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Screening of Some Long Duration Pigonpea (*Cajanus cajan* (L.) Millsp.) Genotypes against Major Insect Pests in Varanasi

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ABSTRACT

Pigeonpea (Cajanus cajan (L.) Millsp.), an important grain-legume of semi arid tropics is severely attacked by many insect species, resulting in losses of quantity and nutritional quality. In the present study, fifteen long duration genotypes of pigeonpea were assessed against the attack of M. obtusa, C. gibbosa and H. armigera for two years (2017-2018 and 2018-19) in Varanasi. Resistance to pigeonpea genotypes was evaluated by measuring pod and grain damage per cent in accordance with their yields. Pest susceptibility rating revealed that none of the genotypes fell in resistant/highly-resistant categories. However, genotypes IVT-705, IVT-706 and IVT-907 were found to least susceptible for all the three insect pests (except for IVT-907 for C. gibbosa) and also showed higher yields. In other words, yield losses were lower in genotypes which shown less pod/grain damage by insects. Pod damage of some other genotypes viz. IVT-208 (M. obtusa-31.3%, C. gibbosa-12.6%, H. armigera-4.8%), IVT-12-904 (M. obtusa-29.5%, C. gibbosa-12.8%, H. armigera-7.3%) also accounted for their lower levels of susceptibility to the insect pest complex.

Key words: Resistance, varieties, susceptibility, *M. obtusa, C. gibbosa*, *H. armigera*, yield

INTRODUCTION

Pigeonpea (*Cajanus cajan* (L.) Millsp.) is an important pulse-cum-grain legume crop of semi-arid and subtropical areas of the world and especially of India, where more than 90% of the world's pigeonpea is grown. The nutritional value of pigeonpea is high due to its high protein content (22.3%), minerals and essential amino acids like lysine, cystine and arginine (Rathod *et al*. 2014). Among the several factors responsible for lower yields of pigeonpea, insect pests are the major limiting factors. Pigeonpea is attacked by a large number of insects at all growth stages. From seedling to harvest stage, about 250 species of insects belonging to 61 families of 8 orders infesting this crop are known, although only a few of them have been found to cause significant damage to the crop (Singh *et al.* 2014, Yadav *et al*. 2016). On an estimate, losses due to insect pests may vary from 27% to 100% and on an average annually 2.5 to 3.0 million tonnes of pulses are lost (Srilaxmi and Paul 2010). The major insect pests of pigeonpea are redgram pod fly *Melanogromyza obtusa*, gram pod borer *Helicovelpa armigera*, spotted pod borer *Maruca vitrata* and pod sucking bug (*Clavigralla gibbossa)* (Sunitha *et al*. 2008; Tyagi and Keval 2021). Among all insects, pod fly *Melanagromyza obtusa* (Malloch) (Diptera: Agromyzidae) is the most obnoxious one causing grain damage ranging from 20 to 80% (Subharani and Singh 2009). The pod fly oviposit eggs on the inner surface of the pod walls. This concealed mode of life of pod fly within the pod makes it hard to control with conventional insecticides. The gram pod borer, *Helicoverpa armigera* (Hübner) (Lepidoptera: Noctuidae) is also an important insect pest of pigeonpea having polyphagous nature, high fecundity and strong migratory ability. Because of its feeding habit on critical growth stages *viz* flowering and pod filling, it results in direct reduction of the crop yield causing economic damage. Among the sucking insect pests of pigeonpea, tur pod bug, *Clavigralla gibbosa* (Spinola) (Hemiptera: Coreidae) has also emerged as a threat to the quality grain production, causing yield losses from 25 to 40% (Gopali *et al*. 2013). Both nymphs and adults of *Clavigralla* spp. feed on pigeonpea by piercing the pod wall and extracting nutrients from the developing seeds (Bindra 1965), causing shrivelled/darkened grains and deformed pods, resulting in significant losses to pigeonpea crops. The identification of insect resistant pigeonpea genotypes would be of particular importance to marginal farmers in India who are unable to

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access costly inputs like pesticides. Use of resistant varieties virtually does not involve any skill or costly investment in pest management and is ecologically safe. Therefore, host-plant resistance can be used as an important tool for the management of these pests. Thus, keeping these views in mind, the present study was conducted to evaluate the genotypes for reduced susceptibility and higher yields to the insect pest complex in pigeonpea.

MATERIALS AND METHODS

The present investigation was carried out during *Kharif* season of 2017 and 2018 at Agriculture Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi (25°16'N, 82°59'E; altitude-81m). For the experiment, fifteen long duration pigeonpea genotypes were taken in randomized complete block design with three replications including controls (susceptible check BAHAR and resistant check MAL-13) during both the years. The spacing adopted were 75cm from row to row and 30cm from plant to plant, respectively. Standard agronomic practices were followed and open field screening technique using natural pest population was adopted. For the screening of insect pests, pods from five tagged plants from each plot were plucked separately at the time of physiological maturity of the crop. The criteria set for identifying different insect pests damage was adopted from Yadav *et al*. (1987), according to which pod damage in the form of a pin shaped hole with immature drying was identified for *M. obtusa* and the presence of round, large bored holes in pods for *H. armigera*. The seeds which have become shrivelled with dark patches were identified for *C. gibbosa* damage. Pod damage was recorded by observing randomly plucked 100 pods from previously tagged plants of each genotype. From them, numbers of damaged pods by each insect pest were recorded separately and converted into per cent pod damage as: Per cent pod damage = (Number of pods damaged/ total number of pods examined x 100). Similarly, for the grain damage assessment, cleaned seeds were taken after harvesting and threshing, from which damaged seeds were separated, counted and per cent grain damage was computed per plot per insect. The susceptibility of different genotypes to insects' damage was calculated on the basis of per cent pod damage at the time of the crop maturity. Insect pest susceptibility values (Lateef *et al.* 1982), form the basis of Pest susceptibility ratings (PSR) that were assigned to the genotypes in the following manner:

Pest susceptibility	Grade	Category
100%	1	Highly resistant
75 to 90%	2	Resistant
50 to 75%	3	Least susceptible
25 to 50%	4	Least susceptible
10 to 25%	5	Least susceptible
-10 to 10%	6	Moderately susceptible
-10 to -25%	7	Moderately susceptible
-25 to -50%	8	Highly susceptible
<-50%	9	Highly susceptible

For the estimation of grain yield, dried seeds from each plant of every plot were assessed for their weight measurement. Total yield per plot was calculated and later converted on kg ha^{-1} basis. The data obtained during both the years were pooled and analysis of variance (Two factor repeated ANOVA at P = 0.05) was carried out in randomized block design to assess the differences in susceptibility of various genotypes. Pest damage data were transformed to Arc sin (data in per cent) transformation prior to statistical analysis and means were compared based on the Fisher least significant difference (LSD) test at P = 0.05. All the statistical analysis work was done in R (4.0.0).

RESULTS AND DISCUSSION

Fifteen pigeonpea genotypes were raised for studying the damage assessment in the form of pod and grain damage by major insect pests. Amongst many insect pests attacking pigeonpea, gram pod borer, pod bug, legume pod borer and pod fly caused significant reduction in the crop yield of pigeonpea (Sujithra and Chander, 2014). The pest susceptibility rating and relative yield were also computed after harvesting of the crop. The results showed that among fifteen genotypes, none was found free from infestation of the pests. The average pod damage caused by *M. obtusa* was 62%, 27% by *C. gibbosa* while 10% by *H. armigera* in both the years.

Screening for resistance/tolerance against M. Obtuse

Pigeonpea genotypes assessed for their reaction against *M. obtusa* infestation were found to be significantly different (P ≤ 0.05). Pod damage on different genotypes varied from 27.1% in IVT-705 to 36.0% in IVT-1-2-908. Lower pod damages were also seen in IVT-706 (29.0%) and IVT-12-904 (29.5%) against the susceptible check BAHAR (38.6%) and the resistant check MAL-13 (26.0%) damage. The grain damage caused by *M. obtusa* was recorded highest in IVT-1-704 (18.2%) and lowest in IVT-907 (13.1%), followed by IVT-706 (13.1%), which were at par with each other as compared to checks MAL-13 (11.6%) and BAHAR (17.5%) (Table 1) Pandey and Srivastava (2012) observed that ovipositional preference of the pod fly as well as tolerance mechanism operates in resistant genotypes. The authors have rated *M. obtusa* as the serious pest in northern part of India with an estimation of 80% pod and 40 to 60% of grain infestation (Tyagi and Keval 2021). Our findings confirms with the findings of these authors.

Table 1: Per cent damage done by insect pests during *Kharif* 2017-19 (pooled mean)

Genotypes	*M. obtusa*			*C. gibbosa*			*H. armigera*		
	% Pod damage	% Grain damage	PSR	% Pod damage	% Grain damage	PSR	% Pod damage	% Grain damage	PSR
IVT-1-704	35.83(36.75)^{b}	18.27(25.28)^{a}	6	17.17(42.70)^{a}	5.78(13.82)^{ab}	8	6.17(14.30)^{abc}	2.11(8.26)^{b}	6
IVT-702	33.83(35.55)^{bc}	17.86(24.99)^{a}	5	17.00(42.47)^{a}	5.49(13.51)^{abc}	8	5.67(13.71)^{bcde}	2.06(8.23)^{bc}	6
IVT-703	35.50(36.55)^{b}	16.23(23.74)^{abc}	6	16.67(42.01)^{ab}	5.92(14.05)^{ab}	8	6.00(14.17)^{abcd}	0.92(5.47)^{d}	6
IVT-706	29.00(32.56)^{de}	13.19(21.26)^{de}	4	12.83(36.52)^{de}	3.83(11.26)^{c}	6	3.83(11.18)^{f}	1.96(7.99)^{bc}	4
IVT-705	27.17(31.40)^{ef}	14.83(22.61)^{cd}	4	11.17(33.99)^{e}	4.42(12.09)^{bc}	5	3.67(10.93)^{f}	1.82(7.63)^{bc}	4
IVT-701	30.83(33.71)^{d}	14.13(22.03)^{d}	5	15.33(40.15)^{abc}	4.55(12.31)^{abc}	7	6.00(14.17)^{abcd}	0.89(5.41)^{d}	6
IVT-208	31.33(34.01)^{cd}	14.46(22.32)^{cd}	5	12.67(36.30)^{de}	5.52(13.55)^{abc}	6	4.83(12.55)^{cdef}	1.60(7.20)^{bc}	5
IVT-907	31.50(34.12)^{cd}	13.18(21.26)^{de}	5	15.83(40.87)^{ab}	4.90(12.77)^{abc}	8	5.50(13.50)^{bcde}	1.92(7.88)^{bc}	5
IVT-1-901	33.50(35.34)^{bc}	17.86(24.98)^{a}	5	13.50(37.48)^{cd}	5.30(13.29)^{abc}	6	4.50(12.23)^{ef}	1.75(7.58)^{bc}	4
IVT-12-904	29.50(32.88)^{de}	15.03(22.74)^{bcd}	5	12.83(36.56)^{de}	4.36(12.04)^{bc}	6	7.33(15.68)^{a}	0.96(5.61)^{d}	7
IVT-1-903	30.00(33.20)^{d}	16.89(24.23)^{ab}	5	14.33(38.77)^{bcd}	6.09(14.26)^{ab}	7	7.33(15.69)^{a}	2.00(7.98)^{bc}	7
IVT-1-2-908	36.00(36.85)^{b}	14.07(22.02)^{d}	6	13.33(37.32)^{cd}	5.67(13.71)^{ab}	6	5.50(13.55)^{bcde}	1.84(7.74)^{bc}	5
IVT-1-2-902	30.00(33.20)^{d}	14.99(22.76)^{bcd}	5	12.67(36.31)^{de}	6.44(14.69)^{a}	6	6.00(14.14)^{abcd}	1.46(6.95)^{cd}	6
BAHAR	38.67(38.43)^{a}	17.51(24.71)^{a}		12.50(36.07)^{de}	5.95(14.08)^{ab}		6.17(14.34)^{ab}	1.76(7.61)^{bc}	
MAL-13	26.00(30.63)^{f}	11.65(19.93)^{e}		12.33(35.84)^{de}	5.39(13.40)^{abc}		4.67(12.44)^{def}	3.27(10.35)^{a}	
CD(P=0.05)	3.62	2.83		3.27	1.59		1.94	0.99	
SE(m) ±	1.81	1.41		0.27	0.79		0.97	0.49	

Figures in parentheses are arc sine transformed values. Means marked with different letters are significantly different (P<0.05) by LSD test

Screening for resistance/tolerance against C. Gibbosa

Susceptible genotypes with more damage per cent were more preferred for oviposition and feeding by the bug than the other test genotypes. The incidence of pod and grain damage incurred by *C. gibbosa* varied significantly (P ≤ 0.05) among the genotypes. The minimum pod damage was shown by IVT-705 (11.1%), followed by IVT-208, IVT-1-2-902 (12.6%) and IVT-12-904, IVT-706 (12.8%), which were at par with each other against the checks BAHAR (12.5%) and MAL-13 (12.3%) (Table 1). The least grain damage by *C. gibbosa* was observed in IVT-706 (3.8%), while the highest grain damage occurred in IVT-1-2-902 (6.4%), making it the most susceptible, as compared to the checks BAHAR (5.9%) and MAL-13 (5.3%). Ganguly *et al*. (2016) found that the per cent grain damage caused by pod bug on different genotypes ranged from 1.96% in genotype ICP 13212-1 to 16.97% in the genotype Bahar (check).

Screening for resistance/tolerance against H. Armigera

The degree of damage caused by *H. armigera* was recorded least as compared to all other pests' damage. Minimum per cent pod damage was observed in IVT-705 (3.6%). Maximum pod damage was observed in IVT-12-904 and IVT-1-903 (7.3%), which were found to be at par with each other against checks BAHAR (6.1%) and MAL-13 (4.6%). Based on per cent grain damage, the highest damage by *H. armigera* was observed in IVT-1-704 (2.1%). The lowest grain damage was recorded in IVT-701 (0.89%) which was also at par with IVT-703 (0.92%) and IVT-12-904 (0.96%), against checks BAHAR (1.76%) and MAL-13 (3.27%). Pod borers impart considerable damage to the reproductive parts of the plant (Tyagi *et al*. 2021; Pandey 2017). According to some studies late-maturing varieties suffered less pod damage, particularly by *H. armigera* and *M. testulalis* as compared to extra-early or early varieties of pigeonpea (Rathod *et al*. 2014).

Pest susceptibility rating

Pest susceptibility rating (PSR) is based upon the damage done by different insect pests on pigeonpa pods. Pigeonpea crop is attacked simultaneously by several insect pests though at different rates. In some cases resistance to some insects may enhance the other pest population and cause enough damage to negate the effect of resistance (Cheboi *et al.* 2016). For instance, IVT-907 having PSR = 5 for *M. obtusa* and *H. armigera*, showed PSR = 8 (highly susceptible) to *C. gibbosa.* Among fifteen genotypes for their reaction against *M. obtusa*, the least susceptible genotypes were found to be IVT-705 and IVT-706 (PSR = 4). Against *C. gibbosa*, IVT-705 showed pest susceptibility rating of 5 rendering it least susceptible. In case of *H. armigera*, the lowest pest susceptibility rating is 4, which was computed for the genotypes IVT-705, IVT-706 and IVT-1-901, thus making them least susceptible. None of the genotypes fell in resistant or highly resistant category and therefore did not offer strong resistance to either of the insect damage. Most of the genotypes were more susceptible to both pod borer and sucking bug but less to pod fly. Four genotypes (IVT-705, IVT-706, IVT-208 and IVT-907) showed consistent results of resistance to all the three insect pests in both the years, excepting IVT-907 for *C. gibbosa*.

Grain yield assessment

The major insect pests causing grain yield losses in pigeonpea are; gram pod borer, pod bug, legume pod borer and pod fly (Sujithra and Chander 2014). The interaction between the genotypes and the environment affected the yield production of the genotypes. The average yields obtained in both the years were 857 kg ha^{-1} and 888 kg ha^{-1}, respectively (Table 2). During 2017-18, the yield obtained in different genotypes ranged from 650 kg ha^{-1} in IVT-1-704 to 1060 kg ha^{-1} in IVT-701. Moderate levels of yield were also obtained from the genotypes IVT-706, IVT-907, IVT-12-904. During 2018-19, the yield obtained in different genotypes varied from 695 kg ha^{-1} in IVT-1-704 to 1119 kg ha^{-1} in IVT-706. Higher levels of yield were also obtained from the genotypes IVT-701, IVT-907, IVT-12-904, which showed consistent results to the insect pest tolerance except for a few like IVT-907 which was susceptible to pod sucking bug. This might be due to its higher number of branches yielding higher number of pods so that the damage could not be significant to its performance. There is a lower yield loss in those genotypes which showed lesser incidence of pod borers (Banu *et al.* 2007 and Khan *et al*. 2014) and lower percentage of pod damage (Anitha *et al*. 2006).

Table 2: Yearly yields of different pigeonpea genotypes (2017-18 & 2018-19) in kg ha^{-1}

Genotypes	2017-18	2018-19	Average
IVT-1-704	650	695	672.5
IVT-702	732	714	723.0
IVT-703	836	821	828.5
IVT-706	1025	1119	1072.0
IVT-705	847	881	864.0
IVT-701	1060	1091	1075.5
IVT-208	787	940	863.5
IVT-907	922	1012	967.0
IVT-1-901	852	755	803.5
IVT-12-904	863	964	913.5
IVT-1-903	741	862	801.5
IVT-1-2-908	771	786	778.5
IVT-1-2-902	870	810	840.0
BAHAR	916	905	910.5
MAL-13	982	964	973.0
CD (P=0.05)	216.7	187.1	
SE(m) ±	74.4	64.2	

Based on the above study it may be concluded that the damages done by *M. obtusa, C. gibbosa* and *H. armigera* on pigeonpea genotypes revealed different levels of resistance /susceptibility during both the years. Upon screening of the genotypes against these insect pests, *M. obtusa* and *C. gibbosa* emerged as the major damage causing pests. Higher grain yield and lower susceptibility to insect damage was recorded in the genotypes IVT-701, IVT-706 and IVT-907, but none of them proved to be highly-resistant/resistant. Integration of host plant resistance with other management components can effectively manage these insect pests. Further studies are needed on their interaction, mechanism and genetics of resistance.

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