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BIOCHEMICAL BASIS OF RESISTANCE IN EGGPLANT (*Solanum melongena* L.) TO *Leucinodes orbonalis* Guenee AND THEIR CORRELATION WITH SHOOT AND FRUIT INFESTATION

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Abstract

Studies on the biochemical basis of resistance to *Leucinodes orbonalis* Guenee and their correlation with shoot and fruit borer damage in five selected brinjal genotypes done at Tamil Nadu Agricultural University, India during June to December 2005 showed that both shoot and fruit of less susceptible genotypes had the higher amount of poly phenol oxidase (PPO), phenylalanine ammonium lyase (PAL) and lignin and lower amount of reducing sugar. Significant negative correlation was found between percent infestation (shoot and fruit) with PPO, PAL and lignin content, whereas it was positively correlated with reducing sugar content. Among the biochemical constituents, PPO, PAL and lignin contents were negatively correlated with reducing sugar but PPO were positively correlated with PAL and lignin content and vice-versa.

Keywords : Biochemical basis, resistacace, eggplant, *Leucinodes orbonalis*.

Introduction

Brinjal *(Solanum melongena* L.) is a popular vegetable grown year round in Bangladesh and south-east Asia. But production of this cash crop is highly hindered by more than a dozen of insect and disease pests (Alam and Sana, 1962). Among the factors responsible for low yield of brinjal, brinjal shoot and fruit borer (BSFB), *Leucinodes orbonalis* Guen. is the most serious one, which may cause 100% damage if no control measures are applied (Rahman, 2007). There are numerous brunjal varieties available in the subcontinent including Bangladesh. But none has been found to be resistant to BSFB with an appreciable level (Alam *et al.,* 2003).

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) and relatively resistant varieties contained higher amount of secondary metabolites inherently (Dhaliwal and Dilawari, 1993). 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). It has been reported that

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phenols, alkaloids and methyl ketones have been demonstrated to be involved in host plant resistance to several insect pests in *Lycopersicon* (Panda and Khush, 1995), tobacco budworm (Hedin *et al.,* 1983; Hedin, 1986, several rice pests (Saxena, 1986). In brinjal, amino acids, crude protein, ash and sugar content (total and reducing sugars) showed a high positive and silica contents, poly phenol oxidase, phenylalanine ammonia lyase, peroxidase, glycoalkaloids and lignin content showed a highly negative correlation with shoot and fruit borer infestation (Doshi, 2004; Martin, 2004; Jat and Pakeer, 2003). Panda and Das (1975) reported that high sugar content of brinjal may act as feeding stimulants for the borer. Two PAL genes, *PAL 1* and *PAL 2* have been identified and cloned in tobacco against tobacco budworm showed resistant reaction (Sadasivam and Thayumanavan, 2003).

From a series of investigation during 1999 to 2003, Bangladesh Agricultural Research Institute (BARI) has identified few brinjal genotypes relatively less susceptible to BSFB (Anon., 2003). Based on that evaluation, the selected genotypes were assessed through biochemical profiling. The findings of the present investigation may be helpful for the plant breeders to develop new varieties that would be capable to resist a substantial level of borer infestation through selection of plant biochemical characters that have been found associated with borer resistantce, which ultimately help the farmers by minimizing the cost of production. Therefore, the present investigation was undertaken to find out the effect of some biochemical factors on shoot and fruit infestation by BSFB.

Materials and Method

Five selected bnnjal genotypes, namely BLOO9, ISDOO6 (origin: BARI, Joydebpur, Bangladesh), TURBO, EG058 (origin: Thailand) and EG075 (source: AVRDC) were used in the present study. EG0075 was found highly susceptible and rests of them were found resistant with different degrees to BSFB in greenhouse and field condition through antixenosis and antibiosis tests (Alam *et al.,* 2003; Anon., 2001-2003). Chemical analyses of reducing sugar, poly phenol oxidase (PPO), phenylalanine amoniaum lyase (PAL) and lignin content in both shoot and fruit were done at the Department of Biochemistry and Toxicology of the Centre for Plant Molecular Biology and Biotechnology (CPMB), Tamil Nadu Agricultural University (TNAU), Coimbatore, India during June to December 2005 from potted plants grown in transgenic greenhouse. Reducing sugar was estimated using di-nitro salicylic acid (DNS) method, PPO activity using catechol solution method and PAL activity using trans-cinamic acid method following the procedures described by Sadasivum and Manickam (1992). Lignin content was estimated following the methods described by Chesson (1978). Simple correlation was computed between the parameters mentioned above and

the degree of infestation according to the method suggested by Wright (1921, 1934).

Results and Discussion

The finding of the present study provided precise information for the selection of important biochemical factors which may contribute more towards resistance to shoot and fruit borer and presented in Table 1 and 2.

Reducing sugar

Reducing sugar content ranged from 0.84-1.88 and 2.78-4.58 mg per 100 mg dry weight of shoot and fruit, respectively. The highest quantity of reducing sugar was found in the susceptible genotype EG075 (check) which was followed by EG058, ISDOO6 and BLOO9 and the lowest amount was recorded in the genotype TURBO. The amount of reducing sugar was higher in fruit than shoot and follows the similar trends (Table 1). The effects of reducing sugar in brinjal coupled with other biochemical factors have been estimated by several investigators. Panda and Das (1975) found that the susceptible cultivar has high sugar content, therefore, acts as feeding stimulants for the borer. The present findings are in agreement with the findings of Bajaj *et al.* (1989). Similar observations were also reported by Dadmal *et al.* (2004); Doshi (2004); Patil *et al.* (1994) and Darekar *et al.* (1991). From the result, it is revealed that the total soluble and reducing sugars had high positive effect on shoot and fruit infestation by *L. orbonalis* borer.

Table 1. Reducing sugar, PPO activity, PAL activity, and lignin content in shoot and fruit of different brinjal genotypes and BSFB infestation in bnnjal.

Genotypes	Percent infestation		Reducing sugar (mg/ 100 mg dry wt)		PPO activity (δ change in OD ABS/ min/g)		PAL activity (µmole/ml/min.)		Lignin content (mg/g dry wt)	
	Shoot[a]	fruit[b]	Shoot	fruit	Shoot	fruit	Shoot	fruit	Shoot	Fruit
BLOO9	13.44bc	33.31 c	0.97	2.97	6.17	6.32	12.17	12.48	100.0	108.0
EG058	12.83 c	51.88b	1.17	3.57	2.54	2.89	6.73	7.17	80.0	89.0
EG075	18.33 a	75.29 a	1.88	4.58	2.85	3.04	5.81	5.97	10.0	17.0
ISDOO6	9.59 d	47.24 b	1.01	3.77	5.91	6.11	10.37	10.13	50.0	73.0
TURBO	15.37 b	32.63 c	0.84	2.78	6.81	7.09	14.73	14.98	130.0	143.0

Means within the same column having a common letter(s) do not differ significantly (p=0.05).

Poly phenol oxidase (PPO) activity

The highest poly phenol oxidase (PPO) activity was recorded in genotype TURBO (6.81 and 7.09 delta change in optical density (OD) absorbance per min per g in shoot and fruit, respectively, which was followed by BLOO9, ISDOO6, EG075 and EG058 (Table 1). PPO activity was higher in fruit as compared to shoot and follow the similar trends. Findings of the present study are supported by several earlier investigators (Martin, 2004). Doshi (2004) also reported that PPO activity had a high negative direct effect on shoot and borer infestation. These findings are in agreement with the findings of Bajaj *et al.* (1989), Singh *et al.* (1982) and Panda and Das (1975). The results of the present study suggested that the genotypes having high PPO activity showed resistant reaction to borer attack.

Phenyl alanine ammonia lyase (PAL) activity

In shoot, the highest PAL activity was found in TURBO followed by that in BL009, ISD006, EG058 and EG075. PAL activity was measured higher in fruit as compared to shoot and follow the similar trends (Table 1). Several investigators had the similar type of observations in their studies. In an investigation, Martin (2004) obtained higher PAL activity in the wild relatives of brinjal, which showed higher resistance against BSFB in India. Similar findings were also reported by Engelberth (2000) in lima bean pod borer, Feltaon *et al.* (1999) in tobacco with *Heliothis virescens,* McConn *et al.* (1997) in *Manduca sexta.* The present findings of the study revealed that genotypes having higher PAL activity in shoot /fruit received the lowest shoot and fruit infestation.

Lignin content

The range of lignin content was 10-130 and 17-143 mg/100g dry weight of shoot and fruit, respectively. The highest (130 mg/100g in shoot and 143 mg/l00g in fruit) lignin was recorded in TURBO followed by that in BL009 (100 mg/l00g and 108 mg/100g), EG058 (80 mg/100g and 89 mg/100g) and ISD006 (50 mg/100g and 73 mg/100g). The lowest (10 mg/100g and 17 mg/100g) lignin was estimated in the most susceptible genotype EG075 (Table 1). Lignin content of all genotypes was estimated higher in fruit compared to shoot and followed the trends as of shoot. The genotype containing the highest quantities of lignin showed the lowest shoot and fruit infestation by the borer. Martin (2004) in his study obtained the highest lignin content coupled with lowest shoot and fruit infestation in S. *sisymbrifolium,* a wild relatives of *S. melongena* showed highly resistant to the BSFB compared to other cultivated varieties. Lignin is a phenolic compound, which increases un-palatability of the food materials. This may be the possible reason for receiving lowest infestation in that genotype. The results of the present study had the similarity with the findings of many investigators

(Martin, 2004). It has been reported that maximum amount of total phenol were recorded in the shoot (4.21%) compared to fruits (2.39%) in immune cultivars and minimum 0.56% and 0.327% in shoot and fruit of the susceptible cultivars of brinjal, respectively (Dadmal *et al.*, 2004). Ranjan and Chakravarti (2002) also found high level of phenol content in the resistant cultivar.

Correlation between shoot and fruit infestation with biochemical constituents and different pairs of biochemicals

Simple correlation between infestation (shoot and fruit) with biochemical constituents and among different pairs of biochemical constituents were computed for five brinjal genotypes and are presented in Table 2. Estimated results of the present study revealed that percent shoot infestation had a strong significant positive correlation with percent fruit infestation (r = 0.934) and with the amount of reducing sugar (r = 0.968) present in different brinjal genotypes, whereas this correlations are negative and significant with PPO activity (r=0.643), PAL activity (r = - 0.672) and lignin content (r = -0.73). Similarly, percent fruit infestation had also highly significant positive correlation with reducing sugar (r = 0.972) and negative correlation with PPO activity (r = - 0.792), PAL activity (r = -0.874) and lignin content (r= -0.941) (Table 2). These results are highly supported by Shukla *et al.* (1998). Darekar *et al.* (1991), Raju *et al.* (1987) found similar type of correlation in their studies in brinjal.

Table 2. Correlation matrix between biochemical constituents of brinjal genotypes and rate of BSFB infestation.

	% shoot infestation	% fruit infestation	Reducing sugar	PPO activity	PAL activity	Lignin content
% shoot infestation	-					
% fruit infestation	0.934*	-				
Reducing sugar	0.968**	0.972**	-			
PPO activity	- 0.643*	- 0.792*	- 0.758*	-		
PAL activity	- 0.672*	- 0.874**	- 0.766*	0.897**	-	
Lignin content	- 0.730*	- 0.941**	- 0.859**	0.629*	0.827*	-

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

On the other hand, the content of reducing sugar was negatively correlated with PPO (r = -0.758), PAL (r = -0.766) and lignin content (r = -0.859) present in the genotypes. Darekar *et al.* (1991) got similar results in their studies. These results were also supported by Shukla *et al.* (1998). Again, lignin content on the other hand had significant positive correlation with PPO (r = 0.629) and PAL (r = 0.827) activity and vice- versa (Table 2).

From the results, it is clearly evident that genotypes having higher reducing sugar received higher infestation, whereas genotypes with higher amount of PPO, PAL and lignin content received the lower infestation in both shoot and fruit. The results of the present study suggested that the genotypes having high PPO, PAL and lignin content could be utilized in the breeding programme using susceptible popular varieties for the development of BSFB resistant varieties in brinjal. It is noted that *PAL1* and *PAL2* genes have successfully identified for resistance in tobacco (Sadasivam and Thayumanavan, 2003) and these genes could be incorporated into the popular varieties through biotechnological method of gene transformation for the development of BSFB resistant varieties in brinjal.

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