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Weight loss in seeds of different pigeonpea genotypes due to *Melanagromyza obtusa* (Malloch) (Diptera: Agromyzidae) damage

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Abstract
A field experiment was conducted to evaluate twenty pigeonpea genotypes to ascertain actual and per cent weight loss in the damaged grains due to pod fly, *Melanagromyza obtusa* (Malloch) at Agricultural Research Station, Badnapur (Vasantrao Naik Marathwada Krishi Vidyapeeth (VNMKV), Parbhani), Maharashtra, India during *Kharif* season of 2015-2016. The present studies revealed that there was a variation existed among different pigeonpea genotypes with respect to number of maggots and pupae ranging from 0.00 to 277.64 maggots and 0.00 to 101.26 pupae per 100 pods, respectively. The genotype, BRG-2 recorded the highest number of maggots and pupae per 100 pods *i.e.,* 277.64 and 101.26, respectively, whereas the genotype, *Cajanus scarabaeoides* recorded no maggot and pupal population, indicating its virtue of a genetic potentiality against *M. obtusa*. Studies on actual and per cent weight loss in grains due to *M. obtusa* damage ranged from 0.00 to 14.38 g and 0.00 to 85.72 per cent, respectively, with an average of 7.91 g per 100 seeds and 57.53 per cent in different pigeonpea genotypes. The highest actual and per cent weight loss was observed in BRG-1 (14.38 g) and BDN-2013-41 (85.72 per cent); and the genotype, *C. scarabaeoides* recorded no weight loss, indicating its virtue of resistance against *M. obtusa* and it can be used in breeding programmes in order to produce resistant cultivars for the benefit of farmers.

Keywords: Damage, Genotypes, Grain, *Melanagromyza obtusa*, Pigeonpea, Pod Fly, Population, Seed, Wight Loss

Introduction
Pigeonpea (*Cajanus cajan* (L) Mill sp.) is commonly known as red gram or tur or arhar. After Chickpea, it is the second most important grain legume in India [1]. The production of pigeonpea is very low even in the era of the green revolution. In the recent years, there has been a significant decline in the pigeonpea production in India, leading to price increase and a reduction in per capita availability. The relatively low crop yields may be attributed to non-availability of improved cultivars, poor crop husbandry and exposure to a number of biotic and abiotic stresses in pigeonpea growing regions [2]. Among the various constraints, insect pests are one of the major and important ones affecting the productivity of pigeonpea. About 250 species of insects belonging to 8 orders and 61 families have been found to attack on pigeonpea [3] of which the pod fly, *Melanagromyza obtusa* (Malloch) is one of the serious pod borers, an important emerging constraint to increase the production and causes considerable loss to the crop [4]. The pod fly lays eggs in immature pods and after hatching, the young larvae initially feed on the seed surface of soft pigeonpea seeds. Later, they mine into the developing seeds, and these mines change into deep galleries. The infested immature pods do not show external evidence of damage until the fully grown larvae chew exit holes in the pod walls [5]. The loss in yield is due to feeding and boring habits of larvae. There by the soft seeds are rendered totally unfit for human consumption [6]. It was reported to infest 12 to 100 per cent pods causing losses of 2.4 to 95.0 per cent on seed and 2,50,000 tonnes by weight [7,8,9]. The total loss in terms of production and monetary value is estimated to be around 250 to 300 thousand tones and 3750 to 4500 million rupees per year, respectively [10]. Losses due to pod fly damage have been estimated to be US$ 256 millions annually [11]. The seeds damaged by this pest are rendered unfit for sowing and human consumption; and the price and preference of grain is also lowered in the market because of appearance and quality of the grains, respectively. The mixture of healthy and damaged grains in a produce increases labour charges for cleaning [4]. In past several studies have been conducted to estimate the pod and grain

damage in pigeonpea cultivars due to *M. obtusa*, but only few *viz*., Gangrade [12], Bindra and Jakhmola [13], Srivastava [14], Vishakantaiah *et al*. [15], Borikar and Wadnerkar [6], Singh and Rai [16], Singh and Singh [4] and Revathi *et al*. [2] have calculated weight loss in the damaged seeds. It has also found that the variation in weight loss of damaged grains varies according to cultivar, date of sowing, agronomic conditions and at different locations. Therefore the present investigation has been made to ascertain actual and per cent weight loss in the damaged grains due to *M. obtusa*.

2. Material and Methods

A field experiment was conducted in randomized block design with three replications at Research Farm and Laboratory, Agricultural Entomology Unit, Agricultural Research Station, Badnapur (Vasantrao Naik Marathwada Krishi Vidyapeeth (VNMKV), Parbhani), Maharashtra, India during *Kharif* season of 2015 to evaluate the resistance of different pigeonpea genotypes against *Melanagromyza obtusa* (Malloch) incidence and its influence on weight loss, respectively. Total 20 pigeonpea genotypes were evaluated during the study. The plot size was three rows of 5.4 m length (5.4 m × 2.4m = 12.96 m^2) and the row to row and plant to plant distance was maintained at 60 cm and 30 cm, respectively. All recommended cultural and agronomical practices were followed homogeneously in all the genotypes to raise a good crop. None of the insecticide was applied to protect the crop from an infestation of *M. obtusa*. The genotypes were raised under rain-fed conditions and only a protective irrigation was provided during the flowering stage of the crop. The pest reaction was recorded from pod initiation till harvest of the crop. Hand picking of pod borer, *Helicoverpa armigera* (Hubner) larvae and other pest on pods was done to avoid the losses caused by these pests. The population *i.e.*, maggots and pupae of *M. obtusa* was counted from 100 randomly selected pods covering all the plants of each genotype on a weekly basis [17, 18]. For estimating weight loss, the sampled pods were opened and seeds were collected. Precaution was taken not to throw any damaged seed while opening the pods. Weight of hundred healthy seeds and hundred *M. obtusa* damaged seeds of each genotype were recorded. The per cent weight loss was calculated using the following formula given by Singh and Singh [4] and Revathi *et al*. [2] as below.

$$\text{Per cent weight loss} = \frac{\text{Weight of 100 healthy grains - Weight of 100 damage grains}}{\text{Weight of 100 healthy grains}} \times 100$$

The data, thus, obtained were subjected to RBD analysis using an AGRES package [19] for drawing meaningful conclusion.

3. Results and Discussion

The data on mean maggot and pupal population of pigeonpea pod fly, *Melanagromyza obtusa* (Malloch) and its influence on weight loss in 20 different pigeonpea genotypes under study are presented in Table 1. It is clear from the data that all genotypes indicated significant differences with regard to maggot and pupal population of *M. obtusa*. The mean maggot population of *M. obtusa* varied from 0.00 to 277.64 maggots per 100 pods during crop season. The highest maggot population of *M. obtusa* (Malloch) was recorded in BRG-2 (277.64 maggots per 100 pods), followed by BRG-1 (206.60 maggots per 100 pods), ICP-7035 (187.02 maggots per 100 pods), BSMR-846 (112.08 maggots per 100 pods), LRG-41 (99.73 maggots per 100 pods), KHADKI (97.74 maggots per 100 pods), BDN-2 (93.23 maggots per 100 pods) and BDN-2014-1 (85.79 maggots per 100 pods), respectively. The lowest mean maggot population of *M. obtusa* (Malloch) was recorded in the genotype, *Cajanus scarabaeoides* (no maggots), *Cajanus cajanifolius* (3.98 maggots per 100 pods), followed by V-127 (10.35 maggots per 100 pods), BDN-2010-1 (22.27 maggots per 100 pods), BSR-1 (28.46 maggots per 100 pods) and ICP-10531 (35.78 maggots per 100 pods), respectively, while, the genotypes, KALI TUR (52.02 maggots per 100 pods), BDN-2014-3 (55.33 maggots per 100 pods), BDN-2013-41 (56.92 maggots per 100 pods), GULYAL (69.40 maggots per 100 pods), ICPL-322 (73.50 maggots per 100 pods) and BSMR-736 (73.67 maggots per 100 pods), respectively shown intermittent moggot population of *M. obtusa* (Table 1). The present findings are in accordance with Keval *et al*. [20], who reported that the highest mean population of pod fly was recorded in NDA-5-25 (0.57 maggots per 10 pods), followed by MAL-20 (0.46 maggots per 10 pods), PDA 85-5E (0.33 maggots per 10 pods), MAL-13 (0.31 maggots per 10 plots), MAL- 27 (0.28 maggots per 10 pods) and the lowest in KAWR 92-2 (0.21 maggots per 10 pods). Similarly, Revathi *et al*. [2] found a variation among different pigeonpea genotypes with respect to number of maggots ranging from 0-4 per pod, whereas the genotype, 2011-5 recorded highest number of maggots per pod *i.e.*, 1.5 and the genotype ENT-11 recorded least number of maggots (0.5), respectively.

Table 1: Population of *Melanagromyza obtusa* and their influence on weight loss in different pigeonpea genotypes.

GENOTYPE	Population per 100 pods (No.)*		Weight of 100 seeds		Weight loss (g)	Weight loss (%)**
	Maggot	Pupae	Healthy	Damaged		
BDN-2	93.23 (9.68)	33.21 (5.81)	12.10	5.60	6.51	53.28 (46.88)
BDN-2010-1	22.27 (4.77)	9.00 (3.08)	15.36	9.44	5.93	37.45 (37.73)
BDN-2013-41	56.92 (7.58)	20.73 (4.61)	13.83	1.96	11.88	85.72 (67.80)
BDN-2014-1	85.79 (9.29)	36.67 (6.10)	12.12	4.66	7.47	61.43 (51.61)
BDN-2014-3	55.33 (7.47)	31.36 (5.64)	14.92	4.58	10.35	69.09 (56.22)
BSMR-736	73.67	27.48	13.41	5.42	7.99	59.20

	(8.61)	(5.29)				(50.30)
BSMR-846	112.08 (10.61)	41.36 (6.47)	18.69	5.63	13.07	69.70 (56.60)
KALI TUR	52.02 (7.25)	25.74 (5.12)	11.53	4.56	6.97	60.06 (50.80)
KHADKI	97.74 (9.91)	39.46 (6.32)	13.10	5.47	7.63	58.09 (49.65)
GULYAL	69.40 (8.36)	28.89 (5.42)	12.33	4.39	7.95	64.04 (53.15)
BRG-1	206.60 (14.39)	81.93 (9.08)	21.28	6.90	14.38	67.26 (55.10)
BRG-2	277.64 (16.68)	101.26 (10.09)	14.65	5.24	9.41	63.86 (53.05)
LRG-41	99.73 (10.01)	40.55 (6.41)	12.39	5.28	7.11	56.88 (48.96)
ICP-7035	187.02 (13.69)	76.52 (8.78)	18.16	4.75	13.41	73.59 (59.08)
ICP-10531	35.78 (6.02)	14.52 (3.88)	8.57	3.80	4.77	55.64 (48.24)
ICPL-322	73.50 (8.60)	31.29 (5.64)	14.04	4.73	9.31	66.04 (54.35)
BSR-1	28.46 (5.38)	8.13 (2.94)	16.17	7.36	8.81	54.05 (47.32)
V-127	10.35 (3.29)	3.38 (1.97)	9.05	4.68	4.37	48.30 (44.03)
Cajanus cajanifolius	3.98 (2.12)	0.75 (1.12)	2.19	1.16	1.03	46.92 (43.24)
Cajanus scarabaeoides	0.00 (0.71)	0.00 (0.71)	2.50	0.00	0.00	00.00 (0.00)
SE (m) ±	0.13	0.11	0.63	0.08	0.62	2.62
CD at 5%	0.36	0.31	1.81	0.22	1.78	7.48
CV %	2.68	3.64	8.58	2.81	13.66	7.25

*Figures of population in parenthesis are √x+0.5 transformed values
** Figures of percentage in parenthesis are angular transformed values

The mean pupal population of *M. obtusa* varied from 0.00 to 101.26 pupae per 100 pods during crop season. The highest pupal population of *M. obtusa* (Malloch) was recorded in BRG-2 (101.26 pupae per 100 pods), followed by BRG-1 (81.93 pupae per 100 pods), ICP-7035 (76.52 pupae per 100 pods), BSMR-846 (41.36 pupae per 100 pods), LRG-41 (40.55 pupae per 100 pods), KHADKI (39.46 pupae per 100 pods) and BDN-2014-1 (36.67 pupae per 100 pods), respectively. The lowest pupal population of *M. obtusa* (Malloch) was recorded in the genotype, *Cajanus scarabaeoides* (no pupa), *Cajanus cajanifolius* (0.75 pupae per 100 pods), followed by V-127 (3.38 pupae per 100 pods), BSR-1 (8.13 pupae per 100 pods), BDN-2010-1 (9.00 pupae per 100 pods) and ICP-10531 (14.52 pupae per 100 pods), respectively, while, the genotypes, BDN-2013-41 (20.73 pupae per 100 pods), KALI TUR (25.74 pupae per 100 pods), BSMR-736 (27.48 pupae per 100 pods), GULYAL (28.89 pupae per 100 pods), BDN-2 (33.21 pupae per 100 pods), BDN-2014-3 (31.36 pupae per 100 pods) and ICPL-322 (31.29 pupae per 100 pods), respectively shown intermittent pupal population of *M. obtusa* (Table 1). The present findings are in accordance with the reports of Revathi *et al*. [2], who found the variation among different pigeonpea genotypes with respect to the number of pupae ranging from 0-6 per pod, where, the genotype, 2011-5 recorded the highest number of pupae per pod *i.e.*, 1.7 while, the genotype WRG-51 recorded the least number of pupae (0.5) per pod.

The test weight (100 healthy seeds weight) of different genotypes under study varied from 2.19 g to 21.28 g with an average of 12.82 g. Based on test weight, the seeds were classified into three groups *i.e.,* extra-large (> 11 g per 100 seed weight), large (9 to 11 g per 100 seed weight), medium (7 to 9 g per 100 seed weight) and small seeds (< 7 g per 100 seed weight), respectively; and it was found that, there were sixteen extra-large sized seed genotypes *i.e.*, BRG-1 (21.28 g) followed by BSMR-846 (18.69 g), ICP-7035 (18.16 g), BSR-1 (16.17), BDN-2010-1 (15.36 g), BDN-2014-3 (14.92 g), BRG-2 (14.65 g), ICP-322 (14.04 g), BDN-2013-41 (13.83 g), BSMR-736 (13.41 g), KHADKI (13.10 g), LRG-41 (12.39 g), GULYAL (12.33 g), BDN-2014-1 (12.12 g), BDN-2 (12.10 g) and KALI TUR (11.53 g), respectively; one large sized seed genotype, V-127 (9.05 g); one medium sized seed genotype, ICP-10531 (8.57 g) and two small sized seed genotypes *i.e.*, *Cajanus cajanifolius* (2.19 g) followed by *Cajanus scarabaeoides* (2.50 g), respectively (Table 1). These findings are in accordance with; Devi *et al*. [21] wherein it is found that the test weight of different genotypes varied from 8.5 (BWR 376) to 14.9 g (2011- 5) with a mean of 11.4 g. Similarly, Revathi *et al*. [2] reported that the test weight of pigeonpea seeds varied from 8.5 (BWR 376) to 14.9 g (2011-5) among different pigeonpea genotypes indicating existence of a large amount of variation amongst the genotypes.

The weight of hundred damaged seeds due to *M. obtusa* varied from 0.00 g (*Cajanus scarabaeoides*) to 9.44 g (BDN-2010-1). Thus, actual weight loss in seeds due to *M. obtusa* varied from 0.00 (*Cajanus scarabaeoides*) to 14.38 g (BRG-1). The maximum weight loss in seeds was observed in BRG-1 (14.38 g), followed by ICP-7035 (13.41 g), BSMR-846 (13.07 g), BDN-2013-41 (11.88 g), BDN-2014-3 (10.35 g), BRG-2 (9.41 g) and ICPL-322 (9.31 g), respectively. Wherein, no weight loss in seeds was observed on the genotype, *Cajanus scarabaeoides* (0.00 g). The lowest weight loss in seeds was observed in *Cajanus cajanifolius* (1.03 g) and it was followed by V-127 (4.37 g) and ICP-10531 (4.77

g), respectively. The remaining genotypes *viz*., BDN-2010-1 (5.93 g), BDN-2 (6.51 g), KALI TUR (6.97 g), LRG-41 (7.11 g), BDN-2014-1 (7.47 g), KHADKI (7.63 g), GULYAL (7.95 g), BSMR-736 (7.99 g) and BSR-1 (8.81 g) were shown intermittent weight loss in seeds (Table 1). The present findings are in accordance with; Singh and Singh [4] who reported that the actual weight loss in 50 seeds due to pod fly ranged from 1.020 g in Pusa 84-4 to 2.80 g in Pusa 86-4, respectively with an average of 2.012 g. Similarly, Gangrade [12] recorded 0.80 to 3.30 per cent loss in grain weight. Revathi *et al*. [2], who reported that the weight of hundred damaged grains due to pod fly varied from 2.0 (2011-6) to 5.9 g (ICP 13212) among 20 genotypes screened and weight loss in grains due to pod fly varied from 4.9 (ICPHaRL 4985-5) to 12.9 g (2011-5). It may be due to the differences amongst the pigeonpea varieties, since the differences were recorded from 1.03 to 14.38 g per 100 seeds at present.

It was observed that weight loss in pigeonpea seeds due to *M. obtusa* was ranged from 0.00 to 85.72 per cent among different pigeonpea genotypes with an average weight loss of 57.53 per cent indicating that a large amount of variation exists amongst the genotypes. The highest weight loss was observed in the genotype, BDN-2013-41 (85.72 per cent) indicating that the genotype highly susceptible against *M. obtusa* infestation. It was followed by ICP-7035 (73.59 per cent), BSMR-846 (69.70 per cent), BDN-2014-3 (69.09 per cent), BRG-1 (67.26 per cent), ICPL-322 (66.04 per cent), GULYAL (64.04 per cent), BRG-2 (63.86 per cent) and BDN-2014-1 (61.43 per cent), respectively. Wherein, no weight loss was observed on the genotype, *Cajanus scarabaeoides* (0.00 per cent) indicating that the genotype is having complete resistance against *M. obtusa* infestation. Likewise, the lowest per cent weight loss was observed in BDN-2010-1 (37.45 per cent) and it was followed by *Cajanus cajanifolius* (46.92 per cent), V-127 (48.30 per cent), BDN-2 (53.28 per cent) and BSR-1 (54.05 per cent), respectively. The remaining genotypes *viz*., BDN-2014-1 (61.43 per cent), KALI TUR (60.06 per cent), BSMR-736 (59.20 per cent), KHADKI (58.09 per cent), LRG-41 (56.88 per cent) and ICP-10531 (55.64 per cent) were shown intermittent per cent weight loss, indicating that the genotypes are moderately susceptible against *M. obtusa* infestation (Table 1). The results in relation to weight loss in pigeonpea seeds due to *M. obtusa* are in accordance with earlier workers, Singh and Singh [4] who reported that the least weight loss in pigeonpea grains due to pod fly occurred in Hyb. 8 (28.058 per cent) followed by Hyb. 6 (38.261 per cent) and highest weight loss (67.961 per cent) was observed in Pusa 86-4. Thus Hyb. 8 and Hyb. 6 may be considered less susceptible on the basis of less amount of food material consumed by *M. obtusa*; and indicates that large amount of variation exists amongst varieties. On an average 55.816 per cent weight loss due to *M. obtusa* was observed. Similarly, the varieties Prabhat, HY-1 and Pusa Ageti recorded minimum percentage of weight loss; and No. 134 and ICRISAT 6997 on the contrary registered the maximum loss in weight [6]. The damage due to *M. obtusa* ranged from 1.3 to 1.9 g and loss in weight varied from 0.9 to 1.1 per cent on the variety No. 148 [12]. Similarly, Revathi *et al*. [2] reported 60.0 per cent weight loss in grains on an average among different pigeonpea genotypes due to pod fly with the horizon of 47.8 (ICP 13212) to 86.6 per cent (2011-5). Also first ever studies on per cent weight loss calculated also shown variations *i.e.*, 57 per cent [13], 66.40 per cent in green pods and 45.70 per cent in mature pods [14], 66.23 per cent [15] and 65.38 per cent [16], respectively. It may be due to the differences amongst the pigeonpea varieties, varietal characters, composition and environmental factors; since the differences were recorded from 46.92 to 85.72 per cent at present.

4. Conclusion

Melanagromyza obtusa is a major emerging constraint playing an important role in causing considerable loss to the pigeonpea crop. From the present studies, it can be concluded that the weight loss varied from 0.00 (*Cajanus scarabaeoides*) to 85.72 (BDN-2013-41) per cent with an average of 57.53 per cent. The actual weight loss in 100 damaged grains varied from 0.00 (*Cajanus scarabaeoides*) to 14.38 g (BRG-1) with an average of 7.91 g per 100 seeds. The wild genotype, *Cajanus scarabaeoides* shown no damage in seeds and no weight loss, respectively, indicating its virtue of genetic potentiality against *M. obtusa* and it can be used in breeding programmes in order to produce resistant cultivars for the benefit of farmers.

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