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Effect of Sowing Dates on the Incidence of Stem Borer (*Chilo partellus* Swinhoe) and Yield of Sorghum

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Abstract

Sorghum is a valuable cereal and fodder crop that is extensively grown in the semi arid parts of India. The stem borer (*Chilo partellus* Swinhoe) is one of the most devastating insect pests of sorghum that can result in massive losses of yields, through the formation of dead hearts, and undermined growth of plants. The current study was carried out in the farmer's Agricultural Farm, Chandan Nagar, Hisar, Haryana in the period of 2015-17 with the aim to determine the effect of varying sowing dates on the occurrence of stem borer among sorghum variety HC 308. There were 4 dates of sowing, viz. 10th June, 25th June, 10th July and 25th July, which were considered in a Randomized Block Design with five replication. Incidences of pests were observed at 10 days interval after DAS (10 days after sowing) up to the maturity of crops. It was found out that early sowing had a significant effect on the infestation of the stem borers and yield. The lowest degree of infestation was recorded (1.31) on the crop sown on 10th June and the highest infestation (66.52) on the crop sown on 25th July at 110 DAS. The infestation was inversely related to the grain yield with the highest yield (10.88 q ha^{-1}) being obtained at the 10th June sowing and the lowest yield (2.95 q ha^{-1}) being obtained at the 25th July sowing. The results suggest that an early sowing in June is a good cultural practice in reducing the effects of the stem borer and maximizing the yield of sorghum.

Keywords: Sorghum, Chilo partellus, stem borer, sowing date, dead hearts, pest incidence, crop yield

1. INTRODUCTION

One of such cereal crops, which is very common in tropical and subtropical parts of the world, is sorghum (Sorghum bicolor L. Moench). It is a valuable source of food, fodder and raw material of industry in most of the developing nations. Kharif and Rabi seasons are used to prepare sorghum in India, which contributes

greatly to the agricultural economy of the semi-arid areas (Dhaliwal et al., 2015). The sorghum production is also highly influenced by the insect pests even though it has the ability to withstand the unfavourable environmental factors. The sorghum stem borer (*Chilo partellus* Swinhoe) is the one of them that is regarded one of the gravest pests that lead to severe losses of the harvest (Sharma, 1993). The larvae infested the stem and fed on internal tissues leading to the development of the so-called dead hearts that in the end lead to the decrease in plant vigor and grain production (Kfir et al., 2002). Infestation by *C. partellus* depends on a number of factors such as climatic conditions, stage of development of the host plant, and agronomic practices (Karunakar et al., 2016). These factors are varied, but in the determination of the pest incidence, the time of sowing is significant. By planting early, the crop can avoid the high infestations of pests, but in many cases, when it is planted late, it is more prone to pest attack (Patidar et al., 2019). The observation made by the past research revealed on the premise that late sowing in sorghum and maize contributes towards high infestation of stem borers and a high loss of yield (Ullah et al., 2010). Early sowing brings the crop at the right time when the environment is favorable and prevents high levels of pest infestation (Hakeem et al., 2020). Thus, it is necessary to know the correlation between the sowing time and incidence of the stem borers to come up with effective cultural management methods. With this in mind, the current study was conducted in order to determine the impact of varying dates of sowing on cultivation of *Chilo partellus* and sorghum yield.

2. MATERIALS AND METHODS

This experiment was done on the farmer's Agricultural Farm, Chandan Nagar, Hisar, Haryana in 2015-2017 kharif seasons. The variety of sorghum HC 308 was used in the experiment. The experiment was designed as a Randomized Block Design (RBD) having five replications. Plot Size and Spacing Plot size: 3 x 5 m^2 Spacing: 25 x 10 cm^2 Treatments. There were 4 sowing dates considered: Treatment Date of Sowing T1 10th June, T2 25th June, T3 10th July and T4 25th July. Stem borer incidence was observed after 10 days after sowing (DAS) in 10-day time intervals until the crop attained the maturity. To determine the observations of each plot, three random positions of the meter row length were observed. Following parameters were measured: number of infested plants, number of dead hearts and number of healthy plants. Statistical analysis of data was done and percentage factored in by angular transformation.

3. RESULTS

3.1 Stem Borer Incidence

The effect of four date of sowing i.e. 10th and 25th June, 10th and 25th July on the incidence of stem borer, *Chilo partellus* in sorghum crop was tested and it was found that the mean per cent infestation on the crop sown on 25th July was maximum (66.52%) and observed in the increasing order (30.20 -66.52) till maturity and the mean per cent infestation on the crop sown on 10th June was minimum The highest yield of 10.88 q/ha was achieved in case when crop was sown on 10th June whereas the lowest yield was 2.95 q/ha in case of crop sown on 25th July. The significant difference in incidences of pests at 20 DAS up to maturity was statistically significant. A lot of variances in yield of between all the four treatments was also observed (Table 1). The stem borer infestation greatly influenced the yield. Majority of the grain yield was the highest (10.88 q ha^{-1}) at the crop sown on 10th June, and the lowest yield (2.95 q ha^{-1}) was obtained at the crop sown on 25th July. The findings evidently showed that there was a very close negative correlation between yield and pest incidence.

Table 1: Effect of date of sowing on the incidence of Stem borer, *Chilo partellus* Swinhoe in sorghum crop (HC 308) in district Hisar

Treatment (Date of Sowing)	Mean per cent infestation*											Yield (q/ha)
	10 DAS	20 DAS	30 DAS	40 DAS	50 DAS	60 DAS	70 DAS	80 DAS	90 DAS	100 DAS	110 DAS	
T1= 10th	0.01	0.01	0.01	0.01	0.59	0.65	0.87	1.31	1.32	1.30	1.31	10.88

June	(0.57)	(0.57)	(0.57)	(0.57)	(3.35)	(3.50)	(4.61)	(6.52)	(6.89)	(6.40)	(6.52)	(19.25)
T2= 25th June	0.01 (0.57)	0.01 (0.57)	0.62 (4.03)	1.14 (6.08)	2.07 (8.03)	2.07 (9.43)	3.08 (10.8)	3.97 (11.48)	4.62 (12.39)	6.19 (14.40)	6.76 (15.04)	8.72 (17.17)
T3= 10th July	0.01 (0.57)	4.62 (12.39)	13.34 (21.41)	24.75 (29.82)	34.78 (36.09)	40.15 (39.29)	40.59 (39.55)	42.25 (40.52)	43.05 (40.98)	44.69 (41.92)	45.01 (42.11)	5.56 (13.62)
T4= 25th July	0.01 (0.57)	30.20 (33.28)	37.09 (37.47)	46.19 (42.80)	51.71 (45.96)	60.08 (50.81)	61.42 (51.65)	65.22 (53.86)	65.35 (53.94)	65.16 (53.83)	66.52 (54.65)	2.95 (9.87)
C.D. at 5%	NA	2.17	2.44	0.75	3.39	3.08	3.67	1.62	2.20	2.84	2.83	0.60

4. DISCUSSION

The current studies were conducted to establish the relative impact of sowing dates on stem borer and sorghum productivity. In 2015, 2016 and 2017, HC-308 sorghum was sown on four dates (10th, 25th June, 10th and 25th July) in order to assess its resistance to acid rain, salinity, and drought. Incidence of stem borer were observed at 10day intervals until the crop was mature enough. The June 10 sown crop recorded significantly low incidence and yield was high. Late infestation of stem borer has been found to adversely impact the yield in the three years of the study, and is more prevalent in case of late sowing (Sharma, 1993; Dhillon et al., 2005).

4.1 Sorghum stem borer vs. data of sowing (2017 data)

Trend in incidence: Sorghum sown latest (25th July) had almost no stemborer damage (dead hearts ≤1.3% at harvest), but subsequent dates began to increase at a very high rate. The sowing of 25th July was at the dead hearts percentage of approximately 66.5 when 110 DAS and 10th July at 45 percent, 25th June at 6.8 percent and 10th June at 1.3 percent. That is, when the sowing was deferred at the beginning of June, until July, the incidence of borers shot up (Panwar and Sarup, 1983; Singh and Rana, 1989).

Effects on yield: Grain yield decreased respectively - maximum (10.88 q/ha) with sowing on 10th June, and minimum (2.95 q/ha) with sowing on 25th July. The infestation has a very strong negative relationship with the yield (later sowing = more borers = much lower yield) (Sharma, 1993).

Statistics: The critical differences in the table indicate that the differences in infestation since 20 DAS are statistically significant (CD at 5% provided on each interval) and the difference in the yield of the treatments. Concisely, the subsequent sowing dramatically augments the stemborer destruction and yield is highly diminished (Dhillon et al., 2005).

This trend is in line with other researches. In sorghum and maize, early sowing always reduces the losses caused by stemborers. Indicatively, Patidar et al. (2019) established that a timely-sown sorghum crop had a dead heart share of tree, on the average, of only 12 at 45 DAE in comparison with 45 at 45 DAE in a late-sown crop (Patidar et al., 2019). On the same note, Ullah et al. (2010) found that when maize was planted early in June, it had an average of 1.5 stemborer holes per plant as compared to 5.8 borer holes when it was planted in July (Ullah et al., 2010). Early plantings were also in line with optimal pest generations: Hakeem

et al. (2020) found late-sown maize (May) had an average of 63% stemborer infestation compared to an average infestation of 29% in an early-March sowing (Hakeem et al., 2020). Therefore, our finding that the attack of *Chilo partellus* is increased many times by the sowing of sorghum later in July, is substantiated by the literature (Sharma et al., 2007).

4.2 Biological and agronomic situation. *Chilo partellus* is a big pest of sorghum in Asia and Africa, which determines 18-25% loss in farmers conditions (Seshu Reddy and Walker, 1990). Young sorghum is laid on by eggs; the larvae drilled through stems to form so-called dead hearts (whitened central shoots). Its population peaks are predetermined by crop phenology and climate. Timely sowing (June) assists the crop to avoid the worst pest invasions, but late sowing will subject the plants to the peak pest invasion (Polaszek, 1998). As one of the reviews mentions, a major method of combating sorghum shoot fly and stemborer is early planting (Sharma and Nwanze, 1997). Our data confirm this: our 10th June crop (rapid growth under early monsoon) was not attacked heavily, whereas our 25th July crop (slower growth in the very beginning) was affected badly. Agronomic is an important element as well. The fodder sorghum, HC 308, is a probable attractor of borers just like grain sorghum. The overwintering stemborers can be reduced by removing the volunteer sorghum and sorghum/maize residues (Van den Berg and Nur, 1998). There is also host-plant resistance: there are sorghum varieties that are resistant to stem borers (antibiosis/antixenosis) (Sharma et al., 2003). Indeed, there are five inbred lines that are highly resistant to *C. partellus* (minimum death heads and holes when exiting) (Prasad et al., 2015). Damage can be restricted a lot by using resistant hybrids.

4.3 Combined management and suggestions. According to these findings and the literature available, it is highly advisable to ensure that sowing earlier is done to minimize the damage caused by the stem borers. The sooner sorghum can be planted (first half of June in this area) the less dead hearts will be, and the more yield will be obtained. In our experiment, the 3-4x grain yield was recorded because of early sowing in comparison to late planting (Dhillon and Sharma, 2009). The other management strategies involve: Biological control: Larval parasitoids introduced into *C. partellus* include *Cotesia flavipes* (Asian) which are effective against *C. partellus* (Overholt et al., 1997). The population of borers can be suppressed by conserving or increasing the population of these wasps (and other natural enemies). Host resistance: Dead hearts and pest damage can be lowered using tolerant/resistant cultivars (Sharma et al., 2003; Prasad et al., 2015).

4.4 Cultural practices: Plants should be sown early enough (above). Moreover, eliminate and destroy crop stubble following harvesting to eliminate overwintering larvae and not plant sorghum late which coincides with the peak emergence of borers (Van den Berg and Nur, 1998; Dhillon and Sharma, 2009). Checking and control by the threshold: Dead hearts should be scouted on a regular basis. In case of a high increase in dead heart levels, specific insecticides or biopesticides can be used (Kfir et al., 2002; Kumar and Singh, 2018).

To conclude, the data of 2017 demonstrate that a late sowing of sorghum in June into July leads to the catastrophic increase of *Chilo partellus* infestation and dire yield loss. This highlights one of the major principles of IPM, namely crop timing to prevent the peaks of pests. Plumbing of the plants at an early stage and using resistant varieties and using biological control can ensure that stemborer damage is within manageable levels hence resulting to high yield of sorghum (Sharma, 1993; Overholt et al., 1997).

5. CONCLUSION

The experiment demonstrated that the date of sowing has great influence on the occurrence of stem borer (*Chilo partellus*) as well as sorghum yield. The lowest infestation was observed in early sowing on 10th June; and the greatest yield of grain was observed in early sowing; and the highest level of pest incidence and extreme yield reduction was observed in delayed sowing, especially on 25th July. The findings reveal that there is an inverse relationship between the infestation of stem borers and the yield of crops. Hence, it

is suggested that the planting of sorghum in the first half of June should be conducted in order to reduce the damage of the stem borers and receive greater productivity. Combining pest management practices and timely sowing would help in controlling the occurrence of pests and enhance production of sorghum.

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