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DEVELOPMENT OF *MELANAGROMYZA OBTUSA* (MALLOH) IN RELATION TO BIOCHEMICAL PARAMETERS OF PIGEON PEA SEEDS

R.K. MOUDGAL[1], R.K. LAKRA AND B. DAHIYA

Department of Entomology, CCS HAU, Hisar – 125 004, Haryana.

ABSTRACT

Pigeon pea accessions grouped on the basis of plant type, maturity and susceptibility along with standard cultivars to study their response on various developmental stages of the pod fly in relation to biochemical parameters of pigeon pea seeds. The development of pod fly was considerably delayed and survival reduced on least susceptible accessions as compared to susceptible ones. The biochemical assays of pigeon pea seeds revealed that non-reducing sugars, total phenols, tannins, crude fibre and trypsin inhibitor activity adversely affected growth and development of pod fly, suggesting antibiosis against pod fly in pigeon pea.

Key words: *Melanagromyza obtusa*, development, biochemical constituents, pigeon pea seeds

INTRODUCTION

Pigeon pea [*Cajanus cajan* (L) Millsp.] is one of the major pulse crops in the tropics and subtropics. Being cheap source of vegetable protein, it forms an essential part of daily diet of Indians, especially the vegetarians. The average productivity of pigeon pea is very low. Among various constraints for poor yield, incidence of insect pests is the most important. Of these, the pigeon pea pod fly, *Melanagromyza obtusa* (Malloch) is a major pest causing substantial damage to pigeon pea. In general the dipteran fly causes on an average 34.5 per cent damage to the pods, which results in 29.8 per cent loss to grains (Srivastava, 1972). The biochemical constituents of host plants influenced the growth, development, survival and reproduction of the insects in a number of ways (Painter, 1958), however, the information pertaining to the influence on the development of pod fly is meager. Therefore, in the present investigation attempt was made to ascertain the influence of these biochemical parameters of pigeon pea seeds on the development of the pod fly.

MATERIALS AND METHODS

The most susceptible and the least susceptible accession, each belonging to different plant type and maturity group were selected based on the two year field screening during 2001-2002 crop seasons for studying the role of biochemical parameters of pigeon pea seeds on pod fly biology.

Development of pigeon pea pod fly on different pigeon pea accessions : Different pigeon pea genotypes along with standard check were studied under screen house conditions. The branches of each pigeon pea test accessions were sleeved with finely netted synthetic cloth bags so as to ensure that the pods formed subsequently did not contain any eggs. Four mated pairs were released in each such bag/cage when the pods attained partly mature stage. From each of these cage/bags, two pods were randomly removed daily and observed for the various life stages present therein. The duration of larval and pupal stages was recorded. Each test entry was replicated thrice. Some of the pods were opened while still intact on the plant after hatching of the eggs and observed for the presence of larva. These pods containing pod fly larva were closed again and tied with thread without disturbing the larva. Fifteen such pods in each of the three replications were used for recording observations. Observations were also recorded on larval survival, adult emergence and sex ratio.

Biochemical assay: Green pods (30 days after opening of the flowers) were collected from each entry to obtain the seeds for biochemical assay. These were weighed and oven dried at 60°C for 2-3 days. After drying, these samples of seeds were then grinded in a electro grinder and stored in paper envelopes and again kept in oven at 50°C for one day to ensure complete drying, for estimation of biochemical constituents, *viz*., total soluble sugars (Dubois *et al.*, 1956); reducing sugars (Snell and Snell,

1. Part of Ph.D. thesis of the first author

1954); non-reducing sugars (The difference between total sugars and reducing sugars); tannins (Burns, 1971); crude protein and crude fibre (A.O.A.C., 1995); and trypsin inhibitor activity (Roy and Rao, 1971). These biochemical constituents were correlated with biological parameters of pod fly.

RESULTS AND DISCUSSION

The data in Table 1 pertaining to different biological parameters of pod fly observed on accessions with contrasting susceptibility showed that larval period of the insect pest was significantly extended (7.93-8.60 days) on least susceptible accessions as compared to susceptible ones (6.91-7.38 days), whereas, it was 8.09 and 8.16 days in *Manak* and *Prabhat*, respectively used as recommended standard checks.

Survival of the pod fly maggot on the least susceptible accessions ranged between 71.11-80.00% as compared to 90.00-93.33% in susceptible accessions, while, it was 88.88 and 84.44% on standard checks *Manak* and *Prabhat*, respectively, indicating a reduced survival of the pest on least susceptible accessions.

Pupal development was also observed to be extensively delayed on least susceptible entries and standard pigeon pea cultivars as compared to susceptible entries. Pupal period ranged from 12.05-12.60 days on least susceptible accessions in comparison to 9.60-11.38 days on susceptible accessions and, 11.93 and 12.33 days on *Manak* and *Prabhat*, respectively.

Similar trend was recorded for adult emergence, which was slightly low on the least susceptible accessions (81.67-86.11%) as compared to susceptible ones (90.27-93.17%) and check cultivars, *Manak* (92.06%) and *Prabhat* (92.09%). However, the differences were not significant amongst the test entries. Data on sex ratio did not exhibit any definite trend, though, more females emerged in most of the test entries.

The present findings on the development of pod fly revealed prolonged maggot duration and reduced survival on the least susceptible accessions as compared to susceptible ones suggesting some antibiosis. However, no such information against pod fly on pigeon pea has been generated. But, these findings draw support from different reports against *Helicoverpa armigera* (Hübner) on pigeon pea (Rao, 2000).

A perusal of data in Table 2 showed distinct variation in the protein, total soluble sugars, reducing sugars, non-reducing sugars, total phenols, tannins, crude fibre content and trypsin inhibitor activity in seeds of different pigeon pea accessions. The protein content in seeds of least susceptible accessions ranged from 19.54-21.00% as compared to susceptible ones (22.77-23.62%), the

Table 1. Development of pod fly on different pigeon pea accessions

Accessions	Larval period (days)	Larval survival (%)	Pupal period (days)	Adult emergence (%)	Sex ratio M : F
NDT extra early maturing (110 days)					
GP75 (LS)	8.33	80.00 (63.43)	12.09	86.11 (68.12)	1:1.07
GP25 (S)	7.38	91.11 (72.65)	10.44	90.63 (72.18)	1:1.17
NDT early maturing (130 days)					
GP118 (LS)	7.93	80.00 (63.43)	12.05	83.33 (65.90)	1:1.14
GP183 (S)	6.91	90.00 (71.57)	9.60	93.17 (74.85)	1:1.05
Manak (CH_1)	8.09	88.88 (70.52)	11.93	92.06 (73.63)	1:1.18
DT extra early maturing (110 days)					
GP233 (LS)	8.60	71.11 (57.49)	12.60	81.67 (64.65)	1:1.17
GP242 (S)	7.24	91.11 (72.65)	11.38	90.40 (71.95)	1:1.06
DT early maturing (130 days)					
GP253 (LS)	8.31	75.56 (60.37)	12.13	82.78 (65.48)	1:0.93
GP248 (S)	7.18	93.33 (75.03)	11.11	90.27 (71.82)	1:0.90
Prabhat (CH_2)	8.16	84.44 (66.77)	12.33	92.09 (73.66)	1:1.06
CD (p=0.05)	0.75	(8.90)	0.62	NS	
SE(m)	0.25	(3.02)	0.21	(2.90)	

- Figures in parentheses are arc sin values
  NDT = Non-determinate type; DT=Determinate type; LS=Least susceptibles;
  S=Susceptible; CH_2=Standard check

Table 2. Biochemical assay of seeds of different pigeon pea accessions

Accessions	Protein (%)	TSS (%)	RS (%)	NRS (%)	Total phenols (mg/g)	Tannins (mg/g)	Crude fibre (%)	Trypsin inhibitor activity (TIU/g)
NDT extra early maturing (110 days)								
GP75 (LS)	20.42 (26.84)	6.74 (15.04)	0.74 (4.91)	6.00 (14.18)	7.50	1.28	7.18 (15.53)	1146.47 ± 8.92
GP25 (S)	23.62 (29.06)	4.88 (12.76)	1.28 (6.50)	3.60 (10.93)	3.48	0.63	6.54 (14.81)	1000.55 ± 11.06
NDT early maturing (130 days)								
GP118 (LS)	21.00 (27.25)	6.72 (15.02)	0.84 (5.25)	5.88 (14.03)	7.40	1.26	7.11 (15.46)	1136.33 ± 9.52
GP183 (S)	23.62 (29.07)	4.64 (12.44)	1.28 (6.50)	3.36 (10.56)	3.31	0.61	6.46 (14.71)	978.67 ± 6.98
Manak (CH_1)	22.46 (28.27)	5.82 (13.96)	1.05 (5.88)	4.77 (12.61)	5.96	1.13	6.81 (15.12)	1061.59 ± 12.48
DT extra early maturing (110 days)								
GP233 (LS)	1954.00 (26.22)	6.83 (15.14)	0.73 (4.88)	6.10 (14.30)	7.68	1.36	7.22 (15.57)	1152.22 ± 11.61
GP242 (S)	22.77 (28.48)	5.08 (13.02)	1.16 (6.17)	3.93 (11.42)	3.65	0.67	6.51 (14.77)	1025.67 ± 9.77
DT early maturing (130 days)								
GP253 (LS)	20.42 (26.85)	6.74 (15.02)	0.75 (4.96)	5.99 (14.16)	7.58	1.31	7.22 (15.58)	1155.74 ± 5.28
GP248 (S)	23.33 (28.87)	4.88 (12.76)	1.19 (6.25)	3.69 (11.07)	3.48	0.65	6.48 (14.74)	1018.96 ± 9.65
Prabhat (CH_2)	21.58 (29.67)	5.84 (13.98)	1.04 (5.84)	4.80 (12.65)	5.99	1.15	6.85 (15.16)	1063.89 ± 13.67
CD (p=0.05)	(1.81)	(0.19)	(0.55)	(0.46)	0.56	0.17	(0.36)	30.12
SE(m)	(0.61)	(0.07)	(0.19)	(0.16)	0.19	0.06	(0.12)	10.20

* Figures in parentheses are arc sin values
TSS = Total soluble sugars; RS = Reducing sugars; NRS = Non-reducing sugars; NDT = Non-determinate type; DT = Determine type;
LS = Least susceptible; S = Susceptible; CH_1; CH_2 = Standard check

difference being statistically significant. Whereas, in checks, *Manak* and *Prabhat* it was 22.46 and 21.58%, respectively. A negative correlation was found between protein content and larval (r= –0.910) and pupal periods (r= –0.897), while larval survival (r= 0.989), and adult emergence (r= 0.850) showed positive correlation (Table 3).

Chemical analysis for total soluble sugars, reducing and non-reducing sugars in different pigeon pea accessions, revealed total soluble sugar content of seeds of the least susceptible accessions (6.74-6.83%) significantly higher than the susceptible accessions (4.64-5.08%) and standard pigeon pea check cultivars, *Manak* (5.82%) and *Prabhat* (5.84%). Total soluble sugar content of seed was observed to be positively correlated with larval (r = 0.918) and pupal duration (r= 0.848). The relationship was negative with larval survival (r= –0.957) and adult emergence (r= –0.843) (Table -3). However, a higher content of reducing sugars in the seeds of susceptible accessions was observed in comparison to least susceptible accessions. Reducing sugars in the seeds of least susceptible and susceptible accessions ranged from 0.73-0.84 and 1.16-1.28% respectively, while, it was 1.05 and 1.04% in *Manak* and *Prabhat*, respectively. When correlated with biological parameters of pod fly (Table 3), it gave a negative correlation with larval (r= –0.890) and pupal periods (r= –0.826) whereas, a positive correlation with larval survival (r= 0.965) and adult emergence (r= 0.869) was observed. Non-reducing sugars in seeds of the least susceptible accessions were again significantly high (5.88-6.10%) as compared to susceptible accessions (3.36-3.93%) and the standard check cultivars, *Manak* (4.77%) and *Prabhat* (4.80%). It was observed to be positively correlated with larval (r= 0.915) and pupal periods (r= 0.846) and negatively correlated with larval survival (r= – 0.961) and adult emergence (r= –0.850) (Table 3).

Similarly, data on total phenols and tannins content (mg/g) revealed these to be significantly higher in the least susceptible accessions (7.40-7.68 and 1.26-1.36, respectively) as compared to susceptible accessions (3.31-3.65 and 0.61-0.67, respectively), while, these were observed to be 5.96 and 1.13 in variety *Manak* and 5.99 and 1.15 in variety *Prabhat*, respectively. Both these parameters were observed to be positively correlated with larval (r=0.927 and 0.959, respectively) and pupal periods (r=0.821 and 0.875, respectively) and negatively correlated with larval survival (r= –0.935 and –0.927) and adult emergence (r= –0.783 and –0.723) (Table 3).

Table 3. Correlation coefficients between biological parameters of pod fly and biochemical constituents of seeds of pigeon pea

	Larval period	Larval survival	Pupal period	Adult emergence
Protein	– 0.910**	0.989**	– 0.847**	0.850**
TSS	0.918**	– 0.957**	0.848**	– 0.843**
RS	– 0.890**	0.965**	– 0.826**	0.869**
NRS	0.915**	– 0.961**	0.846**	– 0.850**
Total phenols	0.927**	– 0.935**	0.821**	– 0.783**
Tannins	0.959**	– 0.927**	0.875**	– 0.723*
Crude fibre	0.924**	– 0.956**	0.807**	– 0.844**
Trypsin inhibitor activity	0.795**	– 0.965**	0.833**	– 0.886**

* Significant at p=0.05
* Significant at p=0.01
TSS = Total soluble sugars; RS = Reducing sugars; NRS = Non-reducing sugars

Estimation of Crude fibre content in seeds of different pigeon pea accessions showed that it was also significantly high in the least susceptible accessions (7.11-7.22%) when compared with susceptible accessions (6.46-6.54%). The figures pertaining to standard varieties *Manak* and *Prabhat* were 6.81 and 6.85%, respectively. It was positively correlated with larval (r=0.924) and pupal periods (r=0.807) and negatively correlated with larval survival (r= –0.956) and adult emergence (r= –0.844) (Table 3).

Studies on the trypsin inhibitor activity (TIU/g) of the test accessions inferred that it was also significantly higher in the seeds of least susceptible accessions (1136.33-1155.74) as compared to susceptible accessions (978.67-1025.67) and check cultivars, *Manak* (1061.59) and *Prabhat* (1063.89). A correlation between trypsin inhibitor activity and biological parameters of pod fly revealed negative correlation with larval survival (r= –0.965) and adult emergence (r= –0.886) and positive correlation with larval (r= 0.795) and pupal periods (0.833) (Table 3).

The analysis of data on different biochemical assay revealed that protein and reducing sugars proved to be an important nutritional factor for growth, development and damage by the pod fly and these were significantly higher

in susceptible test accessions. Non-reducing sugars, total phenols, tannins, crude fibre and trypsin inhibitors seemed to be important anti-nutritional factors and hampered the growth, development and infestation of the pod fly, if present in higher quantities as in the least susceptible pigeon pea accessions. However, the growth and survival of the pod fly on pigeon pea inspite of the presence of these anti-nutritional factors, which are otherwise hazardous to ruminants, indicated that this pest developed on the crop just to adapt under these conditions.

The present findings on biochemical constituents draw support from the work done by Sahoo and Patnaik (2003) on pod feeders of pigeon pea. Deleterious affect of these compounds on pod fly suggest the use of some compounds like phenols and trypsin inhibitors as possible defense components against this pest due to their toxicity or adverse affect on digestive enzymes. Similar observations were recorded by Kollipara *et al.* (1994) who reported very high level of trypsin inhibitor activity of pigeon pea genotypes and advocated its use against the pigeon pea pod borer complex.

Thus, it can be concluded that low protein, reducing sugars and high non-reducing sugars, phenol, tannin, crude fibre and trypsin inhibitor contents can afford resistance against pod fly in pigeon pea and can be utilized as a selection criterion.

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