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Population dynamics of *Melanagromyza obtusa* (Malloch) (Diptera: Agromyzidae) and its natural parasitization in pigeonpea

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ABSTRACT: Population dynamics of pigeonpea pod fly *Melanagromyza obtusa* (Malloch) and its natural parasitization on Cv. ICP-8863 (Maruthi) studies revealed that the larval population of attained a peak level during 51st standard meteorological week (SMW) with 60 larvae per 100 pods and pupal population on 4th SMW with 47 pupae per 100 pods. During the same period pod damage was at its peak with 81.00 per cent and causing grain damage 54.34 per cent, which subsequently declined to 5.18 per cent during 10th SMW. During the investigation, parasitoids belonging to six families could be recorded on the immature stages of the pod fly. The peak level of natural larval, pupal and total [= overall (larvae + pupae)] parasitization of pod fly was observed during 2nd SMW with 60.00, 51.61 and 55.81 per cent, respectively. Analysis of weather parameters relationship indicated negative correlation between larval population and grain damage *vis-a-vis* maximum temperature and evaporation. The correlation matrix among larval and pupal population; pod and grain damage; and larval, pupal and total parasitization exhibited positive correlation. © 2017 Association for Advancement of Entomology

KEY WORDS: *Melanagromyza obtusa,* parasitization, population, pigeonpea pod fly

INTRODUCTION

Pigeonpea (*Cajanus cajan* (L.) Millsp.) is grown throughout the tropics but most widely in South and South - East Asia, where it is a major source of vegetable protein. Pigeonpea is the second important pulse crop of India after chickpea being grown in an area of 3.71 million hectares with an annual production of about 2.78 million tonnes resulting in an average productivity of 750 kg per ha during 2014-15 (Anonymous, 2015). Nearly 300 species of insects are known to infest pigeonpea crop at its various growth stages in India. Among the major pod infesting insects pod fly, *Melanagromyza obtusa* (Malloch) (Diptera: Agromyzidae), has emerged as a key pest causing 10.00 per cent to 80.00 per cent damage (Shanower *et al*., 1999; Kumar and Nath, 2003) which is estimated to cause a monitory annual loss of US$ 256 million [= Rs. 1500.00 Crores approx.] (Sharma *et al*., 2011; Arbind *et al*., 2013). In the earliest record of this pest from India at Nagpur, estimated damage to tur-pods was at 12.50 per cent of the whole crop (Ahmad, 1938). A single larva destroys minimum of one complete seed in its lifetime and sometimes it has been seen to move to adjacent

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seed of the same pod to continue the feeding, making seeds unfit for human consumption and germination.

The pest being internal feeder difficult to notice its damage outside poses problems to manage with chemical insecticides (Srinivasan and Durairaj, 2007; Sharma *et al.*, 2011). Currently pest management strategies for the pigeonpea pod fly emphasize on chemical control and host plant resistance (Shanower *et al.*, 1998). So far, many molecules have been evaluated against this pest, but the significant control is not obtained. Host plant resistance based on physico-chemical traits of pod especially pod wall thickness, trichome density, reducing and non-reducing sugars, total phenols, tannins, and crude fiber hold promises as an important tool for selection of varieties to fit for the management of this pest (Moudgal *et al.*, 2008). More than 20 Hymenopteran parasitoids have been reported on this pest (Sharma, 2007). Hence, considering the fact that bio-control agents could play an important role in the natural management of the pest, present investigations were under taken to study the population dynamics of pod fly, *M. obtusa vis-a-vis* level of natural parasitization to enable designing of strategies for its management based on ecological and natural parasitization principles of integrated pest management for resource poor farmers in India.

MATERIALS AND METHODS

The field experiment was conducted at Agricultural Entomology Unit, Agricultural Research Station, Badnapur; (VNMKV, Parbhani) to assess the population dynamics of *M. obtusa* and its natural parasitization. The pigeonpea variety, ICP-8863 (Maruthi) was raised with standard agronomical practices during *Kharif* season 2014-15 under normal field conditions with plant to plant and row to row distance of 30 cm and 60 cm, respectively. No insecticides was applied to protect the crop from the natural infestation of pod fly and left to natural conditions. The population of pod fly, *M. obtusa* was recorded from pod initiation till harvest of the crop by destructive method. The larval and pupal population along with its pod and grain damage were recorded on randomly collected 100 pods covering all the plants at weekly intervals till harvest of crop. The per cent pod damage and per cent grain damage was calculated using the following formula as suggested by Naresh and Singh (1984).

Per cent pod/grain damage =

$$\frac{\text{Number of infected pods/grains}}{\text{Total number of pods/grains}} \times 100$$

The collected larvae and pupae were maintained at the rate of one per vial (plastic vials with 30 ml capacity) and reared at ambient temperature for observing the emergence of different parasitoids. These beneficials were later on identified based on taxonomic features and grouped into different families. The per cent larval, pupal and total (larvae + pupae) parasitization was calculated using the following formulae.

Per cent larval/pupal parasitization =

$$\frac{\text{Number of infected larvae/pupae}}{\text{Total number of larvae/pupae}} \times 100$$

Per cent total (larvae + pupae) parasitization =

$$\frac{\text{Number of infected larvae + pupae}}{\text{Total number of larvae + pupae}} \times 100$$

Correlation analysis was also studied to know the role of weather parameters relationship with parasitization for its influence. The strength of the correlation was described using the guide suggested by Evans (1996) as –

0.00-0.19: “very weak”; 0.20-0.39: “weak”; 0.40-0.59: “moderate”; 0.60-0.79: “strong” And 0.80-1.0: “very strong”

RESULTS AND DISCUSSION

Observations revealed that the larval population of *M. obtusa* was active from 48th SMW (22 larvae / 100 pods) which increased gradually and attained a peak on 51st SMW with 60 larvae per 100 pods. The larval population declined later to 2 larvae in

10th SMW. *M. obtusa* pupal population could be observed from 48th SMW (4 pupae /100 pods), which also increased gradually and attaining a peak on 4th SMW with 47 pupae per 100 pods thereafter declining to 9 pupae in 10th SMW. The pod damage could be observed from 48th SMW (26.00 %) which increased gradually and attained a peak of 81.00 per cent on 3rd SMW, which later declined to 13.00 per cent as observed on 10th SMW. The grain damage due to *M. obtusa* was observed from 48th SMW (15.43 %) which increased gradually to reach a peak on 3rd SMW with 54.34 per cent and started declining to 5.18 per cent as observed on 10th SMW (Table 1). The results obtained in the present investigation in relation to population dynamics of pod fly, *M. obtusa* and its damage on pigeonpea are in conformity with the earlier workers, Pillai and Agnihotri (2013) where in the peak activity was reported during 46th standard week while the population of *M. obtusa* was minimum (31 per 100 pods) during 49th standard week. Similarly, Das and Katyar (1998) reported that the pod fly was first noticed in the 43rd SMW, while maximum pods (16.00 %) infestation with larvae were observed during 5th SMW. The studies of Subharani and Singh (2007) during 2002-04 revealed that the damage commenced at pod filling stage (1.23 and 2.00 %) in the third week of January in both years (2002-03 and 2003-04, respectively). The maximum infestation (15.56 %) of the pest was recorded during third week of February in the first year, whereas it was observed a week earlier, i.e. during second week of February as 13.72 per cent in the second year. Paul *et al*. (2005) reported that 10.00 per cent seed damage from approximately 20.00 per cent pod infestation due to *M. obtusa,* could be considered as the threshold level.

In present investigations, six parasitoid families i.e. Eulophidae, Torymidae, Pteromalidae, Ormyridae, Eurytomidae and Chalcididae emerged from the

Table 1. Population dynamics and natural parasitization level of pod fly, *M. obtusa* in relation to weather parameters

SMW	Rainfall (mm)	Temperature (°C)		Humidity (%)		Damage (%)		Population No. / 100 pods		Parasitization (%)		
		Max.	Min.	AM	PM	Pod	Grain	Larva	Pupa	Larva	Pupa	Total (Larvae + Pupae)
48	0.0	31.3	10.8	80	23	26	15.43	22	4	0.00	0.00	0.00
49	0.0	31.1	9.9	81	25	34	18.24	20	4	0.00	0.00	0.00
50	0.0	29.9	14.8	80	43	40	21.75	34	8	8.82	0.00	4.41
51	0.0	27.3	6.3	74	23	67	38.56	60	37	15.00	2.70	8.85
52	0.0	28.8	8.9	72	24	71	39.36	47	20	27.66	40.00	33.83
1	9.2	27.0	15.1	89	52	74	38.51	59	41	33.90	31.71	32.80
2	0.0	28.3	5.8	76	20	77	45.86	45	31	60.00	51.61	55.81
3	0.0	28.9	10.2	72	29	81	54.34	59	41	54.24	48.78	51.51
4	0.0	31.1	14.1	76	26	61	33.53	41	47	43.90	36.17	40.04
5	0.0	30.8	13.0	71	27	64	43.18	57	41	26.32	24.39	25.35
6	0.0	32.2	14.1	65	27	69	40.51	54	38	14.81	15.79	15.30
7	0.0	33.1	12.3	73	18	60	36.01	30	22	23.33	13.64	18.48
8	0.0	35.0	14.6	66	18	24	12.77	14	9	28.57	11.11	19.84
9	24.3	30.9	15.0	79	38	15	7.98	13	4	7.69	0.00	3.85
10	16.6	33.4	16.0	77	29	13	5.18	2	9	0.00	0.00	0.00

immature stages of the host pod fly, *M. obtusa*. Eulophidae, Torymidae and Pteromalidae families restricted to larval parasitism while Ormyridae, Eurytomidae and Chalcididae families to pupal stage. Earlier report (Yadav *et al*., 2012) revealing the parasitoid-complex of four hymenopteran parasitoids *viz*., larval parasitoid, *Euderus lividus* (Ashmead) (Eulophidae) and pupal parasitoids, *Ormyrus orientalis* (Walker) (Ormyridae), *Eurytoma* sp. (Eurytomidae) and *Pseudotorymus* sp. (Torymidae) is in support of the present finding as the four of six families corroborated. Makinson *et al*. (2005) for the first time reared two parasitoids *viz*., *Callitula* sp. (Hymenoptera: Pteromalidae) and *Ormyrus* sp. (Hymenoptera: Ormyridae) from *M. obtusa* on *Cajanus latisepalus* pods in Australia.

The natural larval parasitization level of pod fly was observed from 50th SMW (8.82 %) which increased gradually to reach a peak on 2nd SMW with 60.00 per cent. The larval parasitization got then declined to nil on 10th SMW. The pupal parasitization level of *M. obtusa* was observed from 51st SMW (2.70 %) which increased gradually and attained a peak on 2nd SMW with 51.61 per cent. The pupal parasitization level was then totally declined as observed on 9th and 10th SMW. The total (larvae + pupae) parasitization level of *M. obtusa* was recorded from 50th SMW (4.41 per cent) which increased gradually and attained peak activity on 2nd SMW with 55.81 per cent and then the parasitization level was totally declined as observed on 10th SMW. The results obtained in the present investigation in relation to natural parasitization of pod fly, *M obtusa* on pigeonpea is in conformity with the earlier workers, Pillai and Agnihotri (2013) wherein peak level of weekly per cent parasitization (18.18 %) was observed during 51st SMW while minimum level of weekly per cent parasitization (6.52 %) was observed during 47th SMW. Similarly, Meena *et al*. (2010) reported maximum parasitization of *M. obtusa* by *Ormyrus* sp. during 14th SW (21.00 %) while, Moudgal *et al*. (2005) reported parasitization range of larval - pupal parasitoid *Euderus lividus* Ashmead and the pupal parasitoid *Eurytoma* sp. on *M. obtusa* from 5.45 to 10.00 per cent and 3.69 to 5.00 per cent, respectively. Durairaj (2005) reported *Ormyrus* sp., *Eurytoma* sp. and *Eupelmus* sp. as pupal parasitoids. A high level of parasitism was recorded in August (87.50 %), followed by May and June. More than 50.00 per cent parasitism was recorded in April, June, September and October while a low level of parasitism (2.50 %) in December.

The simple correlation between larval and pupal population; per cent pod and grain damage; per cent larval, pupal and total (larvae + pupae) parasitization of *M. obtusa* infesting pigeonpea with weather parameters during *Kharif* season 2014-15 indicate negative correlation between larval population of *M. obtusa* with maximum temperature (r = 0.7045). Similarly, pod damage with rainfall and maximum temperature was observed to be moderately negatively correlated (r = -0.5339 and -0.6285). Similarly, grain damage with maximum temperature and rainfall was also found negatively correlated (r = -0.5765 and -0.5490, respectively). The results obtained in the present investigation in relation to simple correlation between *M. obtusa* population and weather parameters is in conformity with the earlier workers, Akhauri *et al*. (1997) where in negative correlation was revealed with minimum temperature (r = -0.270) and relative humidity (r = -0.271), indicating that weather does not play important role in infestation. Similarly, Naresh and Singh (1984) reported a negative correlation between larval and pupal population of pod fly with temperature, having its regression coefficient -0.490 and whereas the pod fly population with relative humidity (r = 0.922), wind velocity (r = 0.354) and rainfall (r = 0.542) indicate positive correlation (Table 2).

The correlation between larval population pupal population; pod damage and grain damage; larval and pupal parasitization of *M. obtusa* infesting pigeonpea indicate positive correlation with coefficient of 0.8534, 0.9276 and 0.9195, respectively. There was a strong positive correlation between pupal population with pod damage and grain damage having its regression coefficient 0.847 and 0.8394, respectively. The correlation between pod with grain damage and pupal parasitization of pod fly exhibited significant correlation with

Table 2. Correlation matrix between larval and pupal population, pod and grain damage, larval, pupal and total (Larvae + Pupae) parasitization of pod fly and weather parameters

	Rainfall (mm)	Temperature (°C)		Humidity (%)		Evapo-ration	Wind Velocity (kmph)
		Max.	Min.	AM	PM		
Larva Population	-0.4768	-0.7045*	-0.3929	-0.1127	0.1528	-0.5363*	0.0147
Pupal Population	-0.3305	-0.453	-0.1697	-0.1873	0.0549	-0.3238	0.1913
Pod Damage	-0.5339*	-0.6285*	-0.4775	-0.158	-0.0145	-0.494	-0.0525
Grain Damage	-0.549*	-0.5765*	-0.4912	-0.238	-0.0787	-0.4055	-0.0395
Larval Parasitization	-0.3251	-0.3647	-0.3184	-0.185	-0.1118	-0.2296	-0.1286
Pupal Parasitization	-0.3169	-0.4409	-0.3452	-0.1421	-0.0691	-0.3564	-0.0931
Total (larvae + pupae) Parasitization	-0.3266	-0.4098	-0.3376	-0.1665	-0.0921	-0.2979	-0.1129

Significant at 5% ; * Negative Moderate Correlation.

Table 3. Correlation matrix among larval and pupal population, per cent pod and grain damage, per cent larval, pupal and total (Larvae + Pupae) parasitization

Para-meters	Population		Damage (%)		Parasitization (%)		
	Larva	Pupa	Pod	Grain	Larva	Pupa	Total
Larva	1	0.8534*	0.9276*	0.9195*	0.5618	0.6129	0.5975
Pupa		1	0.847*	0.8394*	0.6836	0.6802	0.6939
Pod			1	0.982*	0.7252	0.7845*	0.7679*
Grain				1	0.7341	0.7825*	0.7715*
Larval					1	0.9314*	0.9828*
Pupal						1	0.9826*
Total							1

Significant at 5%; *Strong positive correlation

coefficient of 0.982 and 0.7845, respectively, indicating that with availability of food, the population of *M. obtusa* increases leading to more pod and ultimately the grain damage. Moderate positive correlation was observed with larval parasitization (0.7252) indicating such increased population also increases the chances of its parasitization naturally. The correlation between grain damage and pupal parasitization of pod fly showed strong positive correlation having its regression coefficient 0.7825, while moderate positive correlation was observed with larval parasitization (0.7341) indicating that with availability of adequate food, the population of *M. obtusa* increases leading to more chances of parasitization. The correlation between larval parasitization with pupal parasitization shows strong positive correlation with its regression coefficient 0.9314, representing that availability of adequate host increases the level of parasitization (Table 3).

Pod fly, *Melanagromyza obtusa* is a major emerging constraint playing an important role in pigeonpea yield reduction. So far various chemical molecules have been evaluated against this pest, but the significant control is not obtained. Many parasitoids are reported on this pest which plays major role in natural control of this pest with natural parasitization varying from 2.00 per cent to 90.00 per cent. Therefore, even on resistant/ tolerant genotype, the need based use of newer botanical or chemical molecules taking care of the environment as well as the parasitoid complex of this pest cannot be a sole panacea for management of pod fly, but the bioagents can rally round to greater extent if explored properly.

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