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Effect of Sowing Dates and Preliminary Screening of Linseed Genotypes for Bud Fly Infestation

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ABSTRACT

Field experiments on effect of sowing dates and screening of genotypes in reference to linseed bud fly infestation were conducted during *rabi* 2016-17 under natural field conditions. The tested genotypes/ varieties have shown high infestation of linseed bud fly and low yield in progressive manner with delay in sowing. The lowest mean bud fly infestation (13.39%) and highest mean yield (1385.30 kg ha^{-1}) was obtained with the crop sown on 08.11.2016 whereas the highest mean bud fly infestation (37.46%) and lowest mean yield (177.75 kg ha^{-1}) was obtained with crop sown on 08.01.2017. In case of varieties, the lowest mean bud fly infestation (19.83%) was observed in BRLS-102 followed by Shekhar (22.23%) whereas Shubhra resulted in highest mean bud fly infestation (32.82%). Out of tested genotypes, a total of 12, 65, 17, 5, 2 genotypes were categorized as resistant, moderately resistant, moderately susceptible, susceptible and highly susceptible, respectively based on bud fly damage index under natural field conditions.

Keywords Linseed genotypes, *Dasyneura lini* Barnes, Resistance, Susceptible, Sowing date.

INTRODUCTION

Linseed / Flaxseed (*Linum usitatissimum* L.), a crop of temperate and subtropical climate is credited with nutritional (534 calories/100g), medicinal (Omega-3-fats), industrial (fibers) and agricultural uses (33-47% oil) (Nayak *et al*. 2014). India accounts for about 1.9 million hectares, with a seed production of 4.98 lakhs of tonnes and occupies the third rank after Australia and Canada among the linseed-producing countries but yield in the country is lowest in the world (Vittal *et al.* 2005). The major linseed growing states are Uttar Pradesh, Madhya Pradesh, Chhattisgarh, Rajasthan, Bihar and Jharkhand. Madhya Pradesh has largest growing area (1.255 lac ha) and production (0.479 lac tonnes) but maximum yield has been found in Bihar (851 kg/ha) (Anonymous 2010). Despite considerable increase in production and productivity, the crop is suffered by variety of biotic and abiotic stresses.

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Among biotic stresses *Alternaria blight* caused by *Alterneria lini* and *A. linicola* is the most important disease in eastern India and known to inflict 40–60 % of theoretical yield losses in linseed (Singh *et al.* 2003). Other than this, more than 36 insect-pests are associated with the crop (Pal and Malik 2018). The bud fly, *Dasyneura lini* Barnes (Diptera: Cecidomyiidae) are recognized as the key pests and the yield loss due to bud fly have been reported ranging between 17-49% with an average of 40% at national level (Malik *et al.* 2008). Such heavy losses in seed yield due to bud fly incidence can be reduced up to respectable extent by manipulations in agronomic practices (Malik *et al.* 2008). In addition, resistant varieties are one of the fundamental, widely accepted and eco- friendly tools of integrated pest management. Since each genotype possessed unique defence mechanism based of alteration of environmental factors and has effect on the reproduction and survival of insect pests. Therefore, the present study was undertaken to study the effect of sowing dates and to identify the resistant genotype against bud fly infesting linseed.

MATERIALS AND METHODS

Two separate field experiments on sowing dates and screening of genotypes were conducted during *rabi,* 2016-17 at Experimental Farm, Bihar Agricultural University, Sabour located in Agro-climatic Zone IIIA of Bihar having subtropical climate characterized with hot desiccating summer, cold winter and moderate annual rainfall (1026 mm) and situated between 25°15'40" North latitude and 82°2'42" East longitude at an altitude of 46 m a.m.s.l. Field experiment on sowing dates was carried out by taking five varieties (Shekhar, Shubhra, Garima, T-397 and BRLS 102) with five sowing dates (8.11.2016, 23.11.2016, 08.12.2016, 23.12.2016 and 08.01.2017) in Split Plot Design having 4.00 × 2.50 m plot size, 25.0 × 10 cm plant spacing with three replications. Data on the total buds as well as infested buds were recorded from five randomly selected plants from the crop near to maturity and per cent bud infestation was calculated. Additionally, the data on yield were also recorded. Obtained data were subjected to analysis of variance after transformation of data as per the procedure suggested by Gomez and Gomez (1984).

Another filed trial on preliminary screening of linseed genotypes was conducted by utilizing 104 linseed genotypes along with resistant (Neela) and susceptible (Neelum) checks in Augmented Plot Design with 3.0 m single row length under natural field conditions and sowing was done on 30th November, 2016. Out of 104 genotypes, 36 entries belonged to Uniform Pest Nursery (UPN) and 68 belonged to Breeding Material (BM) category. The resistant (Neela) and susceptible (Neelum) checks were sown after every 9 and 17 entries in UPN and BM category, respectively. The bud fly damage was recorded at maturity stage of the crop from five randomly selected plants from each entry. For this purpose, the total number of healthy buds as well as total number of infested buds were counted and per cent bud damage was calculated. On the basis of per cent damage bud, the genotypes were categorized as resistance to highly susceptible on the basis of degree of infestation prescribed by Tripathi *et al.* (2002).

RESULTS AND DISCUSSION

Effect of sowing date on the infestation of *D. lini*: Perusal of data presented in Table 1 revealed that the infestation of bud fly increased in progressive manner with delay in sowing time. Bud fly infestation (%) varied from 10.51 (Shekhar) to 16.51 (Shubhra), 13.50 (BRLS-102) to 26.66 (Shubhra), 19.28 (BRLS-102) to 33.86 (Shubhra), 25.23 (BRLS-102) to 42.11 (Shubhra) and 29.48 (BRLS-102) to 44.98 (Shubhra) in first, second, third, fourth and fifth date of sowing, respectively. The lowest mean bud fly infestation (13.39%) was recorded for first date of sowing for all five varieties followed by second (19.78%) and third (25.82%). Fifth date of sowing recorded the maximum mean bud fly infestation (37.46%) and it was followed by fourth date of sowing (33.53%). In case of varieties, the mean bud fly infestation was found lowest (19.83%) in BRLS-102 followed by Shekhar (22.23%) and T-397 (26.13%). Shubhra resulted in highest mean bud fly infestation (32.82%) followed by Garima (28.97%). The present findings are in conformity with those of Pal *et al.* (1978) who also observed that the bud fly infestation increased with delay in sowing of the corp. Linseed sown on 3rd November gave lowest bud infestation compared to highest bud infestation in the crop sown on 15th

Table 1. Effect of sowing dates on the infestation of *Dasyneura lini* and crop yield.

Date of sowing	Bud fly infestation (%)					
	V1 (Shekhar)	V2 (Shubhra)	V3 (Garima)	V4 (T-397)	V5 (BRLS-102)	Mean
D1 (08.11.2016)	10.51 (18.91)	16.51 (23.97)	14.46 (22.35)	13.82 (21.82)	11.64 (19.95)	13.39 (21.46)
D2 (23.11.2016)	15.48 (23.17)	26.66 (31.09)	23.57 (29.05)	19.68 (26.34)	13.50 (21.55)	19.78 (26.41)
D3 (08.12.2016)	21.64 (27.72)	33.86 (35.58)	28.69 (32.39)	25.63 (30.42)	19.28 (26.05)	25.82 (30.54)
D4 (23.12.2016)	29.58 (32.95)	42.11 (40.46)	36.99 (37.46)	33.71 (35.49)	25.23 (30.15)	33.53 (35.38)
D5 (08.01.2017)	33.93 (36.62)	44.98 (42.12)	41.11 (39.88)	37.80 (37.94)	29.48 (32.89)	37.46 (37.74)
Mean	22.23 (28.13)	32.82 (34.95)	28.97 (32.56)	26.13 (30.74)	19.83 (26.44)	
	D	V	D × V	V × D		
SEm (±)	1.38	1.23	2.74	2.81		
$LSD_{(P=0.05)}$	4.49	3.51	7.84	8.31		

Table 1. Continued.

Date of sowing	Yield (kg ha^{-1})					
	V1 (Shekhar)	V2 (Shubhra)	V3 (Garima)	V4 (T-397)	V5 (BRLS-102)	Mean
D1 (08.11.2016)	1513.21	1039.33	1366.39	1411.23	1596.33	1385.30
D2 (23.11.2016)	1180.53	850.11	998.77	1053.48	1222.00	1061.98
D3 (08.12.2016)	875.33	635.47	706.00	711.00	866.60	758.88
D4 (23.12.2016)	415.33	290.00	371.33	399.33	539.67	403.13
D5 (08.01.2017)	196.33	107.53	191.87	155.70	237.33	177.75
Mean	836.15	584.49	726.87	746.15	892.39	
	D	V	D × V	V × D		
SEm (±)	24.09	15.70	35.11	39.58		
$LSD_{(P=0.05)}$	78.55	44.88	100.37	119.04		

Figures in the parenthesis are angular transformed value.

December at Kanpur (Uttar Pradesh), India. Similarly, Singh *et al.* (1991) also reported that early sowing of crop reduced bud fly damage as compared to late sown crop.

Delay in date of sowing decreased the yield of linseed in a progressive manner across the tested varieties (Table 1). The highest yield (1596.23 kg ha^{-1}) was obtained with variety BRLS-102 followed by Shekhar (1513.21 kg ha^{-1}) and Garima (1366.39 kg ha^{-1}) sown on first date of sowing. Shubhra resulted in lowest yield of 1039.33 kg ha^{-1} followed by 1366.39 kg ha^{-1} in Garima on similar date of sowing. Similar patterns were also obtained for rest of the sowing dates. The mean yield was calculated on the basis of all five varieties and highest mean yield (1385.30 kg ha^{-1}) was obtained with first date of sowing, followed by 1061.98 kg ha^{-1} in second, 758.88 kg ha^{-1} in third, 403.13 kg ha^{-1} in fourth and 177.75 kg ha^{-1} in fifth date of sowing. Among the varieties, the highest mean yield (892.39 kg ha^{-1}) was obtained with BRLS-102 followed by Shekhar (836.15 kg ha^{-1}) and

Table 2. Bud fly infestation in different genotypes of linseed during *rabi* 2016-17.

Code	Genotype	Infested bud (%)	Code	Genotype	Infested bud (%)	Code	Genotype	Infested bud (%)
RC	Neela	8.33	UPN-34	SJKO-03	11.11	RC	Neela	5.71
SC	Neelum	42.31	UPN-35	SJKO-12	11.67	SC	Neelum	18.52
UPN-1	BAU-14-3	18.75	UPN-36	SLS-101	10.81	BM-35	RL-13161	22.22
UPN-2	BAU-2012-1	11.54	RC	Neela	8.33	BM-36	RL-26016	8.51
UPN-3	BAU-833-11	26.67	SC	Neelum	21.95	BM-37	RL-29005	20.00
UPN-4	BAUP-101	41.30	BM-1	BAU-13-01	11.54	BM-38	RL-29210	17.65
UPN-5	BAUP-102	12.50	BM-2	BAU-13-06	16.00	BM-39	RLC-92	20.63
UPN-6	BRLS-102	13.95	BM-3	BAU-15-06	7.62	BM-40	RLC-148	11.48
UPN-7	EC-1419*	-	BM-4	BAUP-101	10.67	BM-41	RLC-151	10.53
UPN-8	EC-278988	13.16	BM-5	BRLS-105	18.18	BM-42	RLC-153	13.74
UPN-9	EC-279864	18.18	BM-6	BRLS-107	14.63	BM-43	RLC-155	11.69
RC	Neela	4.76	BM-7	BRLS-108-1	10.81	BM-44	RLC-156	4.00
SC	Neelum	24.17	BM-8	DLV-1	7.81	BM-45	RLC-157	10.42
UPN-10	EC-282800	12.77	BM-9	KL-285	14.81	BM-46	RLC-158	74.36
UPN-11	EC-322640	13.89	BM-10	LCK-1404	12.24	BM-47	RLC-159	66.67
UPN-12	EC-322676	14.71	BM-11	LCK-1529	10.11	BM-48	RLC-160	29.41
UPN-13	EC-41502	17.24	BM-12	LCK1607	30.91	BM-49	RLC-161	14.29
UPN-14	KYC-76	11.90	BM-13	LCK-1611	12.31	BM-50	RLC-162	16.95
UPN-15	LCK1404	10.71	BM-14	LCK-1625	11.76	BM-51	RLMC-11	7.02
UPN-16	LCK-1529	7.69	BM-15	LCK-1627	15.15	RC	Neela	6.25
UPN-17	LMS-2014-103	13.04	BM-16	LMS-2015-18	11.63	SC	Neelum	23.53
UPN-18	LMS-2014-107	13.04	BM-17	LMS-2015-106	14.29	BM-52	SHA-1	11.54
RC	Neela	5.71	RC	Neela	7.94	BM-53	SLS-107	26.83
SC	Neelum	26.32	SC	Neelum	26.32	BM-54	SLS-101	22.73
UPN-19	LMS-2014-177	12.50	BM-18	LMS-2015-122	10.71	BM-55	SLS-106	26.42
UPN-20	LMS-2014-193	10.00	BM-19	LMS-2015-188	18.18	BM-56	SLS-108	27.78
UPN-21	LSL-93	31.82	BM-20	LSJ-117	10.96	BM-57	SLS-109	30.43
UPN-22	NDL-2011-03	11.59	BM-21	NDL-2011-33	10.20	BM-58	SLS-114	42.42
UPN-23	NDL-2014-01	15.79	BM-22	NDL-2014-01	12.00	BM-59	SLS-99	29.03
UPN-24	NL-294*	-	BM-23	NDL-2014-08	8.00	BM-60	TL-142	28.00
UPN-25	NP(RR)-273	12.24	BM-24	NDL-2014-15	14.10	BM-61	TL-99	31.94
UPN-26	OL-8-2-7	12.00	BM-25	NDL-2014-17	41.67	BM-62	Binwa	28.57
UPN-27	OL-98-15-2	6.52	BM-26	NL-287	12.07	BM-63	Kota-Banarasi Alsi-4	15.79
RC	Neela	7.14	BM-27	NL-294	42.37	BM-64*	BAU-06-03	-
SC	Neelum	29.41	BM-28	NL-315	6.94	BM-65	Padmini	11.94
UPN-28	PCL-55	44.44	BM-29	OL-08-137-14	15.05	BM-66	Sheela	29.41
UPN-29	PKDL-192	10.74	BM-30	OL-08-188-8	25.81	BM-67	Shekhar	25.35
UPN-30	RLC-143	12.50	BM-31	PKDL-164	15.15	BM-68	T-397	3.61
UPN-31	RLC-148	11.67	BM-32	PKDL-165	26.47	RC	Neela	7.69
UPN-32	RLC-153	12.90	BM-33	PKDL-166	12.50	SC	Neelum	25.58
UPN-33	SHA-1	4.26	BM-34	RL-1007	15.38			

RC: Resistant check; SC: Susceptible check; UPN: Uniform Pest Nursery; BM: Breeding Material; *No germination.

T-397 (746.15 kg ha^{-1}). The lowest mean yield was obtained with Shubhra (584.49 kg ha^{-1}) followed by Garima (726.87 kg ha^{-1}). The present findings are in agreement with Pal *et al.* (1978) who observed that linseed sown on 3rd November gave highest yield (10.68 q ha^{-1}) as against the crop sown on 15th December (2.53 q ha^{-1}) at Kanpur (Uttar Pradesh), India. Similar affect was also observed in crop sown on 10th October and 20th November (16.10 and 12.50 q ha^{-1}, respectively) Anonymous (1983). Singh and Singh (2011) also found that the crop sown on 5th November and 25th November yield (883.89 and 765.83 kg ha^{-1}, respectively) and seed quality is also good in brightness and boldness.

Table 3. Grouping of different linseed genotypes on the basis of degree of infestation.

Degree of infestation	No. of genotypes	Genotypes
Resistant (0.00-10.00%)	12	LCK-1529, LMS-2014-193, OL-98-15-2, SHA-1, BAU-15-06, DLV-1, NDL-2014-08, NL-315, RL-26016, RLC-156, RLMC-11 and T-397
Moderately resistant (10.01-25.00%)	65	BAU-14-3, BAU-2012-1, BAUP-102, BRLS-102, EC-278988, EC- 279864, EC-282800, EC-322640, EC322676, EC-41502, KYC-76, LCK-1404, LMS-2014-103, LMS-2014-107, LMS-2014-177, NDL-2011-03, NDL-2014-01, NP(RR)-273, OL-8-2-7, PKDL-192, RLC-143, RLC-148, RLC-153, SJKO-03, SJKO-12, SLS-101, BAU-13-01, BAU-13-06, BAUP-101, BRLS- 105, BRLS-107, BRLS-108-1, KL-285, LCK-1404, LCK1529, LCK-1611, LCK-1625, LCK-1627, LMS-2015-18, LMS-2015-106, LMS-2015-122, LMS-2015-188, LSJ-117, NDL-2011-33, NDL-2014-01, NDL-2014-15, NL-287, PL-08- 137-14, PKDL-164, PKDL-166, RL-1007, RL-13161, RL-29005, RL-29210, RLC-92, RLC-148, RLC-151, RLC-153, RLC-155, RLC-157, RLC-161, RLC-162, SHA-1, Kota-Banarasi Alsi-4 and Padmini
Moderately susceptible (25.01-40.00%)	17	BAU-833-11, LSL-93, LCK-1607, OL-08-188-8, PKDL-165, RLC-160, SLS-107, , SLS-101, SLS-106, SLS-108, SLS-109, SLS-99, TL-142, TL-99, Binwa, Sheela and Shekhar
Susceptible (40.01-60.00%)	05	BAUP-101, PCL-55, NDL-2014-17, NL-294 and SLS-114
Highly susceptible (>60.00%)	02	RLC-158 and RLC-159

Preliminary screening of linseed genotypes for the infestation of *D. lini* : Out of 104 genotypes, three genotypes were failed to germinate and the infestation of bud fly in terms of infested bud was varied from 3.61 to 74.36% in rest of the genotypes under natural field conditions (Table 2). The infestation of bud fly varied from 4.76 to 8.33 and 18.52 to 42.31% in resistant (Neela) and susceptible (Neelum) checks, respectively. On the basis of per cent infested bud, these genotypes were categorized as per Bud fly Infestation Index given by Tripathi *et al.* (2002) in to five categories namely, resistant, moderately resistant, moderately susceptible, susceptible and highly susceptible and presented in Table 3. Out of tested genotypes, only 12 genotypes namely, LCK-1529, LMS-2014-193, OL-98-15-2, SHA-1, BAU-15-06, DLV-1, NDL-2014-08, NL-315, RL-26016, RLC-156, RLMC-11 and T-397 were grouped as resistant. Sixty-five genotypes were categorized in moderately resistant categories. A total of 17 and 5 genotypes were grouped in to moderately susceptible and susceptible categories, respectively. Two genotypes namely, RLC-158 and RLC-159 were grouped as highly susceptible. Several workers Malik and Srivastava (2012), Reddy *et al.* (2013) and Nayak et al. (2014) have also screened different genotypes of linseed for resistance against the infestation of *D. lini* at different places in India under natural conditions and identified the resistant source. In the present study, preliminary screening has been performed for a single season under natural field condition and therefore, further investigations are needed for the confirmation of resistant against bud fly infestation.

CONCLUSION

It is inferred from the present study that the linseed crop sown in first week of November resulted in lowest bud fly infestation and higher yield across the tested varieties. Twelve genotypes which are categorized as resistant to linseed bud fly in preliminary screening under natural field conditions are required to be studied further for confirmation of resistance.

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