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Performance of sorghum genotypes under zero tillage conditions in rice fallows with reference to stem borer, *Chilo partellus* (Swinhoe)

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ABSTRACT: A field experiment was carried out to screen the sorghum genotypes against stem borer in rice fallow under zero tillage condition. Based on mean stem tunnel length the genotypes were categorized as least susceptible (0-5 cm), moderately susceptible (5-10 cm), highly susceptible (>10 cm). The resistant check CSH 16 (C) found as least susceptible with 4.65 cm, whereas, NTJ-2 (C), NLCW-6 and N-14 were found to be highly susceptible as they recorded 10.45, 10.46 and 11.44 cm mean stem tunnel length respectively. The remaining genotypes found as moderately susceptible with 6.60 to 9.84 cm mean stem tunnel length. There is non-significant positive correlation between numbers of larvae with leaf damage, dead hearts stem tunneling, white ears and per cent chaffy grains, but it was negative with tiller damage.

KEY WORDS: Sorghum, stem borer, susceptible, stem tunnel length

INTRODUCTION

Sorghum [*Sorghum bicolor* (L.) Moench] is the fifth major cereal crop after wheat, rice, maize and barley. It is an important crop of Asia, Africa, Australia, America and is cultivated as a staple crop in the semi-arid tropics (SAT). In India it is cultivated in an area of 6.18 m ha with 5.33 million tonnes production and productivity of 863 kg ha^{-1} (Agricultural Census, 2013). In general sorghum is cultivated during *kharif,* maghi (Late *kharif*) and *rabi* seasons in Andhra Pradesh in an area of 2,87,000 ha with production of 5,46,000 tonnes and productivity of 1904 kg ha^{-1} (Agricultural Statistics at a glance, 2012-2013) as against normal area 7,60,000 ha with production of 5,52,000 tonnes and productivity of 730 kg ha^{-1}. The reasons for low productivity under normal type of cultivation might be due to shifting of jowar area to cultivation of commercial crops, high humidity in coastal regions and ravage of pests and diseases in jowar cultivating areas.

Insect pest situations are dynamic in nature and changes with climate, farming practices, introduction of improved varieties have been known to result in pest outbreaks or changes in pest status (Duale and Nwanze, 1999). Sorghum is attacked by more than 150 insect species causing 32% crop loss (Borad and Mittal, 1983). Losses in sorghum due to insect pests differ in magnitude on a regional basis and have been estimated at US $ 1089 million in the SAT, US $ 250 million in USA and US $ 80 million in Australia (Anonymous, 1992). Among the insect pests,

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shoot fly, *Atherigona soccata* (Rondani) and stem borer, *Chilo partellus* (Swinhoe) are the major threatswith 75.6% and 24.3 to 36.3% yield losses respectively (Pawar *et al*., 1984).

Management of the pests is being done with the pesticides. But due to the adverse effects of pesticides it is imperative to seek for alternate integrated pest management methods like host plant resistance as it not only costless or require application skills in pest control techniques, but also enhance the effectiveness of natural enemies and reduce the need to use pesticides (Sharma, 1993). The effect of resistant genotypes on insect population is continuous and cumulative over time. Umakanth *et al*. (2004) reported 'SPV 1022', 'PKV809' and 'CO28' as promising sorghum cultivars in rice-fallows. Performance of sorghum genotypes under zero tillage conditions in rice fallows with reference to stem borer" was carried out during *rabi,* 2014 - 15 in the southern block of Agricultural College Farm, Bapatla.

MATERIALS AND METHODS

Investigation was carried out to screen the sorghum genotypes against stem borer in rice fallow under zero tillage condition. Thirty genotypes were procured from Directorate of Sorghum Research, Hyderabad and Regional Agricultural Research Station, Nandyal were used as source material for the screening study. Mahalakshmi 296, CSH 16, NTJ-1, NTJ-2, NTJ-3 and NTJ-4 were used as checks for this experiment. The experiment was laid out in randomized block design at Agricultural college Farm, Bapatla and the treatments were replicated twice. The crop was sown on 7-1-2015. The length of each line was 4 m and spacing between two lines of each genotype was 45 cm and intra row spacing adopted was 15 cm.

Observations were recorded on larval incidence. Number of larvae per plant were recorded by destructive sampling at vegetative, flowering, grain formation and harvesting stages. Dead hearts caused by *C. partellus* (Number of plants with dead hearts symptoms) and total number of plants were recorded from each plot based on which per cent dead hearts was calculated from 30 DAS to 60 DAS at weekly intervals). Stem tunneling at the time of harvesting, by destructive sampling (the main stem of plants infested with *C. partellus* were split open from the base to the apex, and the cumulative tunnel length and stem length measured in cm), the percentage tunneling was calculated.

Genotypes were categorized as given below, based on stem tunneling as per Rajasekhar and Srivastav (2013).

S. No.	Range of mean tunnel length (cm)	Attribute
1	0-5	Least susceptible
2	5-10	Moderately Susceptible
3	>10	Highly Susceptible

RESULTS AND DISCUSSION

Larval incidence during crop growth

Genotypes exhibited significant variation pertaining to larval incidence during their crop growth period. The data on number of larvae per plant recorded at vegetative stage ranged from 5.00 to 8.90. The highest number of larvae recorded in the genotype CSH 23 (8.90) followed by CSV 15 (8.50), SSV 84 (7.80), CSH 14 (7.80) and CSH 20MF (7.50) while the lowest number of larvae recorded in the genotype CSH 24MF, CSH 25, NTJ-4 (C) (5.00) followed by CSH 13 (5.10), N-14 (5.20) and BRJ-358 (5.60) compared to the resistant check CSH 16 (5.80) and Mahalaxmi 296 (6.80).

At flowering stage, the number of larvae per plant ranged from 4.50 to 11.40. Maximum number of larvae recorded in the genotype SSV 84 (11.40) followed by CSH 22SS (10.90), CSV 26 (9.90) and CSV 24SS (9.60). Minimum number of larvae recorded in the genotype N-14 (4.50) followed by NTJ-2 (C) (5.10), N-13 (5.90) and resistant check CSH 16 (C) (6.20) when compared to the popular check Mahalaxmi 296 (7.90) (Table 1).

At harvesting stage, the number of larvae per plant ranged from 3.20 to 7.60. The highest number of larvae recorded in NTJ-4 (C) (7.60) followed by NLCW-6 (6.70), NLCW-8 (6.60) and BRJ-358

Table 1. Reaction of sorghum genotypes against stem borer, *C. partellus* incidence during 2014-15

S. No	Genotype	No. of DH			No. of larvae per plant at -- stage		
		42 DAE	49 DAE	56 DAE	Vegetative	Flowering	Harvesting
1	CSV 24SS	0.01 (1.01)	0.01 (1.01)	0.02 (1.01)	5.90 (2.62)	9.60 (3.25)	5.00 (2.43)
2	CSH 22SS	0.00 (1.00)	0.00 (1.00)	0.01 (1.00)	7.10 (2.83)	10.90 (3.44)	4.10 (2.26)
3	CSV 23	0.00 (1.00)	0.00 (1.00)	0.02 (1.01)	7.00 (2.83)	8.60 (3.10)	6.00 (2.64)
4	CSH 20MF	0.00 (1.00)	0.00 (1.00)	0.01 (1.00)	7.50 (2.91)	7.60 (2.93)	4.40 (2.32)
5	CSH 24MF	0.00 (1.00)	0.01 (1.01)	0.05 (1.02)	5.00 (2.45)	6.70 (2.77)	5.60 (2.56)
6	CSV 17	0.00 (1.00)	0.00 (1.00)	0.01 (1.00)	7.40 (2.89)	8.30 (3.05)	5.30 (2.49)
7	SSV 84	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	7.80 (2.96)	11.40 (3.39)	3.70 (2.17)
8	CSV 216R	0.01 (1.00)	0.02 (1.01)	0.04 (1.02)	6.50 (2.74)	8.80 (3.11)	3.90 (2.21)
9	CSV 15	0.00 (1.00)	0.01 (1.00)	0.02 (1.01)	8.50 (3.07)	9.20 (3.18)	3.20 (2.03)
10	CSH 14	0.01 (1.01)	0.00(1.00)	0.03 (1.02)	7.80 (2.97)	6.30 (2.70)	3.80 (2.16)
11	CSV 22	0.02 (1.01)	0.02 (1.01)	0.03 (1.02)	7.20 (2.86)	8.90 (3.14)	3.90 (2.21)
12	CSV 26	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	6.80 (2.79)	9.90 (3.29)	3.90 (2.21)
13	CSH 23	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	8.90 (3.14)	7.30 (2.88)	3.40 (2.10)
14	CSV 29R	0.00 (1.00)	0.00 (1.00)	0.01 (1.01)	6.50 (2.72)	9.00 (3.16)	3.50 (2.12)
15	CSH 30	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	6.70 (2.77)	6.80 (2.79)	3.40 (2.10)
16	CSV 14R	0.00 (1.00)	0.01 (1.01)	0.01 (1.01)	7.20 (2.86)	6.40 (2.72)	3.90 (2.21)
17	CSH 13	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	5.10 (2.46)	9.30 (3.19)	4.50 (2.34)
18	CSH 25	0.01 (1.01)	0.01(1.00)	0.01 (1.00)	5.00 (2.45)	6.30 (2.70)	5.30 (2.50)
19	N-13	0.02 (1.01)	0.04 (1.02)	0.04 (1.02)	6.90 (2.81)	5.90 (2.63)	5.70 (2.59)
20	N-14	0.01 (1.01)	0.01 (1.01)	0.01 (1.01)	5.20 (2.49)	4.50 (2.34)	6.00 (2.65)
21	BRJ-358	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	5.60 (2.57)	8.70 (3.11)	6.50 (2.74)
22	NLCW-6	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	6.60 (2.75)	8.90 (3.14)	6.70 (2.77)
23	NLCW-8	0.00 (1.00)	0.00 (1.00)	0.04 (1.02)	6.20 (2.66)	7.60 (2.93)	6.60 (2.75)
24	NLCW-12	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	7.30 (2.88)	8.30 (3.04)	6.30 (2.70)
25	Mahalaxmi 296 (C)	0.01 (1.01)	0.01 (1.01)	0.01 (1.01)	6.80 (2.78)	7.90 (2.98)	4.80 (2.41)
26	CSH 16 (C)	0.00 (1.00)	0.02 (1.01)	0.03 (1.02)	5.80 (2.61)	6.20 (2.68)	4.00 (2.24)
27	NTJ-1 (C)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	7.40 (2.88)	7.50 (2.88)	5.20 (2.49)
28	NTJ-2 (C)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	6.70 (2.76)	5.10 (2.47)	5.60 (2.54)
29	NTJ-3 (C)	0.00 (1.00)	0.00 (1.00)	0.01 (1.00)	6.10 (2.66)	7.30 (2.86)	4.40 (2.32)
30	NTJ-4 (C)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	5.00 (2.45)	6.90 (2.80)	7.60 (2.93)
	SEm±	0.09	0.10	0.09	0.18	0.23	0.16
	CD (0.05%)	0.26*	0.29*	0.27*	0.53*	0.65*	0.47*
	CV%	12.90	14.20	13.20	9.42	10.8	9.48

Values in the parenthesis are square root transformed values. * = Significant
DH = dead jearts' (c) = Check

Table 2. Per cent dead hearts infestation in different sorghum genotypes cultivated under zero tillage in rice fallows during 2014-15

S.No	Genotype	42 DAE	49 DAE	56 DAE
1	CSV 24SS	1.14 (4.34)	1.14 (4.34)	2.27 (6.16)
2	CSH 22SS	0.00 (0.00)	0.00 (0.00)	1.00 (4.07)
3	CSV 23	0.00 (0.00)	0.00 (0.00)	1.96 (5.71)
4	CSH 20MF	0.00 (0.00)	0.00 (0.00)	1.00 (4.07)
5	CSH 24MF	0.00 (0.00)	1.11(4.29)	4.92 (12.81)
6	CSV 17	0.00 (0.00)	0.00 (0.00)	0.98 (4.03)
7	SSV 84	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
8	CSV 216R	0.96 (3.99)	1.92 (5.66)	4.24 (11.69)
9	CSV 15	0.00 (0.00)	0.96 (3.99)	1.92 (5.66)
10	CSH 14	0.96 (3.99)	0.00 (0.00)	3.46 (10.45)
11	CSV 22	2.22 (8.56)	2.44 (6.38)	3.44(10.45)
12	CSV 26	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
13	CSH 23	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
14	CSV 29R	0.00 (0.00)	0.00 (0.00)	1.02 (4.11)
15	CSH 30	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
16	CSV 14R	0.00 (0.00)	1.28 (4.61)	1.28 (4.61)
17	CSH 13	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
18	CSH 25	1.00 (4.07)	1.00 (4.07)	1.00 (4.07)
19	Mahalaxmi 296 (C)	1.02 (4.11)	1.02 (4.11)	1.02 (4.11)
20	CSH 16 (C)	0.00 (0.00)	1.61 (5.18)	3.23 (7.36)
21	N-13	2.18 (8.50)	4.37 (12.06)	4.37 (12.06)
22	N-14	1.02 (4.11)	1.02 (4.11)	1.02 (4.11)
23	BRJ-358	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
24	NLCW-6	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
25	NLCW-8	0.00 (0.00)	0.00 (0.00)	3.55 (10.73)
26	NLCW-12	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
27	NTJ-1 (C)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
28	NTJ-2 (C)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
29	NTJ-3 (C)	0.00 (0.00)	0.00 (0.00)	0.96 (3.99)
30	NTJ-4 (C)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
	SEm±	0.10	0.18	0.42
	CD (0.05%)	0.29*	0.53*	1.23*
	C V%	10.30	12.30	13.80

Values in the parenthesis are arcsine transformed values. (c) = Check

Table 3. Reaction of sorghum genotypes against *Chilo partellus* infestation at different crop growth stages

S.No	Genotype	Stem tunneling percentage	Mean stem tunnel length in cm	Attribute
1	CSV 24SS	5.56 (13.64)	8.78	MS
2	CSH 22SS	4.78 (12.64)	9.45	MS
3	CSV 23	5.71 (13.83)	9.13	MS
4	CSH 20MF	5.12 (13.08)	8.98	MS
5	CSH 24MF	3.53 (10.84)	6.10	MS
6	CSV 17	8.53 (16.99)	8.37	MS
7	SSV 84	5.81 (13.95)	9.35	MS
8	CSV 216R	4.39 (12.10)	8.87	MS
9	CSV 15	5.74 (13.87)	8.07	MS
10	CSH 14	5.99 (14.17)	8.34	MS
11	CSV 22	4.39 (12.11)	8.57	MS
12	CSV 26	3.38 (10.60)	6.60	MS
13	CSH 23	5.16 (13.14)	7.83	MS
14	CSV 29R	4.76 (12.60)	9.19	MS
15	CSH 30	5.83 (13.98)	8.65	MS
16	CSV 14R	4.50 (12.25)	8.60	MS
17	CSH 13	4.42 (12.14)	9.14	MS
18	CSH 25	5.55 (13.63)	9.48	MS
19	Mahalaxmi 296 (C)	5.01 (12.94)	9.84	MS
20	CSH 16 (C)	6.70 (15.01)	4.65	LS
21	N-13	5.46 (13.51)	8.98	MS
22	N-14	9.37 (17.83)	11.44	HS
23	BRJ-358	7.44 (15.84)	9.50	MS
24	NLCW-6	7.80 (16.22)	10.46	HS
25	NLCW-8	6.78 (15.10)	9.60	MS
26	NLCW-12	3.51 (10.80)	7.80	MS
27	NTJ-1 (C)	6.60 (14.89)	8.58	MS
28	NTJ-2 (C)	5.76 (13.90)	10.45	HS
29	NTJ-3 (C)	4.24 (11.88)	9.52	MS
30	NTJ-4 (C)	4.95 (12.86)	9.32	MS
	SEm$\pm$	0.82	0.79	
	CD (0.05%)	2.38*	2.30*	
	CV%	17.0	12.8	

Values in the parenthesis are arcsine transformed values

. * = Significant. MS= Moderately susceptible, HS= Highly susceptible and LS= Least susceptible.

(6.50) while the lowest number of larvae per plant recorded in the genotype CSV 15 (3.20) followed by CSH 23, CSH 30 (3.40), CSV 29R (3.50) and SSV 84 (3.70) compared to the resistant check CSH 16 (4.0), NTJ-3(4.40) and popular check Mahalaxmi 296 (4.80). Mohan *et al.* (1990) reported that the highest seasonal incidence of *C. partellus* on variety HC-136 and JS-20 during *rabi*-summer and *kharif* and larval and pupal populations found to be high during *kharif* season crop than in *rabi*-summer. Adverse effect of resistant genotypes on insect development resulting in low larval mass due to nutritional abnormalities and/or because of poor food utilization by the larvae of resistant varieties (Jotwani *et al*., 1978). Painter (1951) suggested that with rare exceptions, the feeding of insects during the developmental stages on resistant varieties results in individuals that are smaller and have less weight. The sorghum varieties appear to possess some antibiotic factors which exist either in the leaves or in the stem or in both and influence the larval duration adversely (Lal and Sukhani, 1982; Singh and Rana, 1984).

Dead hearts caused by stem borer

The results revealed that at 42 DAE, the number of dead hearts and percent dead hearts ranged from 0.00 to 0.02 and 0.00 to 2.22% respectively. The highest number of dead hearts and percent dead hearts observed in the genotype CSV 22 (0.02 and 2.22), N-13 (0.02 and 2.18) followed by CSV 216R (0.01 and 1.14), CSH 25 (0.01 and 1.00), N-14 and popular check Mahalaxmi 296, resistant check CSH 16 (C) (0.01 and 1.02) and CSV 24SS (0.01 and 1.14). There is no infestation was recorded in the remaining all the genotypes (Table 2).

At 49 DAE, the number of dead hearts and percent dead hearts ranged from 0.00 to 0.04 and 0.00 to 2.44% respectively. The highest number of dead hearts and percent dead hearts observed in the genotype N-13 (0.04 and 4.37) followed by CSV 22 (0.02 and 2.44), CSV 216R, popular check Mahalaxmi 296 (0.02 and 1.61), CSV 216R (0.02 and 0.96) and N-14 and CSH 25 (0.01 and 1.00). The remaining all the genotypes were not recorded the infestation. Similar trend reaction was noticed at 56 DAE. The number of dead hearts and percent dead hearts ranged from (0.00 to 0.05 and 0.00 to 4.92). Very less number of dead hearts were recorded in the tested genotypes.

The present investigation revealed that the percent dead hearts range was very low. These findings are in conformity with the findings of Hussian *et al* (2014) who recorded lowest stem borer dead hearts in the genotype CSH 23 (4.87) and Vyas *et al.* (2014) recorded 2.39% in CSV 21F and 3.58% in CSH 20MF in *kharif* season. The third instar larvae migrate to the base of the plant, bore into the shoot and damage the growing point resulting in the formation of dead heart. The reason might be the influence of weather as the crop is cultivating during off-season and physico-chemical properties responsive for the development of stem borer.

Stem tunneling damage caused by *C. partellus*

After causing damage to the gowing point of the plant, *C. partellus* continue to feed inside the stem throughout the crop growth and cause tunnels inside the stem. The data recorded on stem tunneling revealed that mean stem tunnel length ranged from 6.60 to 10.46 cm with 3.38% to 7.80% tunneling (Table 3). Marulasiddesha *et al.* (2007) recorded 32.57% stem tunneling in the genotype SSV 84 and 49.15 % in CSH 14.

Based on mean stem tunnel length the genotypes were categorized as least susceptible (0-5 cm), moderately susceptible (5-10 cm), highly susceptible (>10 cm). The genotype resistant check CSH 16 (C) found as least susceptible with 4.65 cm, whereas, NTJ-2 (C), NLCW-6 and N-14 were found to be highly susceptible as they recorded with mean stem tunnel length of 10.45, 10.46 and 11.44 cm respectively. The remaining genotypes found as moderately susceptible with 6.60 to 9.84 cm mean stem tunnel length.

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