit had negative direct effect (-0.1794) on per cent fruit infestation. Its indirect effects via phenol (r = -0.3919) and PAL (r= -0.3873) are negative. PAL in fruit had negative direct effect (-0.4016) on per cent fruit infestation. Its indirect effects via phenol (-0.3972) and peroxidase (r = -0.1730) are negative.

The path coefficient analysis in the present study revealed that the highest magnitude of negative direct effect on per cent fruit infestation was exerted by phenol in fruit followed by PAL and peroxidase. It indicates that selection of a genotype based on biochemical factors of fruit such as phenol, peroxidase and PAL would result in an appreciable improvement in reduction of per cent fruit infestation. This indicated that the phenol, peroxidase and PAL content should be taken as an important parameter during the selection of a resistant or tolerant genotype.

The present findings are in accordance with the observations of Asati *et al.* (2002) [1] who noticed that borer infestation percentage was negatively correlated with total phenol content. Doshi (2004) [7] identified a negative correlation between shoot and fruit borer infestation and phenol content.

These results are highly supported by Shukla *et al.* (1998) [28], Darekar *et al.* (1991) [5], Raju *et al.* (1987) [23]; Hazra *et al.* (2004) [9]; Shinde (2006) [30]; Chandrashekhar *et al.* (2008) [3]; Prabhu *et al.* (2009) [19]; Elanchezhyan *et al.*(2009) [8]; Praneetha *et al.* (2011) [20]; Subhodh (2013) [32]; Patil (2014) [18]; Prasad *et al.*(2014) [21]; Showkat *et al.* (2017) [29]; Nirmala and Vithamoni (2016) [16] who found similar type of correlation in their studies in brinjal and the present findings are in conformity with the above reports. A negative correlation was observed between PAL activity and fruit borer incidence by Khorsheduzzaman *et al.* (2010) [13] and the present findings are in agreement with above reports.

Wagh *et al.* (2012) [33] reported a negative and significant correlation with per cent fruit infestation and peroxidase content in fruit. Mutthuraju (2013) [15] reported Peroxidase and PAL content showed a strong and negative correlation (r = -0.823 and r = -0.906) with the corresponding mite population in brinjal genotypes. Kasturi Choudhury (2017) [12] revealed that the peroxidase content of fruits in different varieties had significantly negative correlation (r = -0.7961) with fruit infestation.

The present findings are more or less corroborating with the above reports. However, the set of genotypes used were different from that used in the study. It was found in the present study that among the sixty genotypes of brinjal, IC 136061 showed moderately resistant response against shoot and fruit borer infestation owing to the characters like high levels of phenol, peroxidase and PAL content in shoot as well as in fruit.

Table 4: Genotypic and phenotypic path coefficient analysis between biochemical factors of fruit and fruit infestation caused by *L.orbonalis*

	Phenol	Peroxidase	PAL	Per cent fruit infestation
Phenol	-0.4070	-0.3919	-0.3972	-0.9717**
Peroxidase	-0.1728	-0.1794	0.1730	-0.9586**
PAL	-0.3919	-0.3873	-0.4016	-0.9719**
Per cent fruit infestation	-0.9717**	-0.9586**	-0.9719**	1.0000

Residual effect = 0.2052

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