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Field screening of pigeonpea for their resistance against *Melanagromyza obtusa* (Diptera: Agromyzidae)

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ABSTRACT

Melanagromyza obtusa (Malloch) has been recorded for the first time on pigeonpea at Nagpur, India and named as 'tur pod fly'. It is a monophagous species and devours the developing seeds of pigeonpea crop. It was reported to infest 12 to 100% pods causing losses of 2.4-95.0% on seed or grain (=250000 tonnes by weight) and are estimated at US $ 256 million annually. Therefore, a field experiment was conducted at Research Farm, Agricultural Research Station, Badnapur (VNMKV), India during *kharif* 2015-16 to source some promising pigeonpea genotypes against *M. obtusa*. The present investigations revealed the population of *M. obtusa* on 20 genotypes ranged from 0.00-277.64 maggots per 100 pods; pod and grain damage were ranging from 0.00-89.75 and 0.00-82.02%. The highest *M. obtusa* population, pod and grain damage was recorded in BRG-2 (277.64 maggots and 101.26 pupae per 100 pods; and 89.75 and 82.02%). On the basis of pod damage a total of five, two, eight, four and one genotypes were categorized as highly tolerant, tolerant, moderately tolerant, susceptible and highly susceptible; for grain damage these were seven, seven, three, two and one, respectively. The maximum yield was recorded from BDN-2010-1 (22.33 q/ha), followed by V-127 (21.61 q/ha). However, *Cajanus scarabaeoides* showed no maggot and pupal population, pod and grain damage by *M. obtusa* indicating its virtue of genetic resistance and it can be used in breeding programmes to develop resistant cultivars for farmer's welfare.

Key words: Damage, Maggots, *Melanagromyza obtusa*, Pod fly

Pigeonpea (*Cajanus cajan* (L.) Millsp.) is one of the most important legume crops of tropical and subtropical environment cultivated on almost 5.8 million ha worldwide (FAO 2013), it provides farmers with pulse grain, fodder, fuel, and wood. However, its productivity is far below the potential yield due to heavy infestation of insect pest complex during the reproductive phase of the crop. More than 200 species of insects feed on this crop, of which pod fly, *Melanagromyza obtusa* (Malloch) (Diptera: Agromyzidae) is a major pest and act as a key pest causing heavy crop losses in India (Lateef and Reed 1990, Shanower *et al.* 1999, Kumar and Nath 2003, Kumar *et al.* 2003, Nath *et al.* 2008). It is a monophagous species and devours the developing seeds of pigeonpea crop. A single larva in its lifetime consumes and destroys one complete seed and sometimes it has been seen to move to the adjacent seed of the same pod to continue the feeding if the first seed could not fulfill its requirements (Ipe 1974). Many researchers in India have identified different lines such as ICPL11964, ICP1053, Phule T25, T32, C-11 and BDN-1 to provide moderate resistance to the pigeonpea pod fly (Singh *et al.* , 2013). The potential for developing cultivars with high levels of resistance appears to be good (Shanower *et al.* 1998). Identification and cultivation of cultivars that are less preferred by pod fly have many advantages, particularly for eco-friendly management. However, Singh and Singh (1990) reported that no definite conclusions could be drawn about the relative susceptibility of pigeonpea genotypes to pod fly damage because of staggering flowering and variation in pod fly abundance over time. Since levels of resistance to this pest in the cultivated pigeonpea are low to moderate, it is important to identify pigeonpea cultivar that permits slow growth or lesser population buildup of pod fly. Therefore, keeping in view the above the present investigation will beneficial to farmers as well as useful in breeding programmes to produce the resistant cultivars.

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MATERIALS AND METHODS

The present investigations on field screening of some promising pigeonpea genotypes against *Melanagromyza obtusa* was conducted at Research Farm, Agricultural Research Station, Badnapur (Vasantrao Naik Marathwada Krishi Vidyapeeth (VNMKV), Parbhani), Maharashtra, India during *kharif* 2015-16. A total of 20 pigeonpea genotypes were evaluated during the study and grown each in plots of 3 rows of 5.4 m length (total no. of plots, 60) following row to row and plant to plant spacing of 60 cm and 30 cm, respectively. The genotypes were grown under rain-fed conditions and only protective irrigation was provided during the flowering stage of the crop. All the genotypes were grown by following the recommended cultural and agronomical practices in Randomized Block Design (RBD) with three replications to raise a good crop. None of the insecticides was applied to protect the crop from the infestation of *M. obtusa*. The pest reaction was recorded from pod initiation until the harvest of the crop. Hand-picking of pod borer, *Helicoverpa armigera* (Hubner) larvae and other pests on pods were done to avoid the losses caused by them. The pod and grain damage due to *M. obtusa* was recorded from 100 randomly selected pods covering all the plants of each genotype on basis of standard meteorological weeks (SMW) (Khan *et al.* 2014, Patange *et al.* 2017). Damaged pods, as well as grains, were recorded on per cent basis.

Pod and grain damage was calculated as (Patange *et al.* 2017).

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

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

The genotypes were classified by using the scale based on pod and seed damage and reaction as suggested by Egho (2010) and Kavitha and Reddy (2012), respectively. Five plants of each genotype were selected randomly, tagged and kept without plucking the pods for estimation of actual yield. The yield was recorded from these five randomly selected plants of each genotype from three central rows in each plot and worked out on a hectare basis. The data obtained on various aspects from the field evaluation of popular pigeonpea genotypes against *M. obtusa* were analyzed statistically using randomized block design (RBD) as per the methods described by Panse and Sukhatme (1954).

RESULTS AND DISCUSSION

The data on mean maggot and pupal population of pigeonpea pod fly, *Melanagromyza obtusa* on 20 different pigeonpea genotypes understudy during 44th SMW to 07th SMW is presented in Table 1. It is clear from the data that all genotypes indicated significant differences with regard to the maggot and pupal population of *M. obtusa*. The maggot and pupal population of *M. obtusa* on 20 different pigeonpea genotypes were ranged from 0.00-277.64 maggots and 0.00-101.26 pupae per 100 pods. The highest maggot and pupal population of *M. obtusa* was recorded in BRG-2 (277.64 maggots and 101.26 pupae per 100 pods), followed by BRG-1, ICP-7035, BSMR-846, LRG-41, KHADKI, BDN-2, and BDN-2014-1, respectively. The lowest maggot and pupal population of *M. obtusa* was recorded from the genotype, *Cajanus scarabaeoides* (no. of maggots and pupae = 0.00 maggots and pupae per 100 pods), *Cajanus cajanifolius* (3.98 maggots and 0.75 pupae per 100 pods), followed by

Table 1 Population of *M. obtusa* on different pigeonpea genotypes

Genotypes	Population per 100 pods*	
	Maggots	Pupae
BDN-2	93.23 (9.68)	33.21 (5.81)
BDN-2010-1	22.27 (4.77)	9.00 (3.08)
BDN-2013-41	56.92 (7.58)	20.73 (4.61)
BDN-2014-1	85.79 (9.29)	36.67 (6.10)
BDN-2014-3	55.33 (7.47)	31.36 (5.64)
BSMR-736	73.67 (8.61)	27.48 (5.29)
BSMR-846	112.08 (10.61)	41.36 (6.47)
Kali Tur	52.02 (7.25)	25.74 (5.12)
Khadki	97.74 (9.91)	39.46 (6.32)
Gulyal	69.40 (8.36)	28.89 (5.42)
BRG-1	206.60 (14.39)	81.93 (9.08)
BRG-2	277.64 (16.68)	101.26 (10.09)
LRG-41	99.73 (10.01)	40.55 (6.41)
ICP-7035	187.02 (13.69)	76.52 (8.78)
ICP-10531	35.78 (6.02)	14.52 (3.88)
ICPL-322	73.50 (8.60)	31.29 (5.64)
BSR-1	28.46 (5.38)	8.13 (2.94)
V-127	10.35 (3.29)	3.38 (1.97)
Cajanus cajanifolius	3.98 (2.12)	0.75 (1.12)
Cajanus scarabaeoides	0.00 (0.71)	0.00 (0.71)
SE (m) ±	0.13	0.11
CD (P=0.05)	0.36	0.31
CV %	2.68	3.64

*Figures of the population in parenthesis are $\sqrt{x+0.5}$ transformed values

Table 2 Pod and grain damage, damage rating score and reaction of different pigeonpea genotypes; and correlation matrix among larval population; pod and grain damage; and yield

Sr. No.	Genotype	Pod damage* (%)	Damage rating	Reaction**	Grain damage* (%)	Damage rating	Reaction**	Yield (q/ha)
G_{01}	BDN-2	58.86 (50.10)	6.29	MT	36.06 (36.91)	4.08	T	14.44
G_{02}	BDN-2010-1	15.67 (23.32)	2.02	HT	8.46 (16.91)	1.27	HT	22.33
G_{03}	BDN-2013-41	42.90 (40.92)	4.82	MT	23.01 (28.66)	2.78	T	16.78
G_{04}	BDN-2014-1	52.12 (46.21)	5.57	MT	34.43 (35.93)	3.92	T	14.37
G_{05}	BDN-2014-3	43.98 (41.54)	4.92	MT	19.68 (26.33)	2.41	HT	15.97
G_{06}	BSMR-736	55.18 (47.97)	5.98	MT	29.84 (33.11)	3.39	T	18.84
G_{07}	BSMR-846	64.59 (53.48)	6.86	S	51.20 (45.69)	5.61	MT	10.18
G_{08}	KALI TUR	32.49 (34.75)	3.73	T	21.10 (27.34)	2.51	T	19.16
G_{09}	KHADKI	62.80 (52.42)	6.69	S	43.72 (41.39)	4.78	MT	17.15
G_{10}	GULYAL	44.45 (41.81)	4.88	MT	31.88 (34.37)	3.71	T	18.75
G_{11}	BRG-1	77.65 (61.78)	7.96	S	71.53 (57.76)	7.57	S	10.13
G_{12}	BRG-2	89.75 (71.33)	8.71	HS	82.02 (64.91)	8.53	HS	9.20
G_{13}	LRG-41	53.29 (46.89)	5.76	MT	43.63 (41.34)	4.84	MT	15.03
G_{14}	ICP-7035	70.98 (57.40)	7.45	S	65.14 (53.81)	6.98	S	11.44
G_{15}	ICP-10531	29.35 (32.81)	3.35	T	14.83 (22.65)	1.86	HT	18.49
G_{16}	ICPL-322	60.18 (50.87)	6.43	MT	32.62 (34.83)	3.73	T	19.25
G_{17}	BSR-1	16.53 (23.99)	2.08	HT	9.36 (17.81)	1.39	HT	20.36
G_{18}	V-127	9.16 (17.61)	1.45	HT	3.82 (11.27)	1.00	HT	21.61
G_{19}	*Cajanus cajanifolius*	3.75 (11.16)	1.12	HT	1.07 (5.93)	1.00	HT	12.89
G_{20}	*Cajanus scarabaeoides*	0.00 (0.00)	1.00	HT	0.00 (0.00)	1.00	HT	14.65
	SE (m) ±	0.70	-	-	0.49	-	-	1.08
	CD (P=0.05)	1.99	-	-	1.40	-	-	3.07
	CV %	2.99	-	-	2.66	-	-	11.60
Maggot population × Pod damage							0.8941	
Maggot population × Grain damage							0.9748	
Maggot population × Yield							-0.7083	

* Figures of percentage in parenthesis are angular transformed values. **HT, Highly Tolerant; T, Tolerant; MT, Moderately Tolerant; S, Susceptible and HS, Highly Susceptible.

V-127, BDN-2010-1, BSR-1, and ICP-10531, respectively, while, the genotypes, Kali Tur, BDN-2014-3, BDN-2013-41, Gulyal, ICPL-322, and BSMR-736, respectively shown intermittent maggot and pupal population of *M. obtusa*. The present findings are in accordance with Keval *et al.* (2010), 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.* (2015) found a variation among different pigeonpea genotypes with respect to the number of maggots and pupae ranging from 0-4 and 0-6 per pod, whereas the genotype, 2011-5 recorded the highest number of maggots and pupae per pod, i.e. 1.5 and 1.7; and the genotype ENT-11 recorded the least number of maggots per pod (0.5) and for pupae WRG-51 recorded the least number (0.5), respectively.

The data on pod and grain damage due to *M. obtusa* during the crop period, i.e. 44^{th} to 07^{th} SMW is presented in Table 2. All the genotypes indicated significant variation regarding pod and grain damage due to pod fly. The pod and grain damage due to *M. obtusa* was in the range of 0.00-89.75% and 0.00-82.02% on various genotypes under study. The pod and grain damage was significantly lowest on genotypes *Cajanus scarabaeoides* (no pod and grain damage = 0.00%), *Cajanus cajanifolius* (3.75 and 1.07%), and V-127 (9.16 and 3.82%) which were at par with BDN-2010-1 and ICP-10531, respectively. This was followed by Kali Tur, BDN-2013-41, BDN-2014-3, Gulyal, BDN-2014-1, LRG-41, and BSMR-736 shown moderate pod and grain damage levels and having at par effect with each other. Whereas, the genotypes, BRG-2 (89.75 and 82.02%) recorded highest pod and grain damage due to *M. obtusa* and was at par with BRG-1, ICP-7035, BSMR-846, KHADKI, ICPL-322, and BDN-2, respectively. The results on pod and grain damage due to *M. obtusa* are in accordance with the observations recorded by Sharma *et al.* (2003) reported that accessions belonging to *Cajanus scarabaeoides* (L.) Thouars showed resistance to pod fly damage, while those from *C. cajanifolius* (Haines) van der Maesen were susceptible, the accessions, ICPW 141, ICPW 278 and ICPW 280 (*C. scarabaeoides*) showed resistance to pod fly damage. Similarly, Khan *et al.* (2014) recorded a wide range of variation in pod and seed damage (21.00-38.50% and 12.29-19.87%) with check Bahar among 24 pigeonpea genotypes tested; and the genotype, ICP10531 (12.36%) had the least grain damage. Kumar *et al.* (2015) reported that pod damage caused by pod fly ranged from 24.67 to 88.67% in 40 tested genotypes and the genotype, ICP 14887 recorded the least pod and grain damage (24.67 and 15.12%) and the highest pod and grain damage was observed in ICP 9150 (88.67 and 45.56%), respectively.

The genotypes *Cajanus scarabaeoides* (no damage), *C. cajanifolius* (3.75 and 1.07%) and V-127 (9.16 and 3.82%) were recorded the resistance rating of 1.00 and 1.00, 1.12 and 1.45; and 1.00 and 1.00 for pod and grain damage, respectively categorized under highly tolerant genotypes (Table 2). The highly susceptible genotype BRG-2 (89.75 and 82.02%) recorded 8.71 and 8.53 damage score for pod and grain damage, respectively. On the basis of pod damage a total of five, two, eight, four and one genotypes were categorized as highly tolerant (HT), tolerant (T), moderately tolerant (MT), susceptible (S) and highly susceptible (HS) to *M. obtusa* and for grain damage these were seven, seven, three, two and one, respectively. However the genotype, *C. scarabaeoides* shown no pod and grain damage by *M. obtusa* indicating its genetic resistance against pod fly damage and having the ability to use in breeding programmes to develop resistant cultivars against this pest. The present findings are in accordance with Mishra *et al.* (2015) who reported that a total of 33, 15, 28 and 24 germplasm were categorized as highly resistant, resistant, susceptible and highly susceptible against *M. obtusa*, respectively however, pigeonpea genotype V-100 showed significantly lowest pod damage due to pod fly, while four more entries namely ICE AP-01144-13, B-42, V-82, and V-95 exhibited up to 10% pod infestation. It is clear from the data that all genotypes varied significantly with respect to production (Table 2). The yield of pigeonpea genotypes ranged from 9.20-22.33 q/ha. The maximum yield was recorded by BDN-2010-1 (22.33 q/ha) and it was followed by V-127, BSR-1, ICPL-322, and Kali Tur, respectively having at par effect with each other. This was followed by BSMR-736, Gulyal, ICP-10531, Khadki, BDN-2013-41, BDN-2014-3, and LRG-41, respectively having at par effect with each other. The lowest grain yield was observed from the genotype, BRG-2 (9.20 q/ha) among the genotypes tested under the study. This was followed by BRG-1, BSMR-846, ICP-7035, *C. cajanifolius*, BDN-2014-1, BDN-2, and *C. scarabaeoides*, respectively having at par effect with each other. The results related to yield of different pigeonpea genotypes under study are in accordance with; Khan *et al.* (2014) who observed highest yield in the genotypes, ICPL-909 (1289 kg/ha), ICP-85063 (1278 kg/ha) and ICP-10531 (1278 kg/ha), respectively while the lowest yield was observed in ICP-7035 and ICPL-88039k, i.e. 511 kg/ha among the 24 pigeonpea genotypes tested against pod fly.

The analysis of data exhibited a significant strong positive correlation between maggot population of *M. obtusa* with pod and grain damage with regression coefficient of 0.8941 and 0.9748, respectively; indicating that with availability of food, the population of *M. obtusa* increases which leads to more pod damage and ultimately the grain damage (Table 2). The negative correlation was observed between maggot population of *M. obtusa* and average grain yield ($r = -0.7083$) indicating that an increase in population causes more pod and grain damage which ultimately leads to yield loss. The results are in accordance with Lal *et al.* 1988, Reddy *et al.* 1990, Durairaj 1999 and Minja *et al.* 1999, who reported that pigeonpea cultivars with more bold seeds suffered more damage than the small, seeded ones due to pod fly.

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