The Pharma Innovation Journal 2023; 12(6): 6260-6265

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(6): 6260-6265

www.thepharmajournal.com
Received: 01-03-2023
Accepted: 09-04-2023

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The effect of sowing periods on stem fly, *Melanagromyza sojae* (Zehntner) incidence in kharif black gram

NP Pathan, DB Sisodiya, RD Dodiya and RK Thumar

Abstract
Six sowing periods during *kharif* (3rd week of July, 4th week of July, 1st week of August, 2nd week of August, 3rd week of August and 4th week of August) was evaluated for its impact on incidence of stem fly, *Melanagromyza sojae* (Zehntner) infesting black gram at Entomology Farm, B. A. College of Agriculture, Anand Agricultural University, Anand. The black gram crop sown during 3rd week of July exhibited low infestation (22.69%) and tunnelling (3.85%) followed by 4th week of July during *kharif*. Crop sown early *i.e*., 3rd and 4th week of July registered low larval (0.11 and 0.16/plant, respectively) and pupal (0.16 and 0.19/plant, respectively) counts in comparison to crop sown during August. Maximum seed and haulm yield was harvested from the crop sown during 3rd week of July (806 and 429 kg/ha) during *kharif* season.

Keywords: Black gram, Infestation, Stem fly, Sowing periods and Tunnelling

Introduction
Pulse crops hold immense significance in India, contributing to nutritional security, sustainable agriculture, income generation, food security, price stability, crop diversification, climate change resilience and export potential. Black gram is one of the major pulse crops grown in India and plays a significant role in Indian cuisine. Black gram (*Vigna mungo* L.) reported to be originated in India. In India, the total production of black gram is 30,59,990 tons with 546 kg/ha productivity from an area of 56,02,470 ha in 2018-19 (Anonymous, 2019a) [2]. It is mainly cultivated in Andhra Pradesh, Bihar, Madhya Pradesh, Maharashtra, Uttar Pradesh, West Bengal, Punjab, Haryana, Tamil Nadu and Karnataka. In Gujarat, the production of black gram is 73560 tons with 669 kg/ha productivity from an area of 1,09,960 hectares in 2018-19. The major black gram growing districts in Gujarat are Sabarkantha, Panchmahal, Dahod, Vadodara, Mehsana and Bharuch. It is also cultivated to some extent in Rajkot, Surendranagar and Junagadh districts (Anonymous, 2019b) [3]. In India, quantitative avoidable losses (7-35%) caused by insect-pest complex, both in black gram and green gram vary with different agro-climatic conditions (Hamad and Dubey, 1983) [5]. On an average, 2.5 to 3.0 million tonnes of pulses are lost annually due to pest problems (Rabindra *et al*., 2004) [18]. The annual yield loss due to the insect-pests has been estimated as 30 percent in urd bean and mung bean (Justin *et al*., 2015) [6]. In India, 60 insect species are known to attack black gram at different stages of crop growth (Lal and Sachan, 1987) [8]. Yield loss due to stem fly varies between locations and according to the plant growth stage. Gaur *et al*. (2015) [4] reported 100% infestation and 33.84% stem tunnelling caused by *M. sojae* in soybean at Pantnagar in Uttarakhand. Pathan *et al*. (2023) [14] from Anand, Gujarat reported that *Melanagromyza sojae* (Zehntner) severely damages black gram at the seedling stage. The first set of seedling leaves are favoured locations for oviposition and result in widespread tunnelling in young plants. Infested plants grow yellowish, stunted, and in severe situations, the pest completely destroys the crop as a result of the maggot feeding inside the stem after the egg hatches.
Stem fly, *M. sojae* (Diptera: Agromyzidae) is an emerging pest of black gram in Gujarat. In the present scenario, effective management techniques other than insecticidal application against the pest are not available. Under these circumstances, it becomes necessary to find out some eco-friendly alternative methods for insect-pest management which include the manipulation of the cultural practices like deviating the period of sowing. Secondly day by day, organic farming as well as natural farming is gaining the importance where one can not use chemical insecticides.

Keeping these points in view, detail investigations were undertaken to observe the impact of date of sowing on incidence of stem fly, *M. sojae* in *kharif* black gram.

Materials and Methods

With a view to examine the effect of sowing periods on infestation of stem fly in black gram, an experiment was laid out during *kharif*, 2017 and 2021 at Entomology farm, B. A. College of Agriculture, Anand Agricultural University, Anand. Black gram variety GU 1 was grown in a gross plot of 3.15 m × 5.0 m with Net plot size of 2.25 × 4.80 m at 45 × 10 cm spacing in a Randomized Block Design with four replications at six different periods of sowing (3rd week of July, 4th week of July, 1st week of August, 2nd week of August, 3rd week of August and 4th week of August). All the recommended agronomical practices were adopted to raise the crop.

In order to record the stem fly infestation, ten randomly selected plants were uprooted from each plot and brought in the departmental laboratory. The roots were gently washed in tap water to remove adhering soil. Stem of each plant was dissected with a scalpel and observations on the number of larva (e) and pupa (e) present in the stem as well as length of stem and length of tunnel were recorded. The number of stem fly infested plants in each sample were also recorded. The observations were recorded at weekly interval starting from one week after germination. Tunnelling and infestation percent were calculated based on given formula (Laxmigudi *et al*., 2014) [9]. The seed and haulm yield (kg/plot) were also recorded from the net plot area and were converted to kg/ha.

$$\text{Infestation (\%)} = \frac{\text{No. of plants infested}}{\text{Total no. of uprooted plants}} \times 100$$

$$\text{Tunnelling (\%)} = \frac{\text{Length of tunnel}}{\text{Length of total stem}} \times 100$$

Result and Discussion

Infestation and tunnelling caused by the *M. sojae* to the black gram were commenced from one week after germination and continued till the crop was harvested. Larval population of *M. sojae* initiated from first week after germination and continued up to fifth week in *kharif*. Similarly, pupal population of *M. sojae* initiated from second week after germination and continued up to seventh week in *kharif*.

Plant infestation (%)

The data on infestation of stem fly, *M. sojae* infesting black gram recorded during *kharif* season of 2017 and 2021 as well as pooled are presented in Table 1. Data recorded during 2017 indicated that there was significant variation in infestation due to *M. sojae* in different treatments. Infestation data recorded during 2017 clearly indicated that the black gram crop sown during 3rd week of July registered significantly least infestation (22.10%) of stem fly over rest of the sowing periods. The crop sown during 4th week of July exhibited 26.25% infestation and stood next better treatment. The crop sown during first fortnight of August registered 37.99 to 39.54% infestation and found at par. Maximum infestation was recorded in crop sown during 4th week of August (53.12%) followed by 3rd week of August (51.66%). Both these sowing periods found statistically at par and registered significantly higher infestation over remaining sowing periods. Almost similar trend of infestation was noticed during 2021 as observed during 2017.

Pooled data (Table 1 & Fig. 1) computed for the year 2017 and 2021 highlighted that impact of sowing period was significant. The crop sown early *i.e*., 3rd week of July exhibited significantly minimum (22.69%) damage of stem fly to black gram crop in comparison to rest of the treatments of sowing period. The crop sown during 4th week of July also showed relatively less infestation (26.96%) of the pest and proved better sowing period. Black gram crop sown during first fortnight of August showed moderate level of infestation (38.75 to 40.27%) and the treatments found significantly at par. Significantly highest infestation was revealed in the crop sown during 4th week of August (53.68%) followed by 3rd week of August (52.13%) and found least suitable sowing periods.

Stem tunnelling (%)

The data on tunnelling (%) caused by *M. sojae* to black gram crop recorded in *kharif* season of 2017 and 2021 are presented in Table 1. It indicated that significantly least tunnelling was noticed in crop sown during 3rd week of July (3.47%) during 2017. The crop sown during 4th week of July exhibited 4.46% tunnelling and differs significantly from former treatment. The infestation ranged from 8.79 to 9.30% in the crop sown during first fortnight of August. Both these treatments found statistically at par. Among the different treatments evaluated, significantly, highest tunnelling was noticed in the crop sown during 4th week of August (14.95%) over rest of the sowing periods except 3rd week of August. Similar trend of treatment effect was observed during 2021 as it was observed during 2017.

Pooled data (Table 1 & Fig. 1) clearly revealed that least tunnelling due to *M. sojae* in black gram was recorded in crop sown during 3rd week of July (3.85%). In terms of tunnelling (%), the treatment of crop sown during 4th week of July found next better treatment and exhibited 4.92% infestation. The crop sown during 1st and 2nd week of August registered 9.37 and 9.77% infestation, respectively. Both these treatments found at par. Significantly, maximum tunnelling was recorded in crop sown during 4th week of August (15.44%) followed by the crop sown during 3rd week of August (14.82%). The data clearly highlighted that the crop sown during second fortnight of July exhibited significantly low tunnelling than the crop sown in August.

Table 1: Impact of sowing period on infestation and tunneling due to stem fly, *M. sojae* in black gram (*Kharif*)

Tr. No.	Treatments	Infestation (%)			Tunneling (%)		
		2017	2021	Pooled	2017	2021	Pooled
T_1	3rd week of July	28.04 (22.10)	28.85 (23.28)	28.45 (22.69)	10.73 (3.47)	11.91 (4.26)	11.32 (3.85)
T_2	4th week of July	30.82 (26.25)	31.73 (27.66)	31.28 (26.96)	12.19 (4.46)	13.43 (5.39)	12.81 (4.92)
T_3	1st week of August	38.05 (37.99)	38.95 (39.52)	38.50 (38.75)	17.25 (8.79)	18.38 (9.94)	17.82 (9.37)
T_4	2nd week of August	38.96 (39.54)	39.82 (41.01)	39.39 (40.27)	17.76 (9.30)	18.66 (10.24)	18.21 (9.77)

T_5	3rd week of August	45.95 (51.66)	46.49 (52.60)	46.22 (52.13)	22.19 (14.26)	23.08 (15.37)	22.64 (14.82)
T_6	4th week of August	46.79 (53.12)	47.42 (54.22)	47.11 (53.68)	22.75 (14.95)	23.54 (15.95)	23.14 (15.44)
S. Em. + Treatment (T)		0.79	0.76	0.55	0.32	0.34	0.23
Period (P)		1.12	1.08	0.78	0.45	0.48	0.33
Year (Y)		-	-	0.31	-	-	0.13
T x P		2.74	2.66	1.91	1.12	1.19	0.81
T x Y		-	-	0.78	-	-	0.33
P x Y		-	-	1.10	-	-	0.47
T x P x Y		-	-	2.70	-	-	1.15
C. D. at 5% T		2.20	2.13	1.28	0.89	0.95	0.54
P		3.11	3.01	1.81	1.27	1.35	0.77
Y		-	-	0.74	-	-	0.31
T x P		NS	NS	NS	3.11	3.30	NS
T x Y		-	-	NS	-	-	NS
P x Y		-	-	NS	-	-	NS
T x P x Y		-	-	NS	-	-	NS
C.V. (%)		14.42	13.69	14.05	13.08	13.13	13.11

Note: 1. Figures in parentheses are retransformed values and those outside are arc sine transformed values
2. NS = Not Significant

Number of larva/plant

Data on larval count made in different treatments of sowing period during *kharif*, 2017 as well as 2021 are presented in Table 2. Data indicated that there was significant difference in larval population recorded in different treatments (sowing period). The larval count made during the year *kharif*, 2017 revealed that the crop sown during 3rd week of July (0.09 larva/plant) registered minimum population followed by the crop sown during 4th week of July (0.12 larva/ plant). Both these treatments found statistically at par and registered significantly low larval count as compared to rest of treatments. The black gram crop sown during 1st and 2nd week of August exhibited 0.38 and 0.40 larva/plant, respectively. Further, the data also revealed that the crop sown during second fortnight of August registered significantly higher number of larva (0.69 to 0.71 larva/ plant) than rest of the treatments. Similar trend of treatment effect on larval population was observed during 2021 as it was observed during 2017.

Table 2: Impact of sowing period on larval and pupal population of stem fly, M. sojae in black gram (Kharif)

Tr. No.	Treatments	Larva(e)/plant			Pupa(e)/plant		
		2017	2021	Pooled	2017	2021	Pooled
T_1	3rd week of July	0.77 (0.09)	0.79 (0.12)	0.78 (0.11)	0.80 (0.14)	0.82 (0.17)	0.81 (0.16)
T_2	4th week of July	0.79 (0.12)	0.82 (0.17)	0.81 (0.16)	0.82 (0.17)	0.85 (0.22)	0.83 (0.19)
T_3	1st week of August	0.94 (0.38)	0.96 (0.42)	0.95 (0.40)	0.98 (0.46)	1.00 (0.50)	0.99 (0.48)
T_4	2nd week of August	0.95 (0.40)	0.97 (0.44)	0.96 (0.42)	0.99 (0.48)	1.01 (0.52)	1.00 (0.50)
T_5	3rd week of August	1.09 (0.69)	1.10 (0.71)	1.09 (0.69)	1.13 (0.78)	1.14 (0.80)	1.14 (0.80)
T_6	4th week of August	1.10 (0.71)	1.11 (0.73)	1.10 (0.71)	1.15 (0.82)	1.16 (0.85)	1.15 (0.82)
S. Em. + Treatment (T)		0.019	0.019	0.01	0.017	0.017	0.01
Period (P)		0.017	0.017	0.01	0.017	0.017	0.01
Year (Y)		-	-	0.01	-	-	0.01
T x P		0.042	0.042	0.03	0.041	0.042	0.03
T x Y		-	-	0.02	-	-	0.02
P x Y		-	-	0.02	-	-	0.02
T x P x Y		-	-	0.04	-	-	0.04
C. D. at 5% T		0.045	0.045	0.03	0.04	0.04	0.03
P		0.041	0.041	0.03	0.04	0.04	0.03
Y		-	-	0.02	-	-	0.02
T x P		NS	NS	NS	NS	NS	NS
T x Y		-	-	NS	-	-	NS
P x Y		-	-	NS	-	-	NS
T x P x Y		-	-	NS	-	-	NS
C.V. (%)		8.98	8.79	8.89	8.41	8.39	8.40

Note: 1. Figures in parentheses are retransformed values and those outside are $\sqrt{X + 0.5}$ transformed values
2. NS = Not Significant

Pooled data (Table 2 & Fig. 1) indicated that significantly least number of larvae were counted in the crop sown during 3rd week of July (0.11 larva/plant) followed by the crop sown during 4th week of July (0.16 larva/plant). In terms of larval population, the sowing period in 1st and 2nd week of August found at par. Maximum larval counts were registered in late sown crop *i.e.* 4th week of August (0.71 larva/plant) followed by 3rd week of August (0.69 larva/plant). In short, the crop sown early *i.e.* second fortnight of July registered significantly low larval counts in comparison to crop sown during August in *kharif* season.

Number of pupae/plant

Data on pupal counts recorded in different treatments of

sowing period during *kharif* 2017 and 2021 are presented in Table 2. Data shows that the treatments differed significantly during both the years of experimentation. Data on pupal population of *M. sojae* recorded during 2017 in different treatments indicated that it was significantly least in the crop sown during 3rd week of July (0.14 pupa/plant) followed by 4th week of July (0.17 pupa/ plant). Both these treatments registered significantly less counts of pupae over rest of the treatments and found at par. The crop sown during first fortnight of August exhibited 0.46 to 0.48 pupa/ plant and found to be mediocre in its response to the treatments. On the other hand, the crop sown during second fortnight of August registered significantly higher (0.78 to 0.82 pupa/plant) number of pupae as compared to other treatments evaluated. Similar trend of treatment effect was revealed during 2021 as it was observed during 2017 experimentation.

Pooled data (Table 2 & Fig. 1) clearly revealed that significantly least (0.16 pupa/plant) number of pupae was counted in crop sown during 3rd week of July, followed by the crop sown during 4th week of July. Both these treatments of sowing period found to be superior by registering significantly less number of pupae over rest of the treatments. The black gram crop sown during second fortnight of August (0.80 to 0.82 pupae/ plant) registered significantly higher value of pupae as compared to early sown crops.

Seed and haulm yield (kg/ha)

Seed and haulm yield data of black gram recorded during *kharif* 2017 are presented in Table 4.13. Data indicated that significantly highest seed yield was registered in the crop sown during 3rd week of July (813 kg/ha) followed by the crop sown during 4th week of July (794 kg/ha). Both these treatments produced significantly higher seed yield over rest of the treatments. Significantly minimum seed yield was registered in crop sown during 4th week of August (574 kg/ha). In terms of seed yield, the crop sown during 1st, 2nd and 3rd week of August found at par. Further, the crop sown during second fortnight of July produced 1111 to 1138 kg/ha haulm yield that was significantly higher over rest of the treatments. Poor haulm yield was obtained in crop sown during 4th week of August (774 kg/ha) which was significantly least in comparison to rest of the sowing periods (treatments), except 3rd week of August.

Table 3: Impact of sowing period on yield of black gram (Kharif)

Tr. No.	Treatments	Yield (kg/ha)					
		2017		2021		Pooled	
		Seed	Haulm	Seed	Haulm	Seed	Haulm
T_1	3rd week of July	813	1138	800	1120	806	1129
T_2	4th week of July	794	1111	790	1106	792	1108
T_3	1st week of August	698	949	685	932	691	940
T_4	2nd week of August	685	932	672	914	679	923
T_5	3rd week of August	610	824	573	773	592	799
T_6	4th week of August	574	774	535	722	554	748
S. Em. + Treatment (T)		29.28	41.35	29.98	41.77	20.03	28.10
Year (Y)		-	-	-	-	11.56	16.22
T x Y		-	-	-	-	28.33	39.75
C. D. at 5% T		88.24	124.60	90.33	125.89	47.82	66.78
Y		-	-	-	-	NS	NS
T x Y		-	-	-	-	NS	NS
C.V. (%)		8.42	8.66	8.87	9.00	8.26	8.45

Data on seed and haulm yield of black gram recorded in different treatments of sowing period during *kharif*, 2021 are presented in Table 3. Data revealed that the black gram crop sown during 3rd week of July produced significantly highest seed and haulm yield (800 and 1120 kg/ha, respectively) followed by the crop sown during 4th week of July (790 and 1106 kg/ha). The crop sown during first fortnight of August registered seed and haulm yield ranged from 672 to 685 and 914 to 932 kg/ ha, respectively. The treatments of both the sowing periods found at par. On the other hand, significantly minimum seed and haulm yield was harvested from the crop sown during 4th week of August (535 and 722 kg/ha, respectively) followed by the crop sown during 3rd week of August (573 and 773 kg/ha, seed and haulm yield, respectively).

Pooled over years data of seed and haulm yield recorded during *kharif* 2017 and 2021 are presented in Table 3 and depicted in fig. 2. It clearly indicated that there was significant difference among the treatments. Maximum seed and haulm yield was harvested from the crop sown during 3rd week of July (806 and 1129 kg/ha, respectively). It was followed by the treatment of crop sown during 4th week of July wherein it produced 792 and 1108 kg/ha seed and haulm yield, respectively. Both these treatments differed significantly from rest of the treatments. The crop sown during 1st and 2nd week of August registered seed and haulm yield ranging from 679 to 691 and 923 to 940 kg/ha, respectively. Minimum seed and haulm yield was obtained from the crop sown late *i.e.*, 4th week of August (554 and 748 kg/ha, respectively). In terms of yield, both the treatments of sowing period *i.e.*, 3rd and 4th week of August found at par and differed significantly from rest of the treatments.

This finding is in accordance with the reports of Prodhan *et al.* (2008) [16] as well as Manjula *et al*. (2019) [10] who have reported low infestation of stem fly in black gram crop sown early in comparison to late sown crop. Similarly, many earlier workers have documented that the incidence of *M. sojae* on pea (Kooner *et al*., 1977) [7], bean (Nderitu *et al*., 1990) [12], gram (Prodhan *et al*., 2000) [17], green gram (Oo *et al*., 2004) and soybean (Meena and Shrama, 2006) [11] exhibited low incidence of stem fly, *M. sojae* on respective pulse crop. However, in contrast to above, Abdallah (2014) [1] reported that the infestation of *M. sojae* in soybean was heavier in the early planting date which had the highest larvae and pupae. The discrepancy in sowing period noticed in literature may be attributed due to the variation in climatic conditions prevailed in respective study place, crop variety and ecological factors. Pathan *et al*. (2022) revealed that the black gram crop sown

during 1st and 2nd week of March exhibited low larval (0.22 and 0.26 /plant), pupal (0.22 and 0.27 /plant) counts of the stem fly as well as less infestation (28.38 and 29.73%, respectively) and tunnelling (8.92 and 9.45%, respectively) than rest of the sowing periods during summer season. This contradiction in the sowing period observed in prose may be ascribed due to variation in the season.

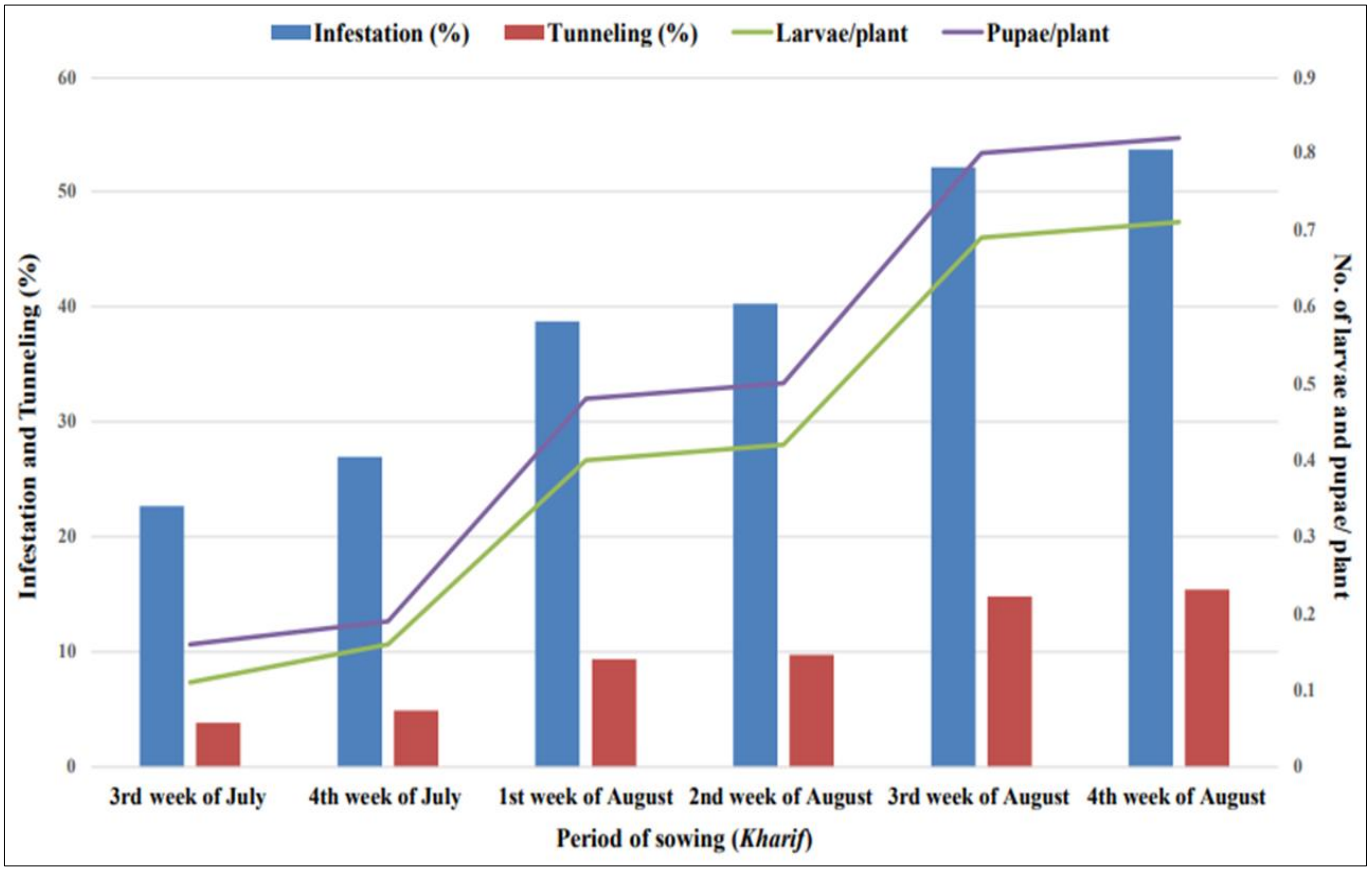

Fig 1: Impact of sowing period on infestation, tunneling, larval and pupal population of stem fly, *M. sojae* in black gram (*Kharif*, Pooled over year)

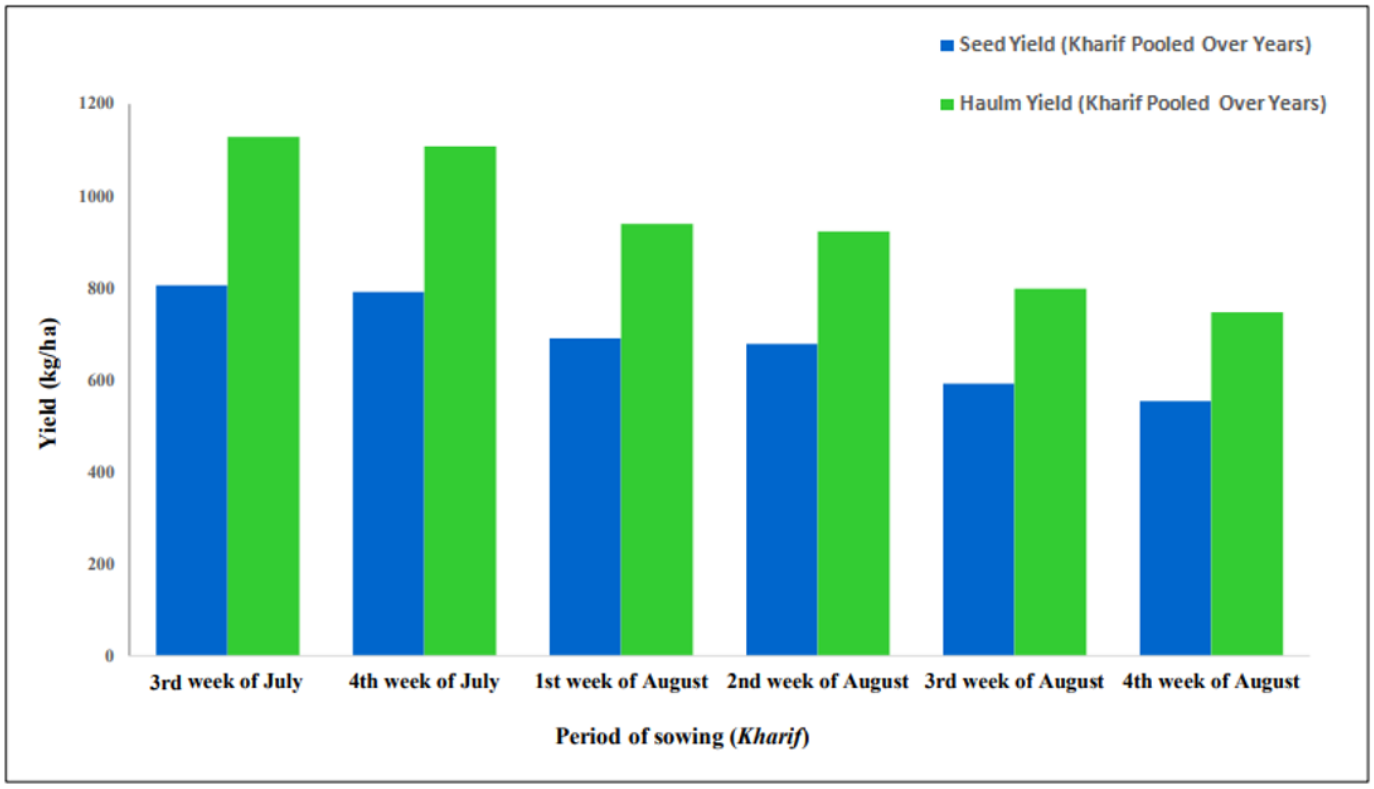

Fig 2: Impact of sowing period on yield of black gram (*Kharif*, Pooled over years)

Conclusion

Black gram crop sown during 3rd week of July exhibited minimum (22.69%) damage of stem fly to black gram crop in comparison to rest of the sowing periods. The least tunnelling due to *M. sojae* in black gram was recorded in crop sown during 3rd week of July (3.85%) followed by fourth week of July and exhibited 4.92% tunnelling. Minimum number of larva was counted in the crop sown during 3rd week of July (0.11 larva/plant) followed by 4th week of July (0.16 larva/plant). Similarly, During, *kharif* least (0.16 pupa/ plant) number of pupae were counted in crop sown during 3rd week of July followed by 4th week of July. Maximum seed and haulm yield was harvested from the crop sown during 3rd week of July (806 and 429 kg/ha, respectively) during *kharif* season followed by the crop sown during last week of July wherein it produced 792 and 1108 kg/ha seed and haulm yield, respectively.

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