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Impact of sowing period and variety on pod fly, *Melangromyza obtusa* in Pigeonpea

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Abstract
A field experiment was conducted to study the impact of sowing period and variety on damage by pod fly, *Melangromyza obtusa* in pigeonpea at Agricultural Research Station, Anand Agricultural University, Derol, Dist. Panchmahal, Gujarat, India during *Kharif*, 2014-15, 2015-16, 2017-18 and 2018-19. Results of the study revealed that per cent grain damage due to pod fly at green pod stage was not affected significantly due to sowing of crop in different sowing periods [(24th, 26th, 28th, 31st and 33rd Standard Meteorological Week (SMW)], whereas significantly lowest per cent grain damage was observed in Vaishali variety (13.95%) as compared to AGT-2 (18.68%) and BDN-2 (20.69%). In case of per cent grain damage, at harvest pigeonpea crop sown in 24th SMW (20.05%) recorded significantly lowest damage and it was at par with 26th SMW (23.01%). At harvest, Vaishali (22.02%) suffered significantly lowest grain damage as compared to AGT-2 (28.26%) and BDN-2 (29.86%). The grain yield of pigeonpea was not influenced significantly due to sowing period and variety.

Keywords: *Melangromyza obtusa*, Variety, pigeonpea, sowing period

1. Introduction
Pigeonpea [*Cajanus cajan* (L.) Millsp.], also known as redgram, is one of the most important and widely grown legume crops of the tropics and subtropics of Asia and Africa. The world's largest producer and consumer of pulses, including pigeonpea, is India [11]. The area under pigeonpea cultivation in India is 44.38 lakh hectare, whereas its production is 42.89 lakh tonne with productivity of 967 kg/ hectare [2] In Gujarat, pigeonpea is cultivated in an area of 2.71 lakh hectare, while its production is 3.37 lakh tonne and productivity is 1243 kg/ hectare [2]. The average productivity of pigeonpea in the state and county is very low. Among the several constraints responsible for the low productivity of pigeonpea in the state and country, damage by insect pests is a major one. More than 90 insect species were reported to occur on pigeonpea crop in India [4]. Among them pod fly, *Melangromyza obtusa* is a key and serious pest of pigeonpea. It causes serious damage to the pods and seeds of pigeonpea from November to February, resulting in poor germination and making them unfit for human consumption and damage seeds are of no value. Pods damaged by pod fly do not show obvious external symptoms of pod fly attack till the fully grown maggot make small exit hole in the pod walls through which the pod fly adult emerge after pupation in the pod [11]. As all immature stage of pod fly remain inside the pod it is very difficult to monitor this pest [11]. The percentage of infestation ranged from 12 to 100 per cent pods causing losses of 2.4 to 95.0 per cent seeds [1, 3, 5, 10] and the annual monetary losses were estimated at US $ 256 million [9]. Late sowing of crop make it more vulnerable to the pod fly attack [11]. Selection of resistant cultivars has been suggested for the management of pod fly [11]. Further, of sowing time and variety are the eco-friendly tools to minimize the damage caused by insect pests. Integration of these methods of pest management may help in minimizing damage by insect pests. Hence, the field experiment was conducted to study the impact of the sowing period and variety on damage by pod fly, *M. obtusa* in pigeonpea.

2. Materials and Methods
The study on impact of sowing period and variety on pod fly, *M. obtusa* in pigeonpea was carried out at Agricultural Research Station, Anand Agricultural University, Derol, Dist. Panchmahal, Gujarat, India during *Kharif*, 2014-15, 2015-16, 2017-18 and 2018-19. The experiment was laid out in split plot design with three replications sowing period was taken as main plot treatment, whereas variety was taken as sub plot treatments. There were five sowing

periods viz., 24th Standard Meteorological Week (SMW), 26th, 28th, 31st and 33rd SMW. Three varieties viz., BDN-2, AGT-2 and Vaishali were evaluated as sub plot treatment. Pigeonpea crop was sown as per the decided period of sowing and variety with a spacing 90 x 20 cm. The gross plot size was 4.5 x 5 m, whereas net plot size was 2.7 x 4.6 m. All agronomic practices were followed to raise the crop. All the plots were kept free from application of any insecticide. For recording observations of per cent grain damage due to pod fly at green pod stage, 100 pods were randomly plucked from each net plot area. Plucked pods were opened and their grains were segregated into healthy and damaged based on this per cent grain damage was calculated. Similar method was followed to record observation on per cent grain damage at harvest stage. At harvest, grain yield was record from each net plot and it was converted into kg/ha. The data on per cent grain damage and yield were subjected to ANOVA to draw the conclusion.

3. Results and Discussion

3.1 Grain damage due to pod fly at green pod stage:

The data on the impact of sowing period and variety on damage by *M. obtusa* were at green pod stage are given in Table 1. Results show that during the year 2014-15, per cent grain damage was ranging from 12.26 to 15.65 per cent in different sowing periods. The per cent grain damage was not affected significantly by sowing period but significantly lowest per cent grain damage was recorded in Vaishali (12.15%) as compared to AGT-2 (15.60%) and BDN-2 (15.80%). In the year 2015-16, sowing period significantly affected the grain damage by pod fly. Significantly lowest per cent grain damage was recorded in 33rd SMW (11.57%) and it was at par with 31st SMW (11.99%). Higher grain damage was recorded in 24th SMW (19.83%). In case of variety significantly lowest per cent grain damage was recorded in Vaishali (12.40%) and higher per cent grain damage was recorded in BDN-2 (17.20%). During the year 2016-17, the sowing period had no significant influence on the damage by pod fly. Vaishali (14.87%) recorded lowest significantly per cent grain damage, whereas the highest per cent grain damage found in BDN-2 (20.94%). In the year 2017-18, results indicated that the impact of sowing period on pod fly damage was significant. The per cent grain damage varied from 16.65 to 22.48 per cent. Significantly lowest per cent grain damage was observed in the crop sown on 28th SMW (16.65%) whereas the highest per cent grain damage was recorded in crop sown during 24th SMW (22.48%). In case in variety, significantly lowest per cent grain damage were recorded in Vaishali (17.06%) as compared to AGT-2 (19.34%) and BDN-2 (20.95%). The pooled over data of four year indicated that sowing period had non- significant influence on grain damage due to podfly in pigeonpea. Whereas, the significantly lowest per cent grain damage was observed in vaishali (13.95%) as compared to BDN-2 (20.69%) and AGT-2 (18.68%).

Table 1: Impact of sowing period and variety on grain damage at green pod stage due to pod fly in pigeonpea

Treatment	Grain damage (%)				
	2014-15	2015-16	2016-17	2017-18	Pooled
Sowing Period (Main Plot Treatment)					
24th SMW (2nd week of June)	20.49[a]	26.44[b]	25.11[a]	28.30[d]	23.79[a]
	(12.26)	(19.83)	(18.01)	(22.48)	(16.27)
26th SMW (4th week of June)	22.62[a]	25.77[b]	24.49[a]	27.35[d]	24.92[a]
	(14.80)	(18.91)	(17.18)	(21.11)	(17.76)
28th SMW (2nd week of July)	22.72[a]	21.47[b]	24.07[a]	24.08[a]	24.55[a]
	(14.92)	(13.39)	(16.63)	(16.65)	(17.26)
31st SMW (4th week of July)	22.66[a]	20.26[a]	24.79[a]	24.80[b]	25.02[a]
	(14.85)	(11.99)	(17.58)	(17.60)	(17.89)
33rd SMW (2nd week of August)	23.30[a]	19.89[a]	25.00[a]	25.01[b]	26.05[a]
	(15.65)	(11.57)	(17.86)	(17.87)	(19.29)
S. Em. ± D	0.92	0.80	2.15	0.10	1.66
Y	--	--	--	--	0.57
D x Y	--	--	--	--	1.28
C. D. at 5% D	NS	2.50	NS	0.32	NS
Y	--	--	--	--	1.66
D x Y	--	--	--	--	3.70
C.V. (%)	17.54	14.9	16.98	6.92	16.90
Variety (Sub Plot Treatment)					
BDN-2	`123.42[b]	24.50[c]	27.23[b]	27.24[c]	27.06[b]
	(15.80)	(17.20)	(20.94)	(20.95)	(20.69)
AGT-2	23.26[b]	23.17[b]	24.17[ab]	26.09[b]	25.61[b]
	(15.60)	(15.49)	(16.76)	(19.34)	(18.68)
Vaishali	20.40[a]	20.62[a]	22.68[a]	24.40[a]	21.93[a]
	(12.15)	(12.40)	(14.87)	(17.06)	(13.95)
S. Em. ± V	0.63	0.44	1.08	0.08	0.83
P	0.51	0.36	0.88	0.05	1.07
D x V	0.89	0.62	1.53	0.40	1.29
V X Y	--	--	--	--	0.71
D x P	1.40	0.98	2.41	0.27	1.02
V x P	1.14	0.80	1.97	1.1	0.51
Y x D x V	--	--	--	--	1.59
Y x D x P	--	--	--	--	1.30
Y x V x P	--	--	--	--	1.01
D x V x P	1.98	1.39	3.41	0.80	1.13

Y x D x V x P	--	--	--	--	2.26
C. D. at 5% V	1.78	1.25	3.07	0.23	2.87
P	1.45	1.02	NS	NS	NS
D x V	2.52	1.76	4.34	NS	NS
V X Y	--	--	--	--	1.98
D x P	3.98	2.79	NS	0.76	NS
V x P	NS	NS	NS	NS	1.98
Y x D x V	--	--	--	--	4.43
Y x D x P	--	--	--	--	3.61
Y x V x P	--	--	--	--	NS
D x V x P	NS	3.95	NS	2.27	NS
Y x D x V x P	--	--	--	--	NS
C.V. (%)	15.33	10.57	17.93	9.25	15.73

Note: Figures outside parenthesis are arcsine transformed value and those inside parenthesis are retransformed values, Treatment means with the letter(s) in common are at par by DNMRT at 5% level of significance. NS: Non-Significant, SMW: Standard Meteorological Week

3.2. Grain damage due to pod fly at harvest stage

The data grain damage by pod fly recorded at the time of harvest of the pigeonpea crop are presented in Table 2. During year 2014-15, significantly lowest grain damage (19.37%) was observed at 24th SMW as compared to the crop sown on 26th SMW (24.92%), 28th SMW (27.96%), 31st SMW (28.13%) and 33rd SMW (25.44%). Impacts of different varieties were found significant. Among three different varieties, significantly lowest per cent grain damage was recorded in Vaishali (20.01%) and it was at par with AGT-2 (23.91%) whereas, highest grain damage observed in BDN-2 (31.82%). During the year 2015-16, the different sowing period as well as varieties had no significant influence on the per cent grain damage. In the year 2016-17, sowing period significantly affected the damage by pod fly. Significantly lowest per cent grain damage was recorded in 24th SMW (28.03%) and it was at par with 26th SMW (35.44%) and 28th SMW (37.26%). Significantly highest grain damage was recorded in 33rd SMW (53.83%). In case of varieties significant effect was observed on pod fly damage in pigeonpea. Significantly lowest per cent grain damage was recorded in variety vaishali (31.12%) and highest per cent grain damage recorded in BDN-2 (42.55%). In the year 2017-18, the impact of sowing period on grain damage due to pod fly was significant. The per cent grain damage varied from 14.68 to 35.72 per cent. Significantly lowest per cent grain damage was observed in crop sown on 24th SMW (14.68%) and it was at par with 26th SMW (16.52%). Significantly highest per cent grain damge was recorded when crop sown in 33rd SMW (35.72%). In case in variety, significantly lowest per cent grain damage was recorded in Vaishali (22.06%) as compared to AGT-2 (27.41%) and BDN-2 (28.19%). Results show per cent grain damage pooled over years was significantly different among five periods of sowing in crop sown during 24th SMW (20.05%) and it was at par with 26th SMW (23.01%). Significantly highest grain damage was recorded in 33rd SMW (32.51%). The present study is also supported by Patel [6] who reported the lower grain damage was observed when crop sown in 24th SMW (11.81%) and 26th SMW (13.07%). Data on per cent grain damage pooled over years indicate that significantly lowest grain damage was observed in Vaishali (22.02%) and it differed significantly from AGT-2 (28.26%) as well as BDN-2 (29.86%). Patel[7] while studying the effect of sowing period and variety in relation to pod fly recorded lowest per cent grain damage in determinate variety vaishali (16.36%).

Table 2: Impact of sowing period and variety on grain damage at harvest due to pod fly in pigeonpea

Treatment	Grain damage (%)				
	2014-15	2015-16	2016-17	2017-18	Pooled
Sowing Period (Main Plot Treatment)					
24th SMW (2nd week of June)	26.11^{a}	25.79_{a}	31.97^{a}	22.53^{a}	26.60^{a}
	(19.37)	(18.93)	(28.03)	(14.68)	(20.05)
26th SMW (4th week of June)	29.95^{b}	24.18^{a}	36.53^{ab}	23.98^{ab}	28.66^{ab}
	(24.92)	(16.78)	(35.44)	(16.52)	(23.01)
28th SMW (2nd week of July)	31.92^{b}	24.23^{a}	37.62^{ab}	35.88^{cd}	32.41^{bc}
	(27.96)	(16.85)	(37.26)	(34.35)	(28.73)
31st SMW (4th week of July)	32.03^{b}	24.64^{a}	41.37^{bc}	33.66^{c}	32.92^{c}
	(28.13)	(17.38)	(43.67)	(30.72)	(29.54)
33rd SMW (2nd week of August)	30.29^{b}	24.86^{a}	47.20^{c}	36.70^{d}	34.76^{d}
	(25.44)	(17.67)	(53.83)	(35.72)	(32.51)
S. Em. ± D	0.71	1.34	2.11	0.76	1.82
Y	--	--	--	--	0.61
D x Y	--	--	--	--	1.35
C. D. at 5% D	2.463	NS	7.307	2.48	5.62
Y	--	--	--	--	1.75
D x Y	--	--	--	--	3.91
C.V. (%)	7.11	16.20	16.28	7.46	13.07
Variety (Sub Plot Treatment)					
BDN-2	34.34^{b}	25.37^{a}	40.71^{b}	32.07^{bc}	33.12^{bc}
	(31.82)	(18.36)	(42.55)	(28.19)	(29.86)
AGT-2	29.28^{a}	25.40^{a}	42.19^{b}	31.57^{b}	32.11^{b}
	(23.91)	(18.40)	(45.11)	(27.41)	(28.26)

Vaishali	26.57[a]	23.45[a]	33.91[a]	28.01[a]	27.98[a]
	(20.01)	(15.83)	(31.12)	(22.06)	(22.02)
S. Em. ± V	1.075	0.635	0.995	0.75	0.98
D x V	2.403	1.42	2.22	1.67	1.56
V X Y	--	--	--	--	0.88
Y x D x V	--	--	--	--	1.97
C. D. at 5% V	3.171	NS	2.93	2.20	3.40
D x V	NS	NS	6.56	4.93	NS
V X Y	--	--	--	--	2.48
Y x D x V	--	--	--	--	5.55
C.V. (%)	13.85	9.95	9.90	9.48	10.99

Note: Figures outside parenthesis are arcsine transformed value and those inside parenthesis are retransformed values, Treatment means with the letter(s) in common are at par by DNMRT at 5% level of significance. NS: Non-Significant, SMW: Standard Meteorological Week

3.3. Grain yield

Data on pigeonpea grain yield are given in Table 3. Results show that during the year 2014-15, the sowing periods had no significant influence on grain yield. In case of varieties significant effect was observed on grain yield of pigeonpea. Significantly highest grain yield (1527 kg/ha) was recorded in variety Vaishali as compared to BDN-2 (1368 kg/ha) and AGT-2 (1219 kg/ha).

During the year 2015-16, the differences among sowing period with respect to grain yield were non-significant. BDN-2 (1608 kg/ha) recorded significantly highest grain yield and it was at par with AGT-2 (1472 kg/ha), whereas the lowest grain yield damage recorded in Vaishali (1417 kg/ha).

In the year 2016-17, significantly highest grain was observed in crop sown on 2^{4th} SMW (1480 kg/ha) and it was at par with 26th SMW (1365 kg/ha). Significantly lowest grain yield was recorded when crop sown in 33rd SMW (1196 kg/ha). The variety had no significant influence on the grain yield of pigeonpea.

Table 3: Impact of sowing period and variety on grain yield of pigeonpea

Treatment	Grain yield kg/ha				
	2014-15	2015-16	2016-17	2017-18	Pooled
Sowing Period (Main Plot Treatment)					
24th SMW (2nd week of June)	1296[a]	1408[a]	1480[a]	1543[a]	1432[a]
26th SMW (4th week of June)	1272[a]	1413[a]	1365[ab]	1353[a]	1351[a]
28th SMW (2nd week of July)	1528[a]	1553[a]	1212[bc]	1312[a]	1401[a]
31st SMW (4th week of July)	1419[a]	1667[a]	1210[c]	1207[a]	1376[a]
33rd SMW (2nd week of August)	1341[a]	1455[a]	1196[c]	1239[a]	1308[a]
S. Em. ± D	58.44	77.74	47.32	72.42	32.54
Y	--	--	--	-	29.11
D x Y	--	--	--	-	65.08
C. D. at 5% D	NS	NS	154.33	NS	NS
Y	--	--	--	-	83.05
D x Y	--	--	--	-	187.48
C.V. (%)	12.79	15.56	10.98	16.33	14.22
Variety (Sub Plot Treatment)					
BDN-2	1368[b]	1608[a]	1275[a]	1352[a]	1401[a]
AGT-2	1219[c]	1472[ab]	1335[a]	1356[a]	1345[a]
Vaishali	1527[a]	1417[b]	1267[a]	1284[a]	1374[a]
S. Em. + V	47.90	46.45	45.56	23.21	52.76
D x V	107.098	103.88	101.87	51.90	46.99
Y x V	--	--	--	-	42.03
Y x D x V	--	--	--	-	93.98
C. D. at 5% V	141.30	137.04	NS	NS	NS
D x V	NS	NS	NS	NS	NS
Y x V	--	--	--	-	118.29
Y x D x V	--	--	--	-	NS
C.V. (%)	13.53	12.00	13.65	-	11.85

NS: Non Significant

During the year 2017-18, the sowing period as well as variety had no significant influence on grain yield. Among five sowing period highest grain yield was recorded in 24th SMW. In case in variety AGT-2 (1356 kg/ha) recorded highest grain yield than the BDN-2 (1352 kg/ha) and Vaishali (1284 kg/ha. Similarly, pooled over data of four year indicate that sowing period and variety did not significantly influence the grain yield of pigeonpea. highest grain yield was recorded when crop sown in 24th SMW (1432 kg/ha). In the variety, highest grain yield was recorded in BDN-2 (1401 kg/ha) as compared to Vaishali (1374 kg/ha) and AGT-2 (1345 kg/ha).

4. Conclusion

Pigeonpea crop sown in the 24th SMW (2nd week of June) suffered significantly lower grain damage due to pod fly at harvest as compared to 28th, 31st and 33rd SMW. Per cent grain damage at harvest were at par in crop sown in 24th SMW and 26th SMW. Per cent grain damage due to pod fly, at green pod stage as well as harvest, was significantly lowest in Vaishali variety as compared to BDN-2 and AGT-2. Sowing period and variety did not significantly influence the grain yield of pigeonpea

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