Journal of Entomology and Zoology Studies
Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2019; 7(4): 452-455

Received: 10-05-2019
Accepted: 13-06-2019

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Effect of spraying schedules on grain damage, by *Melanagromyza obtusa* (Malloch) on different varieties of pigeon pea

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Abstract
The studies on management of pod borer complex on four different cultivars of pigeon pea was worked out in split plot design during *Kharif*-2017-18 and *Kharif*-2018-19 with two consecutive sprays of emamectin benzoate 5% SG @ 4.4 gm followed by flubendiamide 39.3% SC @ 3.9 ml/10 lit. of water at 15 days interval were taken at various crop growth stages. Four cultivars of pigeon pea *viz*., BDN-711 (early), BSMR-736 (late), BSMR-853 (late) and BSMR-716 (mid-late) were observed under field condition. The results revealed that in variety BDN-711 the least per cent grain damage by *M. obtuse* was found 17.85 and 19.28, respectively as compared to other varieties. Whereas, the least per cent grain damage was found when crop was sprayed at pod formation stage 15.25 and 17.58, respectively as compared to other maturity stage of the crop and noted that pod formation stage is most important stage to minimize pod fly infestation during both the years.

Keywords: Different cultivars, pigeon pea, *M. obtuse,* different maturity stage, emamectin benzoate, flubendiamide

Introduction
Pigeon pea (*Cajanas cajan* (L) Millsp.) cultivated in more than 25 countries of the world on 4.59 million hectares areas with production of 3.28 million tons annually. Leading pigeon pea growing states are Maharashtra, Uttar Pradesh, Madhya Pradesh, Bihar, West Bengal, Karnataka, Andhra Pradesh, Gujarat and Tamil Nadu. In Maharashtra, during 2016-17, it was grown on an area of 14.35 lakh ha, production 1495.75 lakh tons and productivity was 1042 kg per hectare. (Annon. 2017) [1].
The pod fly, *Melanagromyza obtusa*, Malloch (Diptera: Agromyzidae) is small black fly, lay eggs through the wall of young pods and it causes according to Yadav and Chaudhary (1993) [8] around 14 and 10 per cent damage to medium to long duration varieties. Partially matured pods are preferred for egg laying than the tender or fully matured pods. All the immature stages remain within the developing pods and are very difficult to monitor without dissecting the pods. More damage is seen during pod maturing and pod filling stage. These varieties have different flowering periods which is most vulnerable stage of crop to pod fly attack. Therefore, a common recommendation regarding stage of crop and pest management cannot satisfy the demand of optimum yield. Hence an attempt was made to find out the most effective time of spraying in respect to crop stage that can provide satisfactory pest control.

Resources and Materials
The field experiment was conducted during *Kharif* 2017-18 and *Kharif* 2018-19 at the Experimental Farm of Department of Agricultural Entomology, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani (MH) in split plot design with three replications on four different varieties of pigeon pea BDN- 711, BSMR- 716, BSMR-736 with spacing of 120 cm x 30 cm.

Experimental Detail

1.	Year and Season	:	*Kharif*-2017-18, and *Kharif* -2018-19.
2.	Name of crop	:	Pigeon pea
3.	Varieties	:	BDN-711 (Early), BSMR-736 (Late), BSMR-853 (Late) and BSMR-716 (Mid-late).
4.	Design	:	Split plot Design

5. Spacing : 120 cm × 30 cm
6. Net plot size : 4.8 m × 4.2 m
7. No. of treatments : 06
8. Replication : 03
9. Number of plots : 72
10. Date of sowing : 16/06/2017 (1st year) and 20/06/2018 (2nd year)

Treatment details

Spray No.	Name of Insecticides	Concentration (%)	Dose /10 litre of water
1st	Emamectin benzoate 5% SG	0.0022	4.4 g
2nd	Flubendiamide 39.3% SC	0.0078	3.9 ml

Main plot treatment: Varieties
V1- BDN-711 (Early), V2 - BSMR-736 (Late) V3 -BSMR - 853 (Late) and V4 - BSMR-716 (Mid late),

Sub plot treatments: (Crop growth stages)
T_1 : 1st spray at bud initiation stage followed by 2nd spray after 15 days
T_2 : 1st spray at 50% bud formation stage followed by 2nd spray after 15 days
T_3 :1st spray at flower initiation stage followed by 2nd spray after 15 days
T_4 : 1st spray at 10% flowering stage followed by 2nd spray after 15 days
T_5 : 1st spray at 50% flowering stage followed by 2nd spray after 15 days
T_6 : 1st spray at pod formation stage followed by 2nd spray after 15 days

Method of recording observations
At the time of harvesting, hundred pods from five randomly selected plants was collected from each plot, threshed and weighed separately to study the extent of grain damage by *M. obtusa* in different treatments after 1st and 2nd spray.
The per cent grain damage was calculated by using following formula:

$$\% \text{ grain damage} = \frac{\text{Number of infested grains}}{\text{Total number of grains}} \times 100$$

The data obtained in insect numbers were subjected to poison formula $\sqrt{X+0.5}$ before further analysis. The analysis of pooled data was carried out to ascertain effect of different spraying dates on management of pod borer complex of pigeon pea and their effect on natural enemies of pod borer complex. Appropriate statistical methods were employed to work out standard error (SE) and critical difference (CD) to know the significance of treatments (Gomez and Gomez, 1984) [2].

Results and Discussin
Effect of different varieties and spray schedules on grain damage by *M. obtusa* during 2017-18
Data pertaining to the effect of different dates of spraying on management of *M. obtusa* are presented in Table 1.

Varietal performance
The data during *Kharif*-2017-18 showed that there was a non-significant difference among different varieties tested with respect to per cent grain damage done by *M. obtusa*. However, least grain damage of 17.85 per cent was observed in variety V_1- BDN-711 and highest 20.22 per cent was observed in variety V_2 - BSMR-736 and maximum yield obtained in BSMR-736 (2380.22 kg/ha) followed by BSMR-716 (2009.44 kg/ha), BSMR-853 (1955.00 kg/ha), and BDN-711 (1835.61 kg/ha). During *Kharif*-2018-19 data showed that there was a non-significant difference among different genotypes However, least grain damage of 19.28 per cent was observed in variety V_1- BDN-711 and highest 24.78 per cent was observed in variety V_2-BSMR-736 and yield obtained per hectare numerically showed that maximum yield was recorded in BSMR-736 (1736.11 kg/ha) followed by BSMR-853 (1359.56 kg/ha), BSMR-716 (1354.39 kg/ha) and minimum recorded in BDN-711 (882.33 kg/ha). Whereas, the pooled data also showed that there was a non-significant difference among different genotypes tested with respect to per cent grain damage. The least grain damage of 18.53 per cent was observed in variety V_1- BDN-711 and highest 22.50 per cent was observed in variety V_2 - BSMR-736 and maximum yield obtained in BSMR-736 (1872.33 kg/ha) followed by BSMR-853 (1688.67 kg/ha), BSMR-716 (1654.69 kg/ha) and minimum recorded in BDN-711 (1358.97 kg/ha).

Effect of crop growth stages
During *Kharif*-2017-18 the spraying schedules significantly influenced the per cent grain damage by *M. obtusa*. The least grain damage of 15.25 per cent was observed when crop was sprayed at pod formation stage and highest 22.67 per cent at 50% flowering stage. Maximum yield was obtained when treatment were administered at T_6-pod formation stage (2232.50 kg/ha). *Kharif*-2018-19 concluded spraying schedules influenced the per cent grain damage by *M. obtusa*. However, least grain damage 17.58 per cent was observed when crop was sprayed at pod formation stage and highest 24.75 per cent was observed at 50% flowering stage. Maximum yield was obtained when treatment were applied at T_6-pod formation stage (1875.00 kg/ha) and minimum when crop was sprayed at T_1-bud initiation stage (937.67 kg/ha). Pooled (2017-18 and 2018-19) data showed the least grain damage of 16.42 per cent was observed when crop was sprayed at pod formation stage and highest grain damage of 23.71 per cent was observed at 50% flowering stage and maximum yield was obtained when treatment were administered at pod formation stage (2053.75 kg/ha) and minimum when crop was sprayed at bud initiation stage (1396.71 kg/ha).

Interaction effect
The data from Table 1 showed that non-significant interaction between variety and spray schedule was noted against *M. obtusa*.
The reviews regarding effect of spraying dates applied at various crop growth stages and there interaction effect against

M. Obtuse are quite scanty since this is a new affect to study in entomological research. The work done and reviews reported by earlier worker regarding parallel issues are being presented here. Wadaskar *et al.* (2013) [7] represented that minimum per cent pod damage by pod fly was recorded with the application of emamectin benzoate 5 SG @ 0.3g/l and endosulfan 35 EC @ 2.0ml/l (6.2%). Whereas, application of emamectin benzoate 5 SG @ 0.3g/l, rynaxypyr 20 SC @ 0.25 ml/l and spinosad 45 SC @ 0.3ml/l potentially restricted grain damage due to pod fly to 4.2, 5.0 and 5.8 per cent, respectively. The grain yield data statistically similar with rynaxypyr 20 SC @ 0.25 ml/l and flubendiamide 20 WDG @ 0.5 g/l to translate in higher yield of 13.4 and 13.3 q per ha, respectively. Srujana and keval (2013) [6] revealed per cent pod damage by pod fly was minimum is thimethoxam 25 WG @ 75 g a.i. /ha treated plot and next to this fipronil 25 EC @ 8 g a.i. /ha and gave lowest per cent grain damage followed when crop sprayed first at 50% flowering and second after 15 days interval. Srinivasan and Durairaj (2007) [5] revealed that the grain damage due to pod fly was lowest in monocrotophos 36 WSC @ 270 g a.i/ha followed by bifenthrin 10 EC (25.6%) with highest grain yield recorded in bifenthrin treated plots (925.6 kg/ha) followed by indoxacarb (864.0 kg/ha) and spinosad 45 SC @ 73 g a.i/ha (841.1 kg/ha) as against the minimum yield of 432.7 kg/ha in the untreated control when three rounds of spray gives starting from 50 per cent flowering stage. Sharma *et al.* (2011) [3] represented that emamectin benzoate 5 SG in combination with acetamiprid 20 SP or dimethoate 20 EC gave higher rain yield of 1399 and 1392 kg/ha and lowest grain damage 13.30 and 11.95 per cent. Keval *et al.* (2016) recorded lowest pod and grain damage plot treated with spinosad 45% SC @ 73 g a. i./ha (22.66 & 23.00% and 11.55 & 7.74%, respectively) when crop first sprayed at 50% flowering and subsequent sprays were applied at 15 days interval. Shinde *et al.* (2017) [4] revealed that treatment V_1 (BDN-711) has minimum damaged grains 18.97% followed by V_2 BSMR-716 (19.07%) and V_3-BSMR-736 (19.99%) treated at pod formation stage followed by 10% flowering stage, flower initiation stage, 50% bud initiation stage and bud formation stage. However interaction effect found to be non-significant.

Table 1: Grain damage and yield (kg/ha) obtained in different varieties of pigeon pea during *Kharif*-2017-18, *Kharif*-2019-18 and pooled (2017-18 and 2018-19)

Treatment	2017-18			2018-19			Pooled		
	Grain damage (%)	**Yield (Kg/ plot)**	**Yield (Kg/ ha)**	**Grain damage (%)**	**Yield (Kg/ plot)**	**Yield (Kg/ ha)**	**Grain damage (%)**	**Yield (Kg/ plot)**	**Yield (Kg/ ha)**
A. Main treatment: Variety									
V_1-BDN-711	17.85 (24.99)*	3.70	1835.61	19.28 (26.04)	1.78	882.33	18.56 (25.52)	2.74	1358.97
V_2- BSMR-736	20.22 (26.72)	4.80	2380.22	24.78 (29.85)	3.50	1736.11	22.50 (28.32)	3.76	1872.33
V_3- BSMR-853	18.33 (25.35)	4.05	2009.44	20.67 (27.04)	2.74	1359.56	19.44 (26.17)	3.39	1688.67
V_4- BSMR-716	18.72 (25.64)	3.94	1955.00	20.22 (26.72)	2.73	1354.39	19.47 (26.19)	3.36	1654.69
S.E. ±	0.54	1.22	573.67	0.62	0.92	398.66	0.57	1.03	481.04
CD at 5%	**NS**	3.58	1682.62	**NS**	2.70	1169.31	**NS**	3.02	1410.94
B. Sub plot treatment: Spray schedule									
T_1- Bud initiation stage	18.25 (25.29)	3.74	1855.75	19.92 (26.51)	1.79	937.67	19.08 25.90	2.76	1396.71
T_2- 50% bud formation stage	19.33 (26.08)	4.08	1858.75	23.67 (29.11)	2.25	1116.67	21.50 (27.62)	3.17	1570.42
T_3- Flower initiation stage	18.36 (35.37)	4.00	1984.17	18.92 (25.78)	2.33	1156.67	18.56 (25.52)	3.21	1576.67
T_4- 10% flowering stage	18.83 (25.72)	4.17	2065.75	22.58 (28.37)	2.92	1447.00	20.71 (27.07)	3.54	1756.38
T_5- 50% flowering stage	22.67 (28.43)	4.25	2108.08	24.75 (29.83)	3.00	1465.58	23.71 (29.14)	3.63	1786.83
T_6- Pod formation stage	15.25 (22.99)	4.50	2232.50	17.58 (24.79)	3.83	1875.00	16.42 (23.90)	3.58	2053.75
S.E. ±	0.66	1.49	702.60	0.76	1.13	488.26	0.70	1.26	589.15
CD at 5%	1.92	4.38	2060.78	2.22	3.31	1432.11	2.06	3.69	1728.04
C. Interaction (V X T)									
S.E. ±	13.11	2.99	1405.20	15.11	2.26	976.52	14.02	2.52	1178.31
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS
*Figures in parentheses are angular transformed values									

Conclusion

In pigeon pea varieties BDN-711, BSMR-736, BSMR-853 and BSMR-716 least per cent grain damage was observed when spraying taken at pod formation stage. The precise conclusion from above study can be made in such a way that varieties having different duration have to be protected at its different growth stages. Now a day's most of the farmers are following the spray schedule of 1st spray at 50% flowering stage followed by second spray at 15 days interval, to manage pod borer complex of pigeon pea. In the present investigation it was clearly observed that this recommendation does not satisfy the pest management strategies for all varieties having early and late duration and more studies in this aspect are to be conducted in future.

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