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The Incidence of Pod Fly, *Melanagromyza obtusa* (Malloch) (Diptera : Agromyzidae) in Major Pigeonpea Growing Areas of Southern Karnataka and its Biology on Pigeonpea, *Cajanus cajan* (L.) Millsp.

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ABSTRACT

Pod fly, *Melanagromyza obtusa* (Malloch) is one among the economically important pests on pigeonpea and is responsible for major yield losses. Field survey carried out in different pigeonpea fields during 2020-21 revealed that, the severity of pod fly infestation varied across the locations as well as on different varieties of pigeonpea. Of different locations surveyed around Bengaluru for pod fly infestation, the highest pod damage (92%) and grain damage (65.22%) was recorded from the pigeonpea fields at Honnayyanapalya village, Magadi taluk, Ramanagara district, while minimum pod damage (18%) and grain damage (7.45%) were recorded from pods sampled from Basavapura village of Gowribidanur taluk, Chikkaballapur district. From survey studies, it was also found that, pigeonpea variety BRG 2 was highly susceptible to pod fly infestation and recorded the highest mean pod damage (42.57%) and grain damage (25.13%) followed by local varieties grown by the farmers. Studies on the biology of pod fly revealed that, the incubation period ranged from 2 to 4 days with an average of 2.75 ± 0.14 days. There were three maggot stages with a total mean duration of 9.5 days. The mean pupal duration was 9.15 ± 0.36 days. The average female and male fly longevity were 5.9 ± 0.32 and 3.45 ± 0.25 days, respectively. The lifecycle of adults was completed in 27.89 ± 0.64 days in case of females and 25.44 ± 0.51 days in case of males.

Keywords : Pigeonpea, Pod fly, *Melanagromyza obtusa*, Survey, Pod damage, Grain damage

THE cultivation of pigeonpea dates back to 3,500 years. It is assumed that eastern part of peninsular India is the centre of origin of this crop. It is an important pulse crop of tropics and subtropics, cultivated in around 50 countries across Asia, Africa and America. Pigeonpea can be grown in a varied range of agro-ecological situations. Because of its ability to fix nitrogen to the soil and drought tolerant capacity, this crop can be successfully raised in a wide range of soil types. The crop is capable of producing reasonable quantities of yield even in degraded soils with minimal external inputs.

Pigeonpea is attacked by a large number of insect pests (more than 300 species) during its different growth stages, from seedling to harvesting stage. However, the most damaging pests of this crop are pod-borers which attack the reproductive parts of the plant. Amongst the pod borers, the pod fly, *M. obtusa* causes severe yield losses in pigeonpea. There are no obvious external visible symptoms of pod fly damage in pigeonpea. All the immature stages remain within the developing pod.

The fully grown maggots chew the holes in the pod walls leaving a 'window' through which the adult flies emerge from the pupae in the pod. The concealed feeding habit of pod fly causes more loss and farmers cannot notice the infestation and fail to take up timely management practices. As a result, pod fly is becoming

an emerging constraint in pigeonpea production. The grain yield losses due to pod fly have been reported in the range of 60-80 per cent (Durairaj, 1995) with mean pod damage and grain damage of 21 to 38.50 per cent and 12.29 to 19.87 per cent, respectively (Khan *et al*., 2014). Hence, understanding the biology of pod fly will provide relevant insights in planning efficient management techniques.

Material and Methods

The survey studies on pod fly, *M. obtusa* on pigeonpea were carried out in the farmers' fields located in and around the districts of Bengaluru (Ramanagara, Chikkaballapur and Bengaluru Rural district) during 2020-21 as major pigeonpea area is in this part of Southren Karnataka. Sampling for pod fly infestation was done based on random selection of pigeonpea plants in the fields of selected villages of different districts. From each pigeonpea field, a total of hundred pods were randomly sampled and collected in the polyethylene covers. The polyethylene covers were labelled properly and brought to the lab. In the lab, the sampled pigeonpea pods were carefully observed for the presence of window holes or pin holes (Fig. 1)

Fig. 1: Pods showing external symptoms of pod fly infestation

as an external symptom of pod fly attack. The destructive sampling was done to observe characteristic tunnelling symptoms on seeds as a result of feeding by maggots (Fig. 2) and data were recorded.

The pod fly pupae collected during destructive sampling of field samples from different areas were

Fig. 2 : Pod fly infestation symptoms; A. Infested seeds with maggots and pupae; B. Tunnelling on seeds

kept in individual Petri plates and placed in plastic boxes with lids having mesh for adult emergence. The emerged adult flies were cured and were pinned using micro pins with proper labelling including date of collection and locality. Along with adult pod flies, the natural enemies emerged, if any were also collected and preserved in 70 per cent ethyl alcohol and were later identified by the taxonomist Dr. J. Poorani, Principal Scientist, ICAR-NRCB (National Research Centre for Banana), Trichy, Tamil Nadu (Fig. 3).

Fig. 3: Parasitized maggot of pod fly, *M. obtusa*

Taxonomic identification of pod flies was done at ICAR-NBAIR, Bengaluru with the help of Dr. David, K. J., Scientist (Entomology). For identification of the specimen up to species level, abdomen of adult male was separated carefully using sterile forceps under microscope and put in to the test tube containing 10 per cent KOH and placed in boiling water for 3 minutes for chitin digestion. Later the specimen abdomen was carefully transferred to acetic acid to stop further digestion. After serial dehydration with absolute ethanol (70, 80 & 90%), dissection was done carefully by placing the specimen abdomen in glycerol to examine male phallic complex.

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During the survey, from each field, one hundred pod samples were randomly collected along with details of village, variety, area under pigeonpea etc. from the selected farmers using the questionnaire. Later the survey data were compiled to record the extent of damage by pigeonpea pod fly at different locations.

Pod damage : The data on damaged and healthy pods from the collected samples was recorded and the per cent pod damage was calculated using the formula,

$$\text{Pod damage (\%)} = \frac{\text{Number of pod fly damaged pods}}{\text{Total number of pods observed}} \times 100$$

Grain damage **:** The total number of damaged grains in 100 pods was counted and per cent grain damage was calculated using the formula,

$$\text{Grain damage (\%)} = \frac{\text{Number of pod fly damaged grains}}{\text{Total number of grains from 100 pods}} \times 100$$

Studies on the biology of pod fly, *M. obtusa* were carried out on pigeonpea (Var. BRG 3) under laboratory conditions during 2020-21 at the Zonal Agricultural Research Station (ZARS), GKVK, Bengaluru. Field collected pupae of pod fly*, M. obtusa* were kept in a plastic container provided with lids having mesh for adult emergence. Five pairs of newly emerged adults (same day) were released into oviposition cages and were provided with cotton swabs soaked in 5 per cent sucrose solution as feed. In oviposition cages (30 cm × 30 cm × 30 cm), fresh, healthy twigs of host plant with tender pods were maintained in conical flasks (250 ml) with water for females to oviposit on the pods. Oviposition was ascertained by dissecting the pods.

Observations were taken at 12 hr intervals (12, 24, 36, 48, 60, 72 and 84 hr) to record incubation period of eggs. The larvae were observed continuously to record the duration of total larval and pre-pupal periods. The pupa of pod fly formed inside the pods were kept in the petriplates and then placed inside rearing cages for observation of pupal period. By examining the genetalia, the emerged adults were separated and the duration (days) from adult emergence to adult mortality was noted separately for males and females.

Results and Discussion

During the survey, it was found that BRG 1 was grown in patches whereas, BRG 2 was the more predominant variety grown in the surveyed areas in addition to the local varieties. In Magadi taluk of Ramanagara district, a total of seven pigeonpea fields in seven different villages were studied for pod fly infestation and found that pod infestation ranged from 21 to 92 per cent with mean pod infestation of 52.71 per cent (Table 1). Whereas, the per cent grain damage due to pod fly infestation ranged from 8.77 to 65.22 per cent with mean damage of 31.60 per cent. A total of six pigeonpea fields in six different villages were surveyed for pod fly infestation in Doddaballapur taluk of Bengaluru rural district. It was found that, the per cent pod damage due to pod fly infestation ranged from 23 to 46 per cent with average infestation of 35 per cent. However, the per cent grain damage due to pod fly ranged from 13.62 to 22.89 per cent with an average of 16.59 per cent. In Gowribidanur taluk of Chikkaballapur district, four pigeonpea fields were surveyed in four villages where most of the farmers grow local varieties. The per cent pod and grain damage due to pod fly infestation among the fields surveyed ranged from 18 to 42 per cent and 7.45 to 22.89 per cent, respectively. The per cent pod and grain damage due to *M. obtusa* attack varied from genotype to genotype grown at different locations. From the survey results it was found that BRG 2 was the highly susceptible genotype to pod fly (known as *'Kuttehulu'* by many farmers in vernacular language) attack with the highest mean per cent pod damage (42.57±8.42) and grain damage (25.13±6.05) followed by other varieties grown in the region (Table 2). This may be due to some farmers are going for late sowing of crop due to delay in monsoon rains, which coincides with the maximum pest activity in later stages of the crop and also some ratoon crops which left over on the bunds or nearby fields might serve as a source for the offseason survival of *M. obtusa*. Moreover, many farmers are not giving much importance for weed management in pigeonpea crop as a result it may also

TABLE 1

Details of pigeonpea fields surveyed for the incidence of pod fly, *M. obtusa* and damage levels recorded

District	Taluk	Village	Variety	Area (acres)	% pod infestation	% grain infestation
Ramanagara	Magadi	Basavenahalli	BRG 2	0.25	52	30.83
		Pemmanahalli	BRG 1	0.50	48	28.82
		Kambegowdanapalya	Local	1.00	22	11.79
		Hosahalli	BRG 2	1.00	32	17.32
		Marikuppe	BRG 2	1.00	87	59.06
		Honnayyanapalya	Local	0.50	92	65.22
		Hosur	Local	1.25	21	8.77
				Range	21-92%	8.77-65.22%
				Mean	52.71	31.60
Bengaluru Rural	Doddaballapura	Subraya Nagenahalli	BRG 2	1.00	28	13.93
		Mugachinnenahalli	BRG 2	2.00	34	16.43
		Melinajuganahalli	Local	0.50	46	17.21
		Kondapura	BRG 1	1.25	41	22.89
		Kothur	Local	0.50	38	13.62
		Hadonahalli	BRG 2	1.00	23	15.48
				Range	23-46%	13.62-22.89%
				Mean	35.00	16.59
Chikkaballapur	Gowribidanur	Kallinaikanahalli	BRG 2	0.50	42	22.89
		Doddamallekere	BRG 1	1.50	29	9.59
		Basavapura	Local	1.00	18	7.45
		Kambalahalli	Local	0.50	21	11.09
				Range	18-42%	7.45-22.89%
				Mean	27.50	12.76

act as a main reason for carryover of pest to next season. For example, a common weed like *Rhynchosia minima* will aid in offseason survival of pod fly. Additionally, Farmers are not taking up timely management practices with effective chemicals against pod fly. Because of this they may fail to check the pod fly infestation in the earlier stage itself which may end up with increased infestation of pod fly over a period.

Taxonomic identification of the adult flies collected from different survey locations revealed that, emerged adult flies belonged to the single species, *i.e., Melanagromyza obtusa* (Fig. 4). Adult fly is a small,

TABLE 2

Pod infestation observed in different pigeonpea varieties during survey

Genotype	Per cent pod damage			Per cent grain damage		
	Minimum	Maximum	Mean ± SE	Minimum	Maximum	Mean ± SE
Local	18	92	36.86 ± 9.99	7.45	65.22	19.31 ± 7.74
BRG 1	29	48	39.33 ± 5.55	9.59	28.82	20.43 ± 5.69
BRG 2	23	87	42.57 ± 8.42	13.93	59.06	25.13 ± 6.05

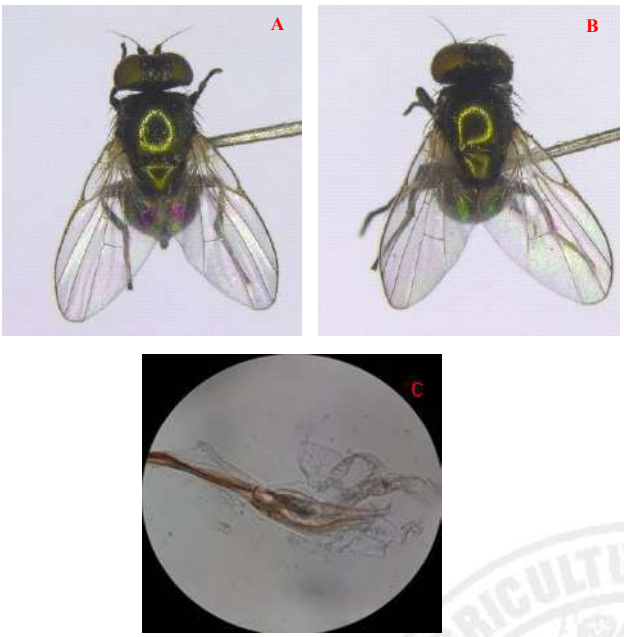

Fig. 4: Adult pod fly, *M. obtusa*; A. Female; B. Male; C. Phallic complex of male

shinning and metallic blue or black in colour. Though similar colouration was observed both in male and females, the eyes were indistinctly pubescent and the orbits had more distinct short hairs in female than in the male (Subharani and Singh, 2009). Ocellar triangle was green, well developed, anteriorly limiting with broader margin of the lunule and with its anterior edge blunt and flat. Wings were hyaline and measured 2.4 to 2.8 mm. Hypandrium and aedeagal apodeme appeared very long. Projection at the tip of epandrium rounded, with long hairs, aedeagus hyaline basiphallus with unusual long side arms, which were extending up to the distiphallus, with dorsal bridge of basiphallus seemed to be missing (Alava *et al*., 2016).

The parasitoids collected from the pod fly were identified as *Ormyrus orientalis* Walker (Ormyridae), *Eurytoma* sp. (Eurytomidae) and *Euderus* sp. (Eulophidae) by the taxonomist Dr. Poorani (Fig. 5). Similar reports of these hymenopteran parasitoids were earlier made by Chiranjeevi and Patange (2017).

The biology of pod fly, *M. obtusa* was studied for three generations under laboratory condition at the Zonal Agricultural Research Station, University of

Fig. 5 : Parasitoids collected from the pod fly infested pods sampled from various pigeonpea fields; A & B. *Ormyrus orientalis* Walker (Ormyridae); C. *Eurytoma* sp. (Eurytomidae); D. *Eurytoma* sp. (Eurytomidae); E. *Euderus* sp. (Eulophidae); F. *Euderus* sp. (Eulophidae)

Agricultural Sciences, GKVK, Bengaluru. The results of the pooled data on duration and morphometrics of different developmental stages of pod fly are given in Table 3 & 4 and Fig. 6.

Fig. 6 : Different developmental stages of pod fly, *M. obtusa* in pigeonpea; A. Egg; B. Maggot; C. Final instar maggot chewing pod wall; D. Prepupa; E. Pupa; F. Adult

TABLE 3

The biology of *M. obtusa* under laboratory conditions

Stage of insect		Sample size (n)	Duration (days)		
			Minimum	Maximum	Average ± S.Em
Egg	Incubation period	20	2	4	2.75 ± 0.14
Maggot			20	2	57.35 ± 0.18
Pre-pupa		20	0.3	1.2	0.59 ± 0.05
Pupa		20	7	12	9.15 ± 0.36
Adult longevity	Male	20	2	5	3.45 ± 0.25
	Female		20	3	85.9 ± 0.32
Total life cycle	Male		20	20.5	30.9 25.44 ± 0.51
	Female	20	23.4	32.9	27.89 ± 0.64

TABLE 4

Morphometrics of different developmental stages of pod fly, *M. obtusa* on pigeonpea

Insect stage		Length (mm)	Breadth (mm)
Egg		0.92 ± 0.02	0.13 ± 0.01
Maggot	III Instar	2.65 ± 0.07	1.34 ± 0.09
Prepupa		2.88 ± 0.06	1.29 ± 0.02
Pupa		2.62 ± 0.07	1.24 ± 0.02
Adult	Male	2.74 ± 0.05	1.15 ± 0.02
	Female	2.95 ± 0.03	1.37 ± 0.02

Eggs

Freshly laid eggs were glistening white in colour, smooth, tapering posteriorly and projecting into the pod cavity, with the pointed process was filled with a transparent fluid. The estimated incubation period ranged from 2 to 4 days with an average of 2.75 ± 0.14 days. Adult females preferred to lay eggs in partially matured pods rather than too young or fully matured pods. The average length and breadth of eggs were 0.92 ± 0.02 mm and 0.13 ± 0.01 mm, respectively. The results related to pod fly egg incubation period are in accordance with earlier worker Ahmad (1938), who reported that the egg stage requires 3.0 to 9.0 days which depend upon weather conditions. While, Ipe (1974) observed that the average incubation period of the eggs to be 2.35 days.

Maggots

The freshly eclosed maggots were transparent, glistening white in colour and later turned to creamy white and had three instars with total duration of 7.35 ± 0.18 days. Just after hatching, maggots were found to feed on the surface of tender seeds and then they started to feed under the epidermis of the seed. The second and third instar maggots were cylindrical, creamy white in colour and they drilled deep into the seed. The final instar maggots measured 2.65 ± 0.07 mm and 1.34 ± 0.09 mm in length and breadth, respectively. The results of the present investigation on total duration of maggot period are in agreement with that of Ahmad (1938), who reported that total maggot development period requires 6.0 to 11.0 days. Similar reports were reported by Subharani and Singh (2009) wherein three larval instars were observed which took 7.75 ± 0.53 days to enter into the pupal stage.

Prepupal and Pupal Stage

Fully grown maggot transformed into pupae inside the pod after passing through the prepupal stage of about 0.59 ± 0.05 days. The pupae were light brownish to dark brownish in colour, cylindrical and having a pair of prominently projecting posterior spiracles that were joined basally. The mean pupal duration was about 9.15 ± 0.36 days and measured 2.62 ± 0.07 mm and 1.24 ± 0.02 mm in length and breadth, respectively. The pupal stage was comparatively quite longer than that of the egg or the maggot stage *i.e.,*

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pupal development remained slower. Lal and Katti (1997) reported that the pupal period of *M. obtusa* ranged from 8.0 to 31.0 days. Under field conditions, the pupal stage lasts for 9 to 23 days as reported by Shanower *et al.* (1999).

Adults

The adult fly was small, shining with metallic green or blue in colour. Adult emergence from the pupae usually took place in the morning hours. Adult longevity on an average was 3.45 ± 0.25 days in case of males whereas, it was 5.9 ± 0.32 days in case of females. Adult males were relatively smaller than females. The mean length and breadth of male fly was 2.74 ± 0.05 mm and 1.15 ± 0.02 mm, respectively whereas, female fly length and breadth were 2.95 ± 0.03 mm and 1.37 ± 0.02 mm, respectively. Subharani and Singh (2009) reported that the adult longevity on an average lasted for 5.72 ± 0.28 days. Total life cycle was completed in 25.44 ± 0.51 days in males and 27.89 ± 0.64 days in females. These results are also in agreement with the findings of Kumar *et al*. (2018) who reported that *M. obtusa* was found to complete its life cycle from egg to adult in 23 to 30 days with an average of 25.84 days in case of males and 28.31 days in case of females. The incubation period, larval period, prepupal period and pupal period lasted for about 2.33, 7.46, 0.71 and 12.27 days, respectively.

Adult longevity was 3.06 days in case of males whereas, it was 5.53 days in case of females.

From the present study, it is concluded that the change in weather conditions greatly influence on duration of various stages of *M. obtusa*. Further the per cent pod and grain damage due to pod fly depends on crop sowing. Late sowing of crop due to delay in monsoon rains, coincided with the maximum pest activity in later stages of the crop experiencing high grain damage due to pod fly.

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