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Research Article

Studies on natural enemies associated with pod fly, *Melanagromyza obtusa* (Malloch) (Diptera: Agromyzidae) on pigeonpea and their correlation with weather parameters

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ABSTRACT: The current study shows the presence of two major hymenopteran parasitoids viz., *Euderus lividus* (Ashmead) and *Ormyrus orientalis* (Walker) on the pigeonpea major pest, *Melanagromyza obtusa* (Malloch). The major activity of the pigeonpea pest started with the inception of pod formation and sustained at different levels, throughout the crop's reproductive cycle. The first appearance of *M. obtusa* larvae and pupa was observed in the 41st Standard Meteorological Week (SMW). The maximum larval and pupal populations of 52.00 and 49.00 per 100 pods were noticed in the 44th and 50th SMW. The parasitism level of *E. lividus* and *O. orientalis* declined from 31.82 to 10.53% in the 46th to 52nd SMW and 25.64 to 3.22% in the 47th to 1st SMW. Analysis of the correlation between weather parameters with pod fly larvae and pupae showed that the larval population exhibited a significant positive correlation with maximum temperature (r = 0.646*) while the pupal population showed a non-significant positive correlation with maximum temperature (0.198). These findings provide important insights into the host preferences and effectiveness of these parasitoids, providing essential knowledge for potential use in biological control strategies against agricultural pests.

KEYWORDS: *Melanagromyza obtusa*, parasitoids, pigeonpea, weather parameters

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INTRODUCTION

Pigeonpea (*Cajanus cajan*) (L.) (Millsp.) is the most significant and nutritious pulse. *Cajanus cajan*, sometimes known as pigeonpea (Sarkar *et al*., 2020). Pigeonpea is India's second-most significant pulse crop after gram and contributes to nearly 90% of the world's pigeonpea production. In India, pigeonpea is cultivated in an area of 5.05 million hectares with an annual production of 4.34 million tonnes resulting in an average yield is 859 kg per hectare (Anonymous, 2022). The average yield per hectare was 10.14 quintals per acre in Punjab state (Anonymous, 2023). The pigeonpea crop provides fuel wood and its husk seed provides valuable fodder for milch animals and dried sticks of the pigeonpea plant are also used for making baskets, thatch, fencing and storage bins. Pigeonpea - pea-associated bacteria benefit the soil through symbiotic nitrogen fixation (Pandey, 2017). Pulses are an essential part of the daily diet as they are the cheapest source of proteins, vitamins, energy and minerals. Khamoriya *et al*. (2017) also established that Pigeonpea is a rich source of protein (21.71%) and provides a major part of the protein requirement of the vegetarian population of the country.

However, over the last 20 years, the production of pulses has increased at a much slower pace than that of cereals, oilseeds and other crops. This inclusion of pigeonpeas in crop rotation aims to ensure the long-term preservation of soil health and fertility. Pod fly is an important insect pest of the Pigeonpea crop belonging to the order Diptera (Soni *et al*., 2018). Above all, pigeonpea pods are available in the field from around October to January and at the same time pod fly infestation increases rapidly. The pod fly, scientifically known as *Melanagromyza obtusa* (Malloch) (Diptera: Agromyzidae) is identified as the most obnoxious pest, leading to grain losses ranging from 20 to 80 per cent due to its destructive impact. Pod fly is a widespread and major pest of pigeonpea crop throughout India. The pod fly exclusively infests pigeonpeas along with its related species. Its infestation leads to significant loss of the pods and seeds of pigeonpeas, resulting in reduced germination rate and rendering them unsuitable for human consumption or any other purpose (Hadiya *et al*., 2020). Pod fly oviposition occurs on the inner surface of the pods. Pod flies leave fewer eggs in December and January when temperatures are low. The pod fly population increases with temperature rise (Chiranjeevi

& Patange, 2018). The female pod fly lays up to 80 eggs into maturing green pods. Such pods don't exhibit any visible signs of damage until the larvae emergency and the same causes shot holes in the pod walls upon maturity. Typically, one maggot requires only a single seed for its development (Yadav *et al*., 2016). After hatching, the larva burrows into the pods and feeds upon tender seeds, rendering them unfit for both human consumption and further propagation. The pod fly, being an internal feeder, inhabits both larval and pupal stages within the pod wall, leaving behind a fragile papery membrane. Inside the pod, the larvae consume the developing seeds, followed by pupal development (Patange *et al*., 2017). This perforation serves as an exit point for the adult flies as they emerge from the pod, as described by Kumar *et al*. (2015). The egg phase typically ranges from 3 to 5 days, followed by larval development duration of 6 to 11 days and further the pupal stage extends from 9 to 23 days. Yadav *et al*. (2020) also discovered that adult insects have a lifespan of about 6 days without nourishment, but this extends to 12 days when they are provided with food. Such newly emerged young ones are small and black-coloured. Dry pigeonpea pods exhibit one or more perforations on the upper surface, indicating infestation. Seeds within infested pods appear desiccated, wrinkled, and partially consumed (Sharma & Keval, 2021). Previous workers have established that more than 20 Hymenopteran parasitoids have been recorded on this pest (Sharma, 2007; Yadav & Yadav, 2011). The incidence of parasitism of *M. obtusa* was studied by several workers (Yadav *et al.*, 2010 and 2012). With these background, the present study has been taken up to investigate the parasitoids associated with pigeonpea pod fly in Punjab and their correlation with the weather parameters.

MATERIALS AND METHODS

The experiment was conducted at the Experimental Research Farm of Lovely Professional University, Punjab, India during 2022-2023 in a randomized block design with seven treatments and three replications. The UPAS-120 variety of pigeonpea crops was cultivated in the mid of June with recommended agricultural practices. Pesticides were not applied in experimentation during the cultivation of UPAS-120 pigeonpeas. Plant spacing was 20X90 cm. Insecticide was not applied to protect the crop against natural insect pest infestations. Weekly observations were recorded throughout the growing season spanning from sowing to harvesting. One hundred pods were plucked by selecting 5 plants (at random) at weekly intervals in each replication (Tiwari *et al*., 2006; Yadav & Yadav, 2013). The following formula was used to calculate the percentage of pod damage and the percentage of grain damage (Patange *et al*., 2017).

$$\text{Percent pod / grain damage} = \frac{\text{Number of infected pod / grain}}{\text{Total number of pod / grain}} \times 100$$

The healthy and damaged pods in pigeonpea crops were regularly monitored by dissecting each pod in the laboratory and placing them in glass vials (capacity of 30 ml) covered with muslin cloth. Larvae and pupae collected were kept at room temperature until the emergence of *M. obtusa* and various parasitoids. Several pod fly larvae and pupae within each pod were recorded by Shanker *et al*., (2021). The percentage of pod fly infestation was calculated during the maturity stage. Observational techniques were employed to examine abiotic factors affecting the population dynamics of the pigeonpea pod fly. Correlations between the growth of the population and weather factors during the same period were determined using weekly meteorological data on temperature, relative humidity and rainfall (Tables 1 and 2). It is interesting to note that seed damage by pod flies in all farming systems is higher due to the higher larval population of pod flies because there is no use of toxic insecticides. As a result, the information on parasitoids emerging from the host fly stages (larvae and pupae of *M. obtusa*) was appropriately processed to determine the percentage of parasitism and interpret the results. The following formula was used to find the percentage of parasitism.

$$\text{Per cent larval / pupal parasitization} = \frac{\text{Number of infected larvae / pupae}}{\text{Total number of larvae / pupae}} \times 100$$

$$\text{Per cent total parasitization} = \frac{\text{Number of infected larvae + pupae}}{\text{Total number of larvae + pupae}} \times 100$$

The correlation analysis was also studied to explain the role of the relationship between weather parameters and parasitization.

RESULT AND DISCUSSION

During the Kharif crop season 2022-23, the major pod fly, *M. obtusa* started with the initiation of pod formation and persisted though at different levels, throughout the reproductive stages of the crop. Presence of larval population of *M. obtusa* was noted at 16.00 larvae per 100 pods during the 41st SMW, which increased to a peak of 52.00 larvae per 100 pods by the 44th SMW before declining to 5.00 larvae in the 2nd SMW. A pupal population of *M. obtusa* (10.00 pupae/ 100 pods) was observed from the 41st SMW (Figure 1) which also showed an increasing trend, progressively, peaking at 49.00 pupae per 100 pods on the 50th SMW and then decreased to 8.00 pupae in the 2nd SMW. Damage symptoms occurred at 29.00 per cent on the 41st SMW, increased gradually, peaked at 79.00 per cent on the 46th SMW and subsequently decreased to 17.00 per cent on the 2nd SMW (Table 1). A similar study was also conducted by Pillai and Agnihotri (2013), about the population dynamics

and impact of the pod fly, *M. obtusa* and extent of damage. The larval parasitism level of pod fly was shown from 43rd SMW at 11.76 per cent while larval parasitism increased to peak at 46th SMW with 31.82 per cent. Subsequently, the larval parasitization decreased to 0.00 during the 1st SMW. The level of *M. obtusa* pupal parasitism was identified during the 44th SMW at 9.37 per cent and it increased gradually until reached a peak, i.e., 47th SMW with 25.64 per cent. Along with the decrease in temperature, the percentage of the pupal population also decreases in 1st SMW with 3.22 per cent. The pupal parasitization level was observed nil during the 2nd SMW. The correlation between weather parameters and the proportion of pod damage, as well as the ratios of larval and pupal populations and the quantities of larval and parasitoids infesting pigeonpeas, were also examined. The findings from the data indicate the relationships between these parameters. Damage pods showed a significant positive correlation with maximum temperature (r = 0.550*) and, a non-significant positive correlation with minimum temperature (r = 0.116), on the contrary, a negative correlation with maximum relative humidity, minimum relative humidity and rainfall (r = -0.276, r = -0.360 and r = -0.161). Larval population showed significant positive correlation with maximum temperature (r = 0.646*), non-significant positive correlation with minimum temperature (r = 0.380), negative correlation with maximum relative humidity, minimum relative humidity and rainfall (r = -0.472, r = -0.515 and r = -0.203). The pupal population showed a non-significant positive correlation with maximum temperature (r = 0.198), non-significant negative correlation with minimum temperature (r = -0.370), correlation with maximum relative humidity, minimum relative humidity (r = 0.217 and r = 0.075) and non-significant negative correlation with rainfall (r = -0.140). Larval parasitization showed a non-significant correlation with maximum and minimum temperature (r = 0.313 and r = 0.018), negative non-significant correlation with maximum relative humidity, minimum relative humidity and rainfall (r = -0.186, r = -0.160 and r = -0.049). While Pupal parasitization non-significant correlation with maximum and minimum temperature (r = 0.194 and r = 0.021), a non-significant negative correlation with maximum relative humidity (r = -0.051) and a non-significant correlation with minimum relative humidity (r = 0.003), non-significant negative correlation with rainfall (r = -0.146). Our present study is in agreement with various research workers like Yadav *et al*. (2012) revealing the parasitoids community, including 4.00 species of hymenopteran parasitoids: the larval parasitoid *Euderus lividus* (Ashmead) (Eulophidae) and three pupal parasitoids, *Ormyrus orientalis* (Walker) (Ormyridae), *Eurytoma* sp. (Eurytomidae) and *Pseudotorymus* sp. (Torymidae). This earlier research aligns with our current findings as 2.00 out of the 6 families studied corroborate with our results (Table 3). Makinson *et al*. (2005) conducted the initial rearing of 2.00 parasitoids, namely *Callitula* sp. (Hymenoptera: Pteromalidae) and *Ormyrus* sp. (Hymenoptera: Ormyridae), from *M. obtusa* found on *Cajanus latisepalus* pods in Australia. The current results align with those reported by Dar *et al*. (2005) indicating that *Ormyrus orientalis*, a parasitoid species was identified as the primary parasitoid of the pod fly. The current results partially coincide with the research conducted by Chakravarty *et al*. (2016), where it was shown that *Euderus lividus* and *Ormyrus orientalis* were detected in association with pod flies. The highest natural parasitization rate (31.82% and 25.64%) of *M. obtusa* by these parasitoids occurred during the 46th and 47th SMW periods.

Table 1. Natural hymenopteran parasitization level of *Melanagromyza obtusa* (Malloch) in relation with weather parameters 2022-23

SMW	Pod damage/ 100 pods	Larvae	Pupae	% of Emergence		Temperature (°C)		RH (%)		Rainfall (mm)
				E. lividus	*O. orientalis*	Max.	Min.	Max.	Min.	
41	29	16	10	0.00	0.00	32	23	59	43	0
42	42	27	28	0.00	0.00	31	20	56	46	0
43	56	34	30	11.76	0.00	29	18	53	43	0
44	78	52	32	17.31	9.37	34	19	56	42	0
45	69	47	28	25.53	17.86	24	18	59	49	0.2
46	79	44	41	31.82	21.95	28	13	52	47	0
47	72	48	39	22.91	25.64	28	19	81	76	0
48	65	36	42	25.00	21.43	25	11	89	77	0
49	70	41	45	12.19	13.33	26	9	89	61	0
50	68	32	49	18.75	8.16	25	10	97	65	0
51	57	22	46	13.64	4.35	24	9	90	79	0
52	43	19	27	10.53	3.70	21	9	98	88	2
1	31	11	31	0.00	3.22	12	6	98	86	0
2	17	5	8	0.00	0.00	12	10	94	86	0

Table 2. Correlation between the population of pod flies with weather parameters

Correlation factor	Temperature (°C)		RH (%)		Rainfall (mm)
	Max.	Min.	Max.	Min.	
Damage Pods	0.550*	0.116NS	-0.276NS	-0.360NS	-0.161NS
Larvae	0.646*	0.380NS	-0.472NS	-0.515NS	-0.203NS
Pupae	0.198NS	-0.370NS	0.217NS	0.075NS	-0.140NS
E. lividus	0.313NS	0.018NS	-0.186NS	-0.160NS	-0.049NS
O. orientalis	0.194NS	0.021NS	-0.051NS	0.003NS	-0.146NS

Table 3. Parasitoids recorded on pod fly, *Melanagromyza obtusa* in pigeonpea

S. No.	Species	Family	Order	Attack of Stage
1.	*Euderus lividus* (Ashmead)	Eulophidae	Hymenoptera	Larvae
2.	*Ormyrus orientalis* (Walker)	Ormyridae	Hymenoptera	Pupae

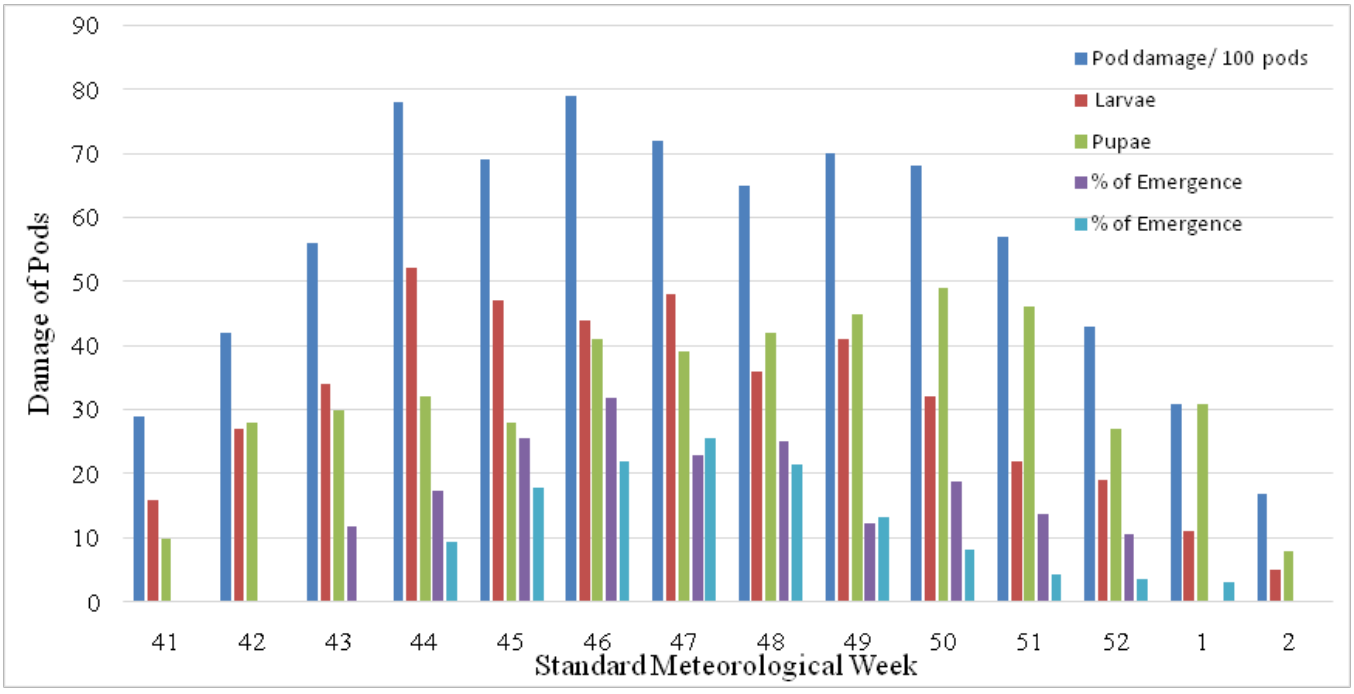


Figure 1. Chart of the percentage of natural parasitization on pod fly.

CONCLUSION

It is concluded that the emergence of two parasitoids of *M. obtusa* (Malloch) viz., *Euderus lividus* (Ashmead) and *Ormyrus orientalis* (Walker) were effective in reducing population to the extent of 31.82% and 25.64%, respectively as natural parasitization. The studies have revealed eco-friendly management of the pigeonpea pod fly by the naturally occurring hymenopteran parasitoids.

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