Management of Maize Stem Borer Using Sowing Date at Arsi-Negele

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Abstract

In Ethiopia maize yield ranges from 2000-kg ha^{-1} to10, 000-kg ha^{-1}. The variation is attributed to many factors among which lepidopterous stem borers are the most important. As part of integrated management of stem borers, sowing date trials were conducted at Arsi-Negele. Ten sowing dates starting from March 20 at 10 days interval were tested. The trials were laid out in two sets: with and without cypermethrin treatment. The result obtained indicates that early sowing with cypermethrin treatment doubled the yield of maize grain. If maize has to be grown without cypermethrin treatment, it should be sown between 20 April and 10 May. The highest economic return with cypermethrin treatment at the rate of 0.30 kg a.i ha^{-1} applied at 4 and 6 weeks after crop emergence was obtained with early sowing indicating that early infestation of stem borer is very detrimental for maize production at Arsi Negele.

Introduction

In Ethiopia, yields of maize vary between 2000 kg ha^{-1} and 10,000 kg ha^{-1} (Benti and Ransom, 1993; CSA, 1997). The former is from small holding subsistence farmers while the latter is in research centers. The yield obtained by the small holders, who contribute over 90% of maize production in this country, is far less than the world average (CSA, 1997).

Among the major constraints leading to low yield are insect pests, particularly the lepidoterous stem borers. Two borer species cause significant yield loss in Ethiopia. These are the maize stem borer (*Buseloa fusca* (Fuller)) and the spotted stem borer (*Chilo Partellus)* (Swinhoe)). *B. fusca* is the dominant species at higher altitudes (1160-2500m) and cooler areas, whereas *C. partellus* is a predominant species at lower altitudes (510-1700m) and in warmer areas of the country (Assefa, 1985; Abraham et al., 1993).

Yield losses caused by the pest and other stem borers in Africa have been estimated to range from 10 to 100% (Usua ,1968). Losses due to these pests have been reported as 0-100% in Ethiopia (Assefa, 1988a & 1988b). The pest attacks almost all plant parts: leaves, stems, tassels and ears.

Crop losses result from death of the growing point (dead hearts), early leaf senescence, reduced translocation, lodging and direct damage to the ears. Indirect yield loss could be also incurred due to diseases since the damaged tissue serve as avenue for disease pathogens (Bosque-Perez, 1992). To reduce these losses, farmers heavily relied on the use of chemical pesticides. Use of chemical pesticides is not economically feasible for small-scale farmers who produce the bulk of maize grain in this country. Moreover, chemical pesticides are not environmentally friendly.

Bosque-Perez (1992) suggested early planting as practical method of *B. fusca* management under small-scale resource poor farmers. Early planting ranging from April to early May also remarkably lowered the infestation of *B. fusca* at Awasa (Assefa, 1988a; Assefa et al., 1989). However, maize and sorghum planted in April to early May at Arsi Negele suffer from heavy infestation of *B. fusca*. The loss in yield ranges from 20% to complete crop failure depending upon cultivar, season and agronomic practices (Emana , Personal observation). This fact brought the need for looking into different sowing date(s) for Arsi-Negele at which *B. fusca* infestation and damage is minimal. This paper therefore summarizes the results of sowing date experiments conducted under Arsi-Negele conditions.

Materials and Methods

Two sets of experiments were conducted in the 1995 and 1996 crop seasons: with and without cypermethrin treatment. Spacing between plants and rows were 30 cm and 75 cm, respectively. Plot size was 7.25 m X 5.25 m. Cypermethrin was applied by hand to the whorl of the plant. Completely randomized block design in three replications for each set was used. The first set of experiment was treated with cypermethrin 1% G at the rate of 0.30-kg a.i. /ha which were applied 4 and 6 weeks after crop emergence. The second set of experiment was without chemical treatment. Except for the treatments, both sets of experiments received similar management practices (weeding, cultivation, fertilizer application, etc.). For both set of experiments, a susceptible maize variety, Beletch, was used. The first sowing date was commenced immediately when the soil received enough moisture and the subsequent sowings were made at 10 days interval. The sowing dates were March 20,30; April 10, 20, 30; May 10, 20, 30; June 10 and 20.

Number of tunneled stems by stem borer, number of damaged cobs by stem borer and yield ha^{-1} were the parameters considered for evaluation. In yield parameter, after counting the number of damaged cobs in relation to the total number of cobs, healthy kernels from damaged cobs as well were considered in addition to healthy cobs. But, damaged cobs according to current data means either small tip damage by stem borer or complete grain rotting by stem borer. Additional return was computed by subtracting total protection costs (insecticide application cost and cost of insecticide for one hectare) from the gross return per hectare. Gross return per hectare was calculated by subtracting the yield obtained in untreated plots from yield obtained in treated plots. These differences in yield were converted to monetary values by multiplying them with the current maize price (800 Birr per ton) (average of four markets). ANNOVA and Mean separation were computed using M-stat computer package.

Percent grain yield loss due to maize stem borer was also calculated using the formula;

$$\%\ \text{grain loss} = \frac{\text{mean grain yield of treated plots} - \text{mean grain yield of untreated}}{\text{mean grain yield of treated plot}} \times 100$$

Results

Results are presented in Tables 1-3 and Figure 1. Number of tunneled stems are significantly higher in 20 March, 30 March, 20 May, 30 May, 10 June and 20 June sowings for the untreated experiment. In the same experiment number of tunneled stems were significantly lower in 10 April, 20 April, 30 April and 10 May sowings (Table 1). In the treated experiment, there was no significant difference among the sowing dates in the number of tunneled stems (Table 2).

Percent cob damage was significantly higher for early sowings (20 March and 30 March) and late sowings (20 May, 30 May, 10 June and 20 June) in the untreated experiment (Table 1). In the treated experiment, there was no significant difference among the sowing dates in percent cob damage (Table 2).

Grain yield was significantly higher in 30 March, 10 April, 20 April, 30 April and 10 May sowings and significantly lower in 30 May, 10 June and 20 June sowings for both untreated and treated experiments (Tables 1&2). March 20 sowing gave the highest grain yield in treated experiment (Table 2), but lower in untreated experiment (Table 1).

The highest yield difference between the untreated and treated experiments was obtained in 20 March sowing followed by 10 April, 30 March, 20 April, 20 June, 10 May and 30 April sowings (Table 3). The yield of untreated plots is greater than the yield of treated plots in case of 20 May, 30 May and 10 June sowings (Table 3).

Percent grain losses due to maize stem borer were shown in Figure 1. According to the Figure the highest grain loss was obtained with 20 March sowing followed by 30 March, 10 April and 20 June sowings. The lowest grain loss was recorded from 20 April followed by 30 April and 10 June. Grain yield losses for 20 May, 30 May and 10 June sowings were not computed, because the yields of untreated plots were greater than the treated plots (Table 3).

Discussion

It has been previously reported that the use of appropriate sowing date is an important component of integrated management of maize stem borer (Assefa, 1989; Bosque-Perez, 1992; Dent, 1991). Our current study also confirmed the importance of sowing date in the control of maize stem borer. As it was indicated by Dent (1991) the important parameter to determine appropriate sowing date is yield. In our study also we have observed certain trend in yield parameter. In both treated and untreated sets the highest yield was obtained with early sowing dates ranging from April to early May (Tables 1 & 2). As shown in Table 3, by the application of cypermethrin, it is possible to increase yield by 100%. The highest net return of 1880 Birr ha^{-1} was obtained with 10 April sowing followed by 20 March (1680 Birr ha^{-1}) and 30 March (1520 Birr ha^{-1}). According to Dent (1991) and Assefa (1989) maize stem borer affects the translocation of substrates which has a direct impact on yield. This is contrary to our findings. As shown in Tables 1&2, the highest numbers of tunneled stems were recorded with early sowings, but this did not affect grain yield, as there are other sowing dates, which have lower number of tunneled stems and at the same time gave low yields. This implies that at early sowing dates there are other factors, which contribute positively to yield. Lowani (1982) indicated that early sown crops have a number of advantages. The advantages include efficient use of minerals in the soil, less weed problem, adequate moisture, less pest problems and the like. In contrary, late sown crops face problems of low fertility, low or too much moisture, high pest infestation, high weed problem and so on. These could be the reasons why in some cases very high number of tunneled stems did not coincide with low yield. Similarly some sowing dates with high percentage of damaged cobs gave highest yields. This implies that cob damage is not a good indicator of yield loss. Instead percent cob tunnel length would have been an appropriate parameter since it describes the intensity of the infestation.

According to Usua (1968) this is also true in stem tunnels since stem tunnel length is proportional to yield loss. Of course, the practicability of tunneled stem length measurement is very remote except at harvesting since it requires destructive sampling.

Assefa (1985) reported that yield loss due to stem borers in Ethiopia ranged from 0-100%. Our current findings are also in agreement with his findings in that our result showed 9 to 48% grain losses (Fig. 1). The highest losses (48 & 36%) for early sowings can be lessened by the application of cypermethrin G treatment while the highest loss (34%) for late sowing may be ignored because of the low yielding ability of maize in that sowing date.

In general, to produce maize at Arsi- Negele specifically where maize and sorghum are grown on the same plot year in and year out like at Arsi-Negele Research Center, to get the maximum potential yield with early planting, use of cypermethrin G is recommended 4 and 6 weeks after emergence. However, if there is limitation of budget or the chemical itself, maize should be planted between April 20 and May 10 as losses for these sowings are relatively low for low value crops like maize.

Table 1. * Effect of sowing date on the number of tunneled stems, percent cob damage and grain yield without cypermethrin treatment (combined analysis over years).

Sowing dates	No. of tunneled stems	% cob damage	Grain yield (t/ha)
20 March	32.5c	15.0b	2.9b
30 March	26.3c	14.0b	3.5a
10 April	8a	8a	3.15a
20 April	6a	7a	4.10a
30 April	8.5a	9a	4.04a
10 May	5a	7a	3.59a
20 May	15b	18b	3.88a
30 May	20b	19b	2.97b
10 June	18b	26c	2.27c
20 June	15b	25c	1.12c

** Means within a column followed by the same letter are not significantly different (p=0.05) according to DMRT*

Table 2 :* Effect of sowing on the number of tunneled stems, percent cob damage and grain yield with cypermethrin treatment (combined analysis over years).

Sowing dates	No. of tunneled stems	% cob damage	Grain yield (t/ha)
20 March	6.2a	5.5a	5.8a
30 March	11.2a	6.0a	5.5a
10 April	7.5a	6.0a	5.5a
20 April	6.0a	5.0a	4.5a
30 April	6.0a	10.0a	4.5a
10 May	6.0a	7.0a	4.3a
20 May	6.0a	9.0a	3b
30 May	7.5a	11.0a	2.5b
10 June	7.5a	10.0a	1.7c
20 June	7.5a	7.0a	1.7c

** Means within a column followed by the same letter are not significantly different (p=0.05) according to DMRT.*

Table 3. Effect of cypermethrin versus sowing dates on economic return of maize grain at Arsi-Negele (combined over years).

Sowing dates	Mean yield (t/ha)		Yield difference (±)	Cost of cypermethrin and its application (Birr)	Net benefit or loss in Birr (1 t maize grain=800 Birr)
	Cypermethrin treated	Untreated			
20 March	5.75	2.90	+2.85	200	+1680
30 March	5.65	3.50	+2.15	200	+1520
10 April	5.75	3.15	+2.60	200	+1880
20 Aspril	5.15	4.10	+1.05	200	+640
30 April	4.40	4.04	+0.36	200	+88
10 May	4.05	3.59	+0.46	200	+168
20 May	2.95	3.88	-0.83	200	-864
30 May	2.50	2.97	-0.47	200	-576
10 June	1.75	2.27	-0.52	200	-610
20 June	1.70	1.12	+0.58	200	+264

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