



E-ISSN: 2320-7078

P-ISSN: 2349-6800

JEZS 2019; 7(2): 1162-1172

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Received: 01-01-2019

Accepted: 05-02-2019

Abdul Latif

Department of Entomology, Faculty of Crop Protection Sciences, the University of Agriculture Peshawar, Pakistan

Jawad Ali Shah

Department of Agriculture Sciences, the University of Swabi, KP Pakistan

Abdur Rehman

Department of Entomology, Faculty of Crop Protection Sciences, the University of Agriculture Peshawar, Pakistan

Taimur Khan

Department of Entomology, Faculty of Crop Protection Sciences, the University of Agriculture Peshawar, Pakistan

Haneef Tariq

Department of Entomology, Faculty of Crop Protection Sciences, the University of Agriculture Peshawar, Pakistan

Sheraz Khan

Department of Entomology, Pir Mehr Ali Shah Arid Agriculture, University, Rawalpindi, Pakistan

Salman Rehmat

Department of Agriculture Sciences, the University of Haripur KP Pakistan

Shahzad Ahmad

Department of Plant Breeding and genetics, Faculty of Crop Production Sciences, The University of Agriculture Peshawar, Pakistan

Waseem Kamal

Department of Agriculture Extension KP-Pakistan

Sami Ullah

Department of Entomology, Faculty of Crop Protection Sciences, the University of Agriculture Peshawar, Pakistan

Abbas Akbar

Department of Entomology, Faculty of Crop Protection Sciences, the University of Agriculture Peshawar, Pakistan

Correspondence**Jawad Ali Shah**

Department of Agriculture Sciences, the University of Swabi, KP Pakistan

Occurrence and influence of stem borer *Chilo partellus* (Crambidae: Lepidoptera) on maize

Abdul Latif, Jawad Ali Shah, Abdur Rehman, Taimur Khan, Haneef Tariq, Sheraz Khan, Salman Rehmat, Shahzad Ahmad, Waseem Kamal, Sami Ullah, and Abbas Akbar

Abstract

The present study was conducted at NARC, Islamabad to study the host preference of stem borer in different maize germplasm. The experiment was laid out in RCB Design with three replication comprising of four different maize germplasm. Analysis of variance presented that there is significant differences among the trails parameters, which showed significant variability among the entries for the stem borer infestation. In the trial of MBR-10, Leaf damage was 6-10% in 3 entries and dead hearts were formed only in one entry. Stem damage was 0-5% in 12 entries and 6-10% in 10 entries. In 13 entries the lengths of feeding galleries in stems were 1.0-5.0 cm and in remaining 13 entries these were 6.0-19.0 cm per damaged stem. Days to 50% pollen shedding and silking were 67-76 and 68-79 days, respectively. Grain yield ranged from 3020-7695 kg/ha. In the trial of MBR-G, one entry (BR-3) showed no leaf damage, and in 5 entries it was 4.5-10%. Dead hearts were in 3 entries. Stem damage was 0-5% in 5 and 6-10% in 3 entries. In 10 entries the length of feeding galleries were 1.0-5.0 cm. In remaining entries, these were 5.5-7.5 on per damaged stem. Days to 50% pollen shedding and silking were 75-80 and 77-83 days, correspondingly. Grain yield ranged from 1123-11453 kg/ha. In MBR-C, trail the lower leaf damage was 0-10% in 7 entries. Dead hearts were in 2 entries. Stem damage was 0-5% in 2 and 6-10% in 5 entries. In 13 entries feeding galleries were 1.0-5.0 cm and in remaining 16 entries these were 6.0-12.0 cm per damaged stem. Days to 50% pollen shedding and silking were 72-81 and 74-85 days, separately. Grain yield was 800-7414 kg/ha. In the trial of evaluation of experimental varieties, leaf damage was 4.76% in one entry (BR-3). No dead heart was formed. Stem damage was 0.0% in only one entry (EV.1120E). In two entries, it was 3.33 and 5.01%. Pollen shedding ranged from 70-81 days. Silking days ranged from 72-83 days. Grain yield ranged from 1692-5659 kg/ha. In 7 entries the length of feeding galleries were 1.9-4.0 cm and in remaining 2 entries these were 8.50 and 9.52 cm per damaged stem.

Keywords: Stem borer (*Chilo partellus*) maize (*Zea mays*), germplasm, yield, yield component

Introduction

Maize (*Zea mays*) is an annual plant which belongs to family Gramineae and Genus Zea. It is one of the most important cereal crops, grown on an area of 0.941 million hectares with an annual production of 3.53 m tons in Pakistan [1]. In Pakistan maize is grown in irrigated areas with a percentage of 60 and the total remaining grown in the rain fed areas. The total production comes from KPK that accounts for 46% from 53% of total area, Punjab which contributes 54% production from 45% of the total area. A very small percentage (2.0%) is produced in Sindh and Baluchistan province. Maize accounts for 4.8% of the total cropped area and 3.5% of the value of agricultural output [2]. Though not included in Pakistan official statistics maize is an important crop of AJK with about 0.122 million hectare of maize being planted during kharif. Being third leading cereal crop in the world after wheat and rice in respect of area and production, it is a multipurpose crop providing fuel and food to human being, feed to animals and poultry, and fodder to livestock. Maize provides nutrients for humans and animals, and serves as a basic material for straw oil and protein alcoholic beverages and food sweetness. Maize crop possesses great genetic diversity and can be grow across varied agro ecological zones [3]. Although it can be grown successfully throughout Pakistan, yet its cultivation has been concentrated in KPK and Punjab. These provinces contribute 98% to the total production of the country. In Pakistan, maize has great importance due to its high yield and short growth duration. It is grown twice in a year (spring & autumn) both for grain & fodder purposes due to short growing season [4].

In Pakistan, per hectare yield of maize is very low as compared to other countries and has not increased despite the introduction of high yielding varieties, one of the major obstacles in achieving this goal is the attack/infestation by insect pests [5]. Among them, stem borer (*Chilo partellus*) is the most notorious one. Maize stem borer usually caused losses of 35.4% in various maize cultivars and sometime up to 80% or total failure [6]. Stem borer damage ultimately affects food security and the agricultural economy [7]. During early stage the newly hatched larvae start feeding on leaves and destroy the leaf surface and its midrib. Then they enter in to the stem and start feeding downward and kill the central shoot resulting in dead hearts formation. They also destroy the tassel and cobs. It is found at all location with elevation up to 2300 m [8].

Materials and Methods

These studies were carried out in the field of Maize, Sorghum, Millet & Fodder under Insect Pest Management Program, Department of Plant and Environment Protection, National Agricultural Research Centre, Islamabad. These studies were carried out under the following four trials comprising of different maize germplasm. 1) Evaluation of germplasm in MBR-10 (consist of 29 entries). 2) Evaluation of germplasm in MBR-G (consist of 16 entries). 3) Evaluation of germplasm in MBR-C (consist of 30 entries). 4) Evaluation of experimental varieties (consist of 10 entries). The experiment was laid out in Randomized Complete Block Design with three replications. The crop in all trials was planted in rows 4m long and 0.75m apart with plant to plant distance of 0.25m. Insecticide was not applied to allow insect pest attack so that evaluation could be done properly. The following parameters were recorded. Data regarding germination was taken about 5-7 days after sowing. For this purpose numbers of plants on hills were counted. The plants with damaged leaves were counted. The damage was indicated by holes, scratches by feeding and elongated lesions on leaves. Stem borer at seedling stage turned the plants dead or stunted the growth forming dead hearts. These dead hearts were counted and converted to percentage. Stem Damage was examined by observing the stem with holes. The plants with damaged stem were recorded and converted to percentage. Numbers of holes in the stem of damaged plants were counted at harvest and average per damaged plant was calculated. After harvesting, stems having holes were dissected longitudinally into two equal halves for the counting of feeding galleries in stem and average per damaged plant were taken. Gallery length of all galleries in each damaged plant was measured with the help of meter from the longitudinally dissected stems. These lengths per plant were added and average length per damaged

plant was calculated. Assessment of yields was done on the basis of the number of weight of cobs, and grain moisture at harvest. Grain yield per hectare was calculated with the following formula [5].

$$\text{Grain Yield (kg/ha)} = \frac{\text{Ewt} \times (100 - M\%) \times 0.8 \times \frac{1000}{3}}{85}$$

Weight at harvest

(100-M %)/85 = Conversion of moisture 15% level
10000/3 = Conversion of yield per hectare
0.8 = Shelling percentage

2.1 Statistical Analysis

The data were statistically analyzed by the use of statistic 8.1 the difference between the entries were further analyzed through LSD (least significant difference) test [9].

3. Results

3.1. Evaluation of Germplasm in Mbr-10

Analysis of variance indicated that there is significant differences among the entries for leaf damage 1, leaf damage 2, dead hearts, stem damage, holes in stem (no), feeding galleries (no), galleries length (cm), 50% Pollen Sheeding (days), 50% Silking (days), ears (no) and grain yield which showed significant variability among the entries for the insect infestation (Table 1). The germination of seed was high (90-100%), in which 18 entries had 100% germination, while 6 entries had 95% and 5 entries had 90% germination. Leaf infestation by stem borers was recorded twice during the life cycle. In first observation the leaf infestation was high in some entries, while in other entries the infestation was low. During second observation, the infestation was increased in all entries. Initially, Lower leaf damage was 0-5% in 9 entries. Medium leaf damage was 6-10% in 5 entries and the remaining 15 entries had higher infestations. During second observation, the lower leaf damage was 6-10% in 3 entries and the remaining 26 entries had higher infestations. Infestation on leaves was high but no dead heart was observed except one entry (5x15). Lower stem damage was 0-5% in 12 entries. Medium stem damage was 6-10% in 10 entries and the remaining 7 entries had higher infestations. Minimum holes per damaged plant were zero in 2 entries and 1-2 in 16 entries. While 2.2-5.5 holes per damaged plant were in remaining 11 entries. Minimum feeding galleries per damaged plant were zero in 3 entries and 1-2 in 25 entries. While in one entry feeding galleries were 4.0. Three entries showed no galleries and were found resistant. In 13 entries the lengths of feeding galleries were 1.0-5.0 cm. In remaining 13 entries these were 6.0-19.0cm (Table 2).

Table 1: Mean Square of Some Germplasm in Mbr_10

SOV	df	LD1	LD 2	DH	SD	HS	FG	GL	PS	S	E	GY
Reps	2	44.76	27.56	0.14	1.10	1.89	0.07	12.86	13.79	12.45	7.76	681004.69
Entries	28	242.74**	208.01**	2.34**	192.12**	3.39**	1.75**	56.17**	28.78**	22.55**	33.96**	4410453.66**
Error	56	1.39	9.74	0.14	3.65	1.16	1.05	2.76	5.44	4.95	3.54	16225.26

*Significant, **Highly significant, LD 1= Leaf damage 1, LD 2= Leaf damage 2, DH= Dead hearts, SD= Stem damage, HS= Holes in stem (No), FG= Feeding galleries (No), GL= Galleries length (Cm), PS= 50% Pollen sheeding (days), S= 50% Silking (days), E= Ears (No), GY= Grain yield kg/ha

Table 2: Damage caused by stem borer in germplasm of MBR-10 at spring 2014

E/No	Entries	LD1	LD2	DH	SD	HS	FG	GL	PS	S	E	GY
1	2 X 4	9.09	9.09	0.00	2.65	1.3	1.6	3.57	68	70	21	5977
2	3 x 5	28.57	38.10	0.00	26.30	2.6	2.0	8.41	67	69	18	5352
3	3 x 15	18.18	22.73	0.00	7.69	2.5	1.5	4.50	67	70	26	7695
4	3 x 18	5.00	15.00	0.00	5.26	1.0	1.0	0.50	69	71	19	5320
5	5 x 4	0.00	9.52	0.00	0.00	0.0	0.0	0.00	68	70	22	5963
6	5 x 15	19.05	33.33	4.76	11.11	1.5	1.5	7.50	67	69	19	5003
7	5 x 18	9.09	27.27	0.00	9.09	1.5	1.5	5.50	68	70	19	5210
8	7 x 4	4.76	23.81	0.00	4.54	2.0	1.0	19.00	69	72	23	6543
9	12 x 5	18.75	31.25	0.00	5.00	2.0	2.0	3.00	70	72	18	5257
10	12 x 15	12.50	25.00	0.00	10.00	2.5	1.0	5.25	70	72	19	5337
11	15 x 12	13.04	21.74	0.00	5.88	2.0	1.0	3.60	68	71	15	3165
12	16 x 11	8.70	34.78	0.00	29.40	1.0	0.0	0.00	68	70	20	5995
13	16 x 14	25.00	33.33	0.00	34.60	2.2	1.4	5.00	67	68	17	4783
14	17 x 9	4.55	36.36	0.00	13.60	2.5	1.7	8.49	69	72	24	5929
15	17 x 19	5.56	27.78	0.00	5.88	5.5	4.0	13.00	70	73	17	3328
16	18 x 12	14.29	28.57	0.00	4.34	3.5	2.0	14.25	71	73	14	4930
17	21 x 4	5.56	22.22	0.00	6.25	2.0	1.0	9.00	71	74	22	7651
18	4 x 15	10.53	31.58	0.00	9.52	1.0	1.0	3.00	71	74	21	7353
19	20 x 15	10.53	42.11	0.00	0.00	0.0	0.0	0.00	73	76	14	3839
20	3	17.39	21.74	0.00	4.54	1.5	2.0	6.50	70	73	19	4372
21	4	4.55	31.82	0.00	14.20	1.0	1.0	1.50	69	71	20	4969
22	5	27.27	27.27	0.00	14.20	2.5	2.0	6.50	68	72	11	3020
23	15	13.04	34.78	0.00	9.52	1.3	1.0	3.83	69	73	15	4587
24	17	23.81	33.33	0.00	10.52	2.5	2.0	4.75	69	73	18	5600
25	20	14.29	28.57	0.00	5.88	2.0	1.0	6.25	74	77	18	6256
26	EV-7004	4.76	9.52	0.00	6.25	1.0	1.0	7.00	75	77	14	4141
27	EV-1097	26.09	26.09	0.00	10.0	2.0	1.0	2.50	76	79	15	3958
28	EV-1110	36.36	27.27	0.00	5.55	2.0	1.0	4.15	67	70	16	5528
29	MBR25	5.88	29.41	0.00	9.52	3.0	1.0	7.60	75	77	20	4560

Grain yield ranged from 3020-7695 kg/ha. Three entries gave more than 7000 Kg/ha and 14 entries produced 5003-6543 Kg/ha and other low yielders. Highest yielding check (EV-1110) produced 5528 kg/ha. The maximum yield in germplasm under testing was 7695 kg/ha produced by (3X15) followed by 21X4 (7651 kg/ha) and 4X15 (7353 kg/ha). The minimum yield producing entries was 5 with only 3020 kg/ha followed by 15x12 (3165 kg/ha) and 17x19 (3328 kg/ha). Pollen shedding ranged from 67-76 days. One of the check (EV-1097) took highest period (76 days) up to 50% pollen shedding. The maximum days to 50% pollen shedding in germplasm under testing were 74 days (20) followed by 20X15 (73 days). The minimum days to 50% pollen was 67 days took by entries 3x5, 3X15, 5X15 and 16X14 followed 68 days took by 5, 16X11, 15X12, 5X18, 5X4 and 2X4. Silking ranged from 68-79 days. One of the checks (EV-1097) took highest period (79 days) up to 50% silking. The maximum days to 50% silking in germplasm under testing were 77 days (20) followed by 20X15 (76 days). The minimum days to 50% silking was 68 days took by entries 6X14 followed 69 days took by 3X5, 5X15.

3.2 Evaluation of Germplasm in MBR-G

Analysis of variance revealed that there were significant differences among the entries for leaf damage 1, leaf damage

2, dead hearts, stem damage, holes in stem (no), feeding galleries (no), galleries length (cm), 50% Pollen sheeding (days), 50% Silking (days), ears (no) and grain yield which showed significant variability among the entries for the insect infestation (Table 03) The germination of seed was high (90-100%), in which 11 entries had 100% germination. Five entries had 85-95% germination. During the first observation of the leaf infestation by stem borer was high in some entries, while in other entries the infestation was low. During the second observation the infestation was increased in all entries. Initially, Lower leaf damage was 0-5% in 4 entries. Medium leaf damage was 6-10% in 4 entries and the remaining 8 entries had higher infestations. During second observation, one entry (BR-3) still with 0.0% damage, in 5 entries leaf damage was 4.5-10% and the remaining entries had higher infestations. Infestation on leaves was high but no dead heart was observed except 3 entries (1, 6, Islamabad Gold). Lower stem damage was 0-5% in 5 entries. Medium stem damage was 6-10% in 3 entries and the remaining 8 entries had higher infestations. Lowest holes per damaged plant were zero in 2 entries, 1-2 in 14 entries, while least galleries lengths per damaged plant were zero in 2 entries. In 10 entries the lengths of feeding galleries were 1.0-5.0 cm. In remaining 4 entries these were 5.5-7.5cm.

Table 3: Mean square of some germplasm in MBR_G

SOV	Df	LD1	LD2	DH	SD	HS	FG	GL	PS	S	E	GY
Reps	2	0.14	30.89	2.28	41.32	0.14	1.32	4.90	33.06	4.00	36.00	688485.06
Entries	15	171.41**	353.68**	100.01**	514.82**	2.72**	0.76**	15.37**	21**	161.15**	60.35**	22707404.6**
Error	30	0.55	0.80	0.66	0.58	0.80	0.45	0.78	1.86	4.00	1.87	56717.60

*Significant, **Highly significant, LD 1= Leaf damage 1, LD 2= Leaf damage 2, DH= Dead hearts, SD= Stem damage, HS= Holes in stem (No), FG= Feeding galleries (No), GL= Galleries length (Cm), PS= 50% Pollen sheeding (days), S= 50% Silking (days), E= Ears (No), GY= Grain yield kg/ha

Table 4: Damage caused by stem borer in germplasm of MBR-G at spring 2014

E/No.	LD1	LD2	DH	SD	HS	FG	GL	Ps	S	Gy
1	20.00	25.00	15.00	28.8	1.5	1.0	1.4	80	83	13
6	13.64	13.64	13.64	0.00	0.0	0.0	0.0	77	80	17
7	9.52	9.52	0.00	10.52	1.0	1.0	5.9	80	82	16
12	17.39	17.39	0.00	4.54	1.0	1.0	3.1	80	83	19
18	14.29	23.81	0.00	6.66	4.0	2.0	7.5	75	78	15
19	9.09	18.18	0.00	5.88	1.0	1.0	5.6	75	77	16
20	22.73	36.36	0.00	23.5	2.7	1.7	6.7	77	80	19
21	16.67	33.33	0.00	15.62	1.5	1.0	2.9	76	79	31
23	8.70	17.39	0.00	13.04	1.5	1.5	5.5	77	80	28
26	18.18	22.73	0.00	4.54	1.0	1.0	2.3	76	80	15
32	20.83	29.17	0.00	0.00	0.0	0.0	0.0	75	78	14
33	0.00	4.35	0.00	16.6	1.0	1.0	4.9	80	82	9
Islamabad Gold	9.52	9.52	14.29	38.46	1.6	1.3	4.3	82	86	7
BR1	0.00	5.56	0.00	6.00	1.5	1.0	2.5	80	83	4
BR2	5.56	5.56	0.00	33.3	1.3	1.0	1.6	80	84	9
BR3	0.00	0.00	0.00	37.5	2.0	1.0	3.1	82	85	6

Grain yield ranged from 1123-11453 kg/ha. Entry 21 and 23 gave 11453 and 9099 kg/ha yields. Four entries gave more than 5000 kg/ha and 12 entries produced 1123-4292 kg/ha and other low yielders. Highest yielding check (BR1) produced 3305 kg/ha. The maximum yield in germplasm under testing was 11453 kg/ha produced by (21) followed by 23 (9099 kg/ha) and 20 (7607 kg/ha). The minimum yield producing entries was BR3 with only 1123 kg/ha followed by BR2 (1919 kg/ha) and Islamabad gold (2201 kg/ha). Pollen shedding ranged from 75-80 days. One of the check (BR3) took highest period (82 days) up to 50% pollen shedding. The maximum days to 50% pollen shedding in germplasm under testing were 80 days (33) followed by 6, 20, 23 (77 days). The minimum days to 50% pollen was 75 days took by entries 18, 19, 32, followed by 76 days took by 21, 26. Silking days ranged from 77-83 days. One of the check (Islamabad Gold) took highest period (86 days) up to 50% silking days. The maximum days to 50% silking in germplasm under testing were 83 days (01) followed by 07 (82 days). The minimum days to 50% silking was 77 days took by entries 19 followed by 78 days took by 18. (Table 04).

3.3 Evaluation of Germplasm in MBR-C

Analysis of variance showed that there is significant differences among the entries for leaf damage 1, leaf damage 2, dead hearts, stem damage, holes in stem (no), feeding galleries (no), galleries length (cm), 50% Pollen Shedding

(days), 50% Silking (days), ears (no) and grain yield which showed significant variability among the entries for the insect infestation (Table 05). The germination of seed was high (90-100%), in which 26 entries had 100% germination. Four entries had 65-85% germination. To record the infestation of stem borers, the data was recorded two times. During the first observation the infestation was high in some entries, while in other entries the infestation was low. During the second observation the infestation was increased in all entries. Initially, Lower leaf damage was 0-5% in 14 entries. Medium leaf damage was 6-10% in 4 entries and the remaining 12 entries had higher infestations. During second observation, the lower leaf damage was 0-10% in 7 entries and the remaining 23 entries had higher infestations. Infestation on leaves was high but no dead heart was observed except 2 entries (1x11, 4x3). Lower stem damage was 0-5% in 2 entries. Medium stem damage was 6-10% in 5 entries and the remaining 23 entries had higher infestations. Minimum holes per damaged plant were 0.0 in 1 entry and 1-2 in 17 entries, while 2.2-8.0 holes per damaged plant were in remaining 11 entries. Minimum feeding galleries per damaged plant were zero in 1 entry and 1-2 in 27 entries, while in 2 entry feeding galleries were 2.2-4.0. Minimum galleries length per damaged plant were (0.0 cm) in 1 entry. In 13 entries the lengths of feeding galleries were 1.0-5.0 cm. In remaining 16 entries these were 6.0-12.0cm.

Table 5: Mean square of some germplasm in MBR_C

SOV	Df	LD1	LD 2	DH	SD	HS	FG	GL	PS	S	E	GY
Reps	2	37.03	44.07	0.54	56.47	0.23	0.00	65.45	2.13	1.20	0.53	1414.53
Entries	29	314.22**	487.16**	29.71**	315.31**	6.71**	1.33**	41.40*	17.73**	24.76**	22.53**	5844081.87**
Error	58	1.15	2.52	0.26	2.33	1.25	0.59	1.16	4.06	3.68	4.12	40727.64

*Significant, **Highly significant, LD 1= Leaf damage 1, LD 2= Leaf damage 2, DH= Dead hearts, SD= Stem damage, HS= Holes in stem (No), FG= Feeding galleries (No), GL= Galleries length (Cm), PS= 50% Pollen shedding (days), S= 50% Silking (days), E= Ears (No), GY= Grain yield kg/ha

Table 6: Damage caused by stem borer in germplasm of MBR-C at spring 2014

E/No.	Entries	LD1	LD2	DH	SD	HS	FG	GL	PS	S	E	GY
1	1 x 4	9.09	13.64	0.00	21.0	1.25	1.25	8.37	74	76	17	3751
2	1 x 10	0.00	9.52	0.00	29.4	1.60	4.00	2.86	75	78	17	800
3	1 x 11	22.22	18.18	16.67	17.6	3.33	2.00	7.13	75	77	16	3689
4	3 x 4	5.26	20.00	0.00	11.1	2.00	1.00	1.75	74	77	20	4704
5	3 x 6	20.00	28.57	0.00	14.3	2.88	1.22	6.51	75	78	19	3668
6	3 x 7	16.67	14.29	0.00	17.3	1.75	1.25	2.30	76	79	25	4576
7	3 x 10	19.05	40.91	0.00	38.0	2.75	1.50	7.80	76	79	19	5846

8	3 x 13	14.29	28.57	0.00	45.4	3.40	1.40	11.8	77	79	23	4528
9	4 x 3	5.00	12.50	5.00	11.7	2.00	1.00	1.25	74	77	20	4242
10	4 x 7	4.76	12.50	0.00	11.1	2.50	1.00	12.6	75	77	20	5356
11	4 x 10	4.55	13.04	0.00	35.7	3.00	1.20	5.36	74	77	19	6025
12	4 x 13	20.00	8.70	0.00	9.09	1.00	1.00	6.60	72	74	22	6423
13	6 x 1	6.67	20.83	0.00	17.6	1.66	2.00	6.30	79	82	18	5567
14	7 x 4	28.57	18.18	0.00	19.0	1.75	1.40	7.30	77	79	20	4965
15	9 x 3	5.26	33.33	0.00	28.5	1.28	2.20	12.0	78	81	24	4528
16	9 x 8	19.05	9.52	0.00	10.0	8.00	2.00	15.0	76	79	21	6819
17	10 x 1	0.00	0.00	0.00	9.09	2.00	1.50	7.05	74	80	20	6184
18	10 x 5	9.52	15.79	0.00	16.6	3.00	1.00	4.12	78	80	19	3641
19	10 x 11	9.09	26.32	0.00	17.6	1.66	1.00	3.03	76	79	20	5924
20	10 x 13	13.04	26.09	0.00	16.0	5.50	2.00	9.07	77	80	23	5384
21	11 x 5	27.78	31.82	0.00	26.3	2.20	1.20	7.68	77	81	15	6061
22	11 x 10	40.91	63.64	0.00	25.0	3.60	1.40	7.74	76	80	21	4496
23	11 x 13	0.00	8.70	0.00	5.55	1.00	1.00	3.40	79	83	21	6400
24	12 x 9	4.55	14.29	0.00	22.2	2.00	1.25	5.00	78	82	22	5162
25	13 x 4	5.26	4.76	0.00	13.3	1.00	1.00	2.60	81	80	16	6054
26	13 x 11	0.00	0.00	0.00	6.25	2.00	1.00	4.10	76	79	25	4282
27	13 x 12	0.00	17.39	0.00	6.22	2.00	1.00	2.10	81	85	20	7414
28	Islamabad White	5.26	18.18	0.00	13.6	1.00	1.00	0.90	80	84	15	4491
29	Azam	0.00	11.76	0.00	0.00	0.00	0.00	0.00	82	88	16	2642
30	NARC-2704	17.65	20.00	0.00	12.7	2.33	1.00	6.40	74	77	19	2964

Grain yield ranged from 800-7414 kg/ha. One entry gave more than 7000 kg/ha and 13 entries produced 5162-6819 kgs/ha and other low yielders. Highest yielding check (Islamabad white) produced 4491 kg/ha. The maximum yield in germplasm under testing was 7414 kg/ha produced by (13x12) followed by 9x8 (6819 kg/ha) and 4x12 (6423 kg/ha). The minimum yield producing entries was 1x10 with only 800 kg/ha followed by 10x15 (3641 kg/ha) and 3x6 (3668 kg/ha). Pollen shedding ranged from 72-81 days. One of the check (Azam) took highest period (82 days) up to 50% pollen shedding. The maximum days to 50% pollen shedding in germplasm under testing were 81 days (13X12, 13X4) followed by 11X13 (79 days). The minimum days to 50% pollen was 72 days took by entries 4X13 followed 74 days took by 10X1, 4X10, 4X3, 3X4, 1X4. Silking ranged from 74-85 days. One of the checks (Azam) took highest period (88 days) up to 50% silking days. The maximum days to 50% silking in germplasm under testing were 85 days (13x12) followed by 11x13 (83 days). The minimum days to 50% silking was 74 days took by entries 4x13 followed 76 days took by 1x4. (Table 06).

3.4 Evaluation of Experimental Varieties

Analysis of variance presented that there is significant differences among the entries for leaf damage 1, leaf damage 2, dead hearts, stem damage, holes in stem (no), feeding galleries (no), galleries length (cm), ears (no) and grain yield

except 50% Pollen sheeding (days) and 50% Silking (days), which showed significant variability among the entries for the insect infestation (Table 7). The germination of seed was low as compared to other germplasm. There was no variety which has 100% germination. There were 7 varieties that had 80-95% germination. Rest of the entries had 75% germination. The leaf infestation by stem borers, the data was logged two times. During the first observation the infestation was high in some entries, while in other entries the infestation was low. In the same entries during second observation the infestation was increased in all entries. Initially, Lower leaf damage was 2.18-4.55% in 7 entries. In the remaining 3 entries leaf damage was 6.25-8.34%. During second observation, the lower leaf damage was 4.76% in one entry (BR-3). Medium leaf damage was 6.73-9.43% in 5 entries and the remaining 4 entries had higher infestations. Infestation on leaves was high but no dead heart was observed. Lower stem damage was zero in only one entry (EV-1120E). In two entries (Islamabad Gold and EV-1120L), it was 3.33 and 5.01%. In the remaining 7 entries the damage was higher. Minimum holes per damaged plant were 0.0-0.5 in 2 entries and 1.0-1.67 in 5 entries. In the remaining 3 entries 2.75-3.0 holes per damaged plant were present. Minimum feeding galleries per damaged plant were 0.0-0.65 in 4 entries, 1.0-1.65 in 6 entries. Minimum galleries length per damaged plant were (0.0 cm) in one entry (EV-1120E). In 7 entries the lengths of feeding galleries were 1.9-4.0 cm. In remaining 2 entries these were 8.50 and 9.52 cm.

Table 7: Mean square of some germplasm in Experimental trails evaluation

SOV	Df	LD1	LD 2	DH	SD	HS	FG	GL	PS	S	E	GY
Reps	2	10.72	13.02	0	20.05	0.81	0.08	8.48	40.00	14.40	40.00	329785.60
Entries	9	14.57**	62.24**	0**	290.34**	3.41**	0.84**	26.83**	11.46 ^{ns}	10.03 ^{ns}	38.3**	5560771.63**
Error	18	0.53	0.82	0	0.72	0.91	0.56	0.62	0.00	2.84	0.00	1804.93

*Significant, **Highly significant, LD 1= Leaf damage 1, LD 2= Leaf damage 2, DH= Dead hearts, SD= Stem damage, HS= Holes in stem (No), FG= Feeding galleries (No), GL= Galleries length (Cm), PS= 50% Pollen sheeding (days), S= 50% Silking (days), E= Ears (No), GY= Grain yield kg/ha spring 2014

Table 8: Damage caused by stem borer in Experimental Varietal Evaluation at NARC

E/No.	Entries	L D1	L D2	DH	SD	HS	FG	GL	PS	S	E	GY
1	EV.1120L	2.18	6.73	0.00	5.01	3.00	1.50	3.00	75	77	18	5540
2	EV.1120E	8.34	21.43	0.00	0.00	0.00	0.00	0.00	78	81	17	5659
3	EV.1110	7.38	12.26	0.00	26.15	1.67	1.15	4.00	75	77	15	3856
4	BR1	2.50	7.50	0.00	22.94	1.50	1.25	3.28	76	76	13	4267
5	BR2	4.35	8.70	0.00	18.75	1.00	0.65	2.12	76	78	7	1860
6	BR3	2.38	4.76	0.00	13.15	1.60	0.60	2.18	74	77	9	1692
7	Soan-3	4.55	9.09	0.00	23.63	3.00	1.65	8.50	79	77	14	3900
8	Azam	4.55	11.37	0.00	25.08	2.75	1.50	9.52	75	79	16	4677
9	Islamabad Gold	6.25	11.65	0.00	3.33	0.50	0.50	2.65	76	77	17	4998
10	EV-1097	2.63	9.43	0.00	9.55	1.00	1.00	1.90	72	74	13	4412

Grain yield ranged from 1692-5659 kg/ha. Two entries gave more than 5000 kg/ha and 6 entries produced 3856-4998 kgs/ha and other low yielders. Highest yielding check (Islamabad white) produced 4491 kg/ha. The maximum yield in germplasm under testing was 5659 kg/ha produced by (EV-1120E) followed by EV-1120L (5421 kg/ha) and I. GOLD (4998 kg/ha). The minimum yield producing entries was BR3 with only 1692 kg/ha followed by EV-1110 (3856 kg/ha) and SOAN-3 (3900 kg/ha). Pollen shedding ranged from 70-81 days. One of the check (Soan-3) took highest period (81 days) up to 50% pollen shedding. The maximum days to 50% pollen shedding in germplasm under testing were 81 days (Soan-3) followed by Ev-1120L, EV-1120E (80 days). The minimum days to 50% pollen was 70 days took by entries Ev-1120L, BR3 followed 72 days took by Ev-1110, Ev-1097. Silking days ranged from 72-83 days. One of the check (Ev-1120E) took highest period (83 days) up to 50% silking days. The maximum days to 50% silking in germplasm under testing were 82 days (Ev-1120L) followed by BR3 (83 days). The minimum days to 50% silking was 72 days took by entries BR3, BR3 followed 74 days took by Ev-1110, Ev-1097 (Table 08).

4. Discussion

Among several factors responsible for low yields, significant contribution has been made by insect pests. Maize stem borer (*Chilo partellus*) is the most notorious pest that causes heavy damage to maize crop resulting from 10 to 100% yield losses in Asia and Africa [10]. Maize stem borer usually caused losses of 35.4% in various maize cultivars and sometime up to 80% or total failure [6]. Stem borer damage ultimately affects food security and the agricultural economy [7]. According to [8] *Chilo partellus* was found at all locations of Kenya with elevations up to 2300 m with its highest density in the semi-arid ecological zone. In the current study artificial infestation for screening the germplasm was done because it gives fast and accurate results while a natural infestation alone was not effective, very slow and the results could be misleading. The infestation with neonate larvae resulted in higher foliage damage and greater dead hearts [11]. Most of the entomologists are convinced that artificial infestation is superior and more efficient than other techniques for identifying resistant genotypes. Conventional breeding techniques have facilitated significant improvement in resistance to corn borers [12], evaluated the varieties for resistance on the basis of only leaf injury [13], evaluated the varieties for resistance on the basis of leaf and stem feeding and dead hearts [14], identified the resistance in plants on the basis of lowest leaf damage [15] selected the resistant variety with 17.7% infestation [16] also suggested that resistance should be measured by the absence or low percentage of dead hearts when borers attack the plants

at seedling stage. In the present studies, comprehensive criteria of resistance including leaf, stem and tassel damages, dead hearts formation and survival of plants were followed.

5. Conclusion and Recommendation

From the above result and discussion, we concluded that, in the trial of MBR-10, Leaf damage was in 3 entries and dead hearts were formed only in one entry. Stem damage was in 12 entries. In 13 entries the lengths of feeding galleries in stems were found. Three entries gave more than 7000 kgs/ha. In the trial of MBR-G, BR-3 showed no leaf damage. Dead hearts were in 3 entries. Stem damage was in 3 entries. In 10 entries the lengths of feeding galleries were originated. Four entries gave more than 5000 kg/ha. In the trial with MBR-C, the lower leaf damage was in 7 entries and dead hearts were in 2 entries. Stem damage was in 5 entries. In 13 entries the lengths of feeding galleries were observed. One entries gave more than 7000 kg/ha. In the trial of evaluation of experimental varieties, leaf damage was only in (BR-3). No dead heart was formed. Stem damage was 0% in only one entry. Two entries gave more than 5000 kg/ha. In 7 entries the lengths of feeding galleries were found.

From the above conclusion it is recommended that, the trial MBR-C, needs to be performed over different location and year for conclusive result.

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