INTERNATIONAL JOURNAL OF APPLIED BIOLOGY AND PHARMACEUTICAL TECHNOLOGY

www.ijabpt.com Volume-4, Issue-4, Oct-Dec-2013 Coden : IJABPT Copyrights@2013

ISSN : 0976-4550

Received: 18th Sept-2013 *Revised: 23rd Sept-2013* *Accepted: 08th Oct-2013*

Research Article

SCREENING OF MAIZE GENOTYPES AGAINST STEM BORER *CHILO PARTELLUS* L. IN *KHARIF* SEASON

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ABSTRACT: Maize (*Zea mays* L.) being the highest yielding cereal crop in the world is of significant importance for countries like India, where rapidly increasing population already out stripped the available food supplies. Maize crop possesses great genetic diversity. Maize Plant is attacked by 140 species of insects causing varying degree of damage causing an annual loss of over 1 billion in the Semi Arid Tropics (ICRISAT, 1992). Out of these, only 10 species cause serious damage from sowing till storage, of which the stemborer *Chilo partellus* (Swinhoe) is the major one (Hiremath et al., 1988). The larvae of *C.partellus* after hatching feed on soft surface of the leaves and then enter the stem through whorl of feeding on the pith of the stem. The growth of the plants becomes shunted and resulting in dead hearts when attacked by *C.partellus* at their initial stages. The larvae transferred from other plants enter the stem through lower nodes by making the holes. Stem borers pupate inside the stem. They make holes before pupation for the emergence of adults. Since host plant resistance is the back bone of Insect Pest Management; hence the present investigation was initiated. Present studies were designed to identify maize genotype resistance against stem borer in order to minimize pesticide use, improve natural balance, and enhance the activity of bio control agents, and to increase crop production. The investigations were carried out on the screening of Maize genotypes against Maize stem borer *Chilo partellus* in *kharif* season were conducted on the agricultural farm of the institute of Agricultural Sciences, Banaras Hindu University, Varanasi during *kharif* season of 2010-2011 to screen the relative resistance /susceptibility of 19 genotypes of maize to the insect pest, maize stem borer (*Chilo partellus*). In order to screen the relative susceptibility of different maize genotypes to maize stem borer the following genotypes were screened under field conditions. The symbols T1 to T19 have been used to represent the following cultivars of maize. HUZM 217, HUZM 185, HUZM 227, HUZM 186, AH 411, NMH 9858, HUM 152, CM 119, QPM 466, QPM 467, QPM 169, QPM 193, QPM 163, HUZQPM 240, HUZQPM 241, HUZQPM 242, HUZQPM 243, HUZQPM 246, HUZQPM 247. The maize varieties were grown in plots having 19 rows, plot size 13x2.5 m². The plant spacing between rows and plants were maintained 70 cm and 20 cm, respectively. The crop was grown as per the normal agronomic practices during the *kharif* season of 2010-2011. The effect of natural infestation was studied. The crop was sown on 22nd July 2010 and harvested on 10th November 2010. Entire screening was based on leaf damage, dead heart formation, no. of exit holes. No. of larvae and pupae population and mean tunnel length. Dead heart formations were higher in more susceptible genotypes than least susceptible genotypes. There were no sign of dead heart was found in cultivar HUZQPM 242, HUZQPM 246, QPM 193, CM 119, AH 411, HUM 152, NMH 9858, HUZM 185, HUZM 217. Maximum occurrences of dead heart were in cultivar HUZM 227, QPM 169. Leaf damage was measured on visual rating scale. In context of leaf injury rating mean was 2.6 to 6.6. Maximum leaf damage was reported on cultivar QPM 169.Average plant height was mean of length from root to flag leaf. Mean tunnel length was divided into three categories-Least susceptible (0-5cm), moderately susceptible (5-10cm), highly susceptible (>10 cm) and respected genotypes also have been identified.

Key Words: Genetic diversity, whorl of feeding, dead hearts, host plant resistance, Insect Pest Management, genotype resistance, resistance /susceptibility, exit holes, tunnel length.

INTRODUCTION

Maize (*Zea mays* L.) being the highest yielding cereal crop in the world is of significant importance for countries like India, where rapidly increasing population already out stripped the available food supplies. Maize crop possesses great genetic diversity and can be grown across varied agro ecological zones (*Ferdu* et al., 2002).

It is grown from 58° N to 40° S, from below sea level to altitudes higher than 3000 m, and in areas with 250 mm to more than 5000 mm of rainfall per year (Shaw, 1988; Dowswell et al., 1996) and with a growing cycle ranging from 3 to 13 months (CIMMYT 2000). India has 5% of corn acreage and contributes 2% 0f world production. Maize is the world's top ranking food crop followed by wheat and rice. In India, it is the third most important cereal after wheat and rice. In India, about 28% of maize produced is used for food purpose , about 11% as livestock feed , 48% as poultry feed , 12% in wet milling industry (for example starch and oil production) and 1% as seed (AICRP on Maize , 2007). It is a short duration , seasonal crop with high yielding potential and can provide good return to the growers with relatively little input and investment . Maize is used in the preparation of starch, glucose, corn feed, and corn gluten and forms a major ingredient in poultry region, and being a source of starch and protein is used as fodder for live stock. *Chaudhary* (1983) report that maize is used as raw material in paper, textile, laundry, refining and food industries (sweetening of candies, ice creams of bakery products) and chemical industries. Maize is a versatile crop grown over a range of agro climatic zones. In fact the suitability of maize to diverse environment is unmatched by any other crop. In India maize is grown in all the seasons i.e., kharif, Rabi and summer. Of these three seasons, nearly 90% of the production is from *kharif* season, 7-8% during rabi season and remaining 1-2% during summer season. Since the maize is rain dependent, it is mainly grown during kharif season. Maize Plant is attacked by 140 species of insects causing varying degree of damage causing an annual loss of over 1 billion in the Semi Arid Tropics (ICRISAT, 1992). Out of these, only 10 species cause serious damage from sowing till storage, of which the stemborer *Chilo partellus* (Swinhoe) is the major one (Hiremath et al., 1988). The larvae of *C.partellus* after hatching feed on soft surface of the leaves and then enter the stem through whorl of feeding on the pith of the stem. The growth of the plants becomes shunted and resulting in dead hearts when attacked by *C.partellus* at their initial stages. The larvae transferred from other plants enter the stem through lower nodes by making the holes. Stem borers pupate inside the stem. They make holes before pupation for the emergence of adults. Sometimes, the larvae inside the stem enter the ears through the shank and damage the ears. The larvae of next generation of stem borer feed on tassels. There are five overlapping generations of *C.partellus* throughout the year in India. The fifth generation undergoes hibernation during winter from mid October /November to mid February /March. The first two or three generations damage the spring maize crop and third to fifth generation damage the summer maize crop. Quality and yield of such an important crop is reduced greatly by the stem borers. Since host plant resistance is the back bone of Insect Pest Management; hence the present investigation was initiated.

MATERIAL AND METHODS

The present studies on the screening of Maize genotypes against Maize stem borer *Chilo partellus* in *kharif* season were conducted on the agricultural farm of the institute of Agricultural Sciences, Banaras Hindu University, Varanasi during *kharif* season of 2010-2011 to screen the relative resistance /susceptibility of 19 genotypes of maize to the insect pest, maize stem borer (*Chilo partellus*).

Selection of genotypes

In order to screen the relative susceptibility of different maize genotypes to maize stem borer the following genotypes were screened under field conditions. The symbols T1 to T19 have been used to represent the following cultivars of maize. HUZM 217, HUZM 185, HUZM 227, HUZM 186, AH 411, NMH 9858, HUM 152, CM 119, QPM 466, QPM 467, QPM 169, QPM 193, QPM 163, HUZQPM 240, HUZQPM 241, HUZQPM 242, HUZQPM 243, HUZQPM 246, HUZQPM 247.

Life cycle & Nature of damage

The insect breeds actively from March-April to October and for rest of the year it remains in hibernation as a full grown larva in maize stubble, stalks or unshelled cobs. The larvae pupate sometimes in March and emerge as moths in the end of that month or in early April. They are active at night when they mate and lay eggs on the underside of the leaves of various host plants, particularly the early crops of maize grown as fodder. The eggs are flat, oval, yellowish and are laid in overlapping clusters each containing up to 20 eggs. A female lays over 300 eggs during its life span 0f 2-12 days and the eggs hatch in 4-5 days in summer. The young first feed on the leaves, making a few shot holes and then bore their way downwards through the central whorl as it opens. More shot holes become visible, indicating an earlier attack and the plant also shows dead hearts.

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Layout:

1.	Number of replications	: 1
2.	Number of treatments	: 19
3.	Area of the plot	: 13 x 2.5m²
4.	Total number of rows	: 19
5.	Row to Row distance	: 70cm
6.	Plant to Plant distance	: 20cm
7.	Number of rows	: 19
8.	Row length	: 2.6m
9.	Length of field	: 13.30m
10.	Date Of sowing	: 22/07/2010
11.	Atrazine spray	: 23/07/2010
12.	Date of harvesting	: 10/11/2010

The maize varieties which are commonly cultivated in this area were grown in plots having 19 rows, plot size 13x2.5 m². The plant spacing between rows and plants were maintained 70 cm and 20 cm, respectively. The crop was grown as per the normal agronomic practices during the *kharif* season of 2010-2011. The effect of natural infestation was studied. The crop was sown on 22nd July 2010 and harvested on 10th November 2010.

Crop culture

The soil of the experiment plot was sandy loam in nature. The field was well prepared. The crop was sown on 22nd July 2010 and harvested on 10th November 2010. Fertilizers 80kg N/ha in the form of urea, 40 kg phosphorous/ha and potash 40kg/ha were applied. Two third of the amount was applied as basal application and remaining one third applied as top dressing 3 days after irrigation. Irrigation was given after three weeks after sowing. One weeding was done after 25 days after sowing.

Since the objective of the experiment to evaluate the relative degree of resistance present in the genotypes against stem borer, the natural infestation of stem borer was allowed to build up. No control measures against stem borer were undertaken.

Observations

Five plants were randomly selected from each line of genotype. In context of leaf damage and dead heart formation data were collected after 60DAS. Whereas average plant height of different genotypes, average number of exit holes (per plants), mean number of larvae, mean number of pupae and mean tunnel length were collected at the time of harvesting.

Meteorological data

The meteorological observations during the investigation period were recorded from the meteorological observatory of the institute of agricultural sciences, Banaras Hindu University, Varanasi.

Seasonal Incidence of stem borer:

To record the seasonal incidence of *C.partellus* in maize the experiment was laid out in plot of 13X2.5 m². The incidence of *C.partellus* was recorded in terms of leaf damage, dead heart formation, no. of larvae and pupae and mean tunnel length.

Leaf Injury Rating

In order to study leaf injury rating damage was recorded at 60 days after planting on scale of 1 to 9, from five selected plant in each line of genotype.

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Rating Scale:

1. Apparently healthy plant

2. Plant showing slight damage pinholes on 1-2 leaves.

3. Plant showing slight damage on 3-4 leaves.

4. Plant showing injury pin holes, shot hole slit in about 1/3 total leaves

5. Plant showing 50% leaf damage.

6. Plant showing 2/3 total leaf injuries.

7. Plant with every type of injury all most all damage.

8. Entire plant with complete leaf injury likely to form dead heart.

9. Complete dead heart.

Average Plant height

At the time of harvesting five plant from each genotype was randomly selected and distance between root to flag leaf was taken. Mean of heights were calculated.

Dead Hearts Symptoms

All the plants showing dead heart formation from rows of the plot were examined to check that dead heart caused by *C.partellus*, were counted and mean value has been taken at 60 days.

Stem tunneling:

In context of study of stem tunneling at harvesting 5 randomly selected plans were uprooted and made split cut. Data related to plant height and tunnel length were noted and their mean was calculated.

Keeping in view data related to stem tunnel length were grouped under following 3 categories.

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

Experimental Finding:

The present investigation was carried out on maize stem borer, *Chilo partellus* with reference to screening of maize genotype in *kharif* season during 2010-2011 at agriculture farm, Banaras Hindu University. The trail was conducted under field condition. The details of result obtained on different aspects of the present investigation have been described here under

Leaf Damage

Leaf injury is the first larval feeding symptom; on the basis of visual scale damage of leaf was evaluated. All the 19 genotypes were examined on the basis of Leaf Injury Rating (LIR). Under natural conditions of infestation, all cultivars had variable degree of infestation while maximum showed LIR was less than 6.6. The range of leaf damage was 2.6 to 6.6, studies revealed that the incidence was maximum in QPM 169, whose mean LIR of five plants was 6.6 i.e. plant showing 2/3 total leaf injuries. Characteristics pin holes, shot holes slit were present (Plate 1 and 2). Whereas leaf damage was less in HUZQPM242, HUZM 185, HUZM 217 average leaf ratings of these genotypes were 2.6, 2.8, 3.4. Rest of the genotypes having leaf injury rating between 3.6 to 5.6. The performance of the some genotype was far better than susceptible one. The detail of outcome is shown in table no.1

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Table No.1 Showing Data about Leaf Injury Ratings:

GENOTYPE	LEAF INJURY RATINGS(MEAN VALUE)		
	AT 20 DAS	AT 40 DAS	AT 60 DAS
HUZM 217	1.2	2.0	2.8
HUZM 185	1.2	2.6	3.4
HUZM 227	2.2	4	4.8
HUZM 186	1.8	3.0	5.6
AH 411	1.0	1.6	3.8
NMH 9858	2.0	3.2	5.6
HUM 152	1.4	2.8	3.6
CM 119	1.6	3.6	4.2
QPM 466	2.2	5.6	4.4
QPM 467	1.6	5.6	5.4
QPM 169	1.6	4.2	6.6
QPM 193	1.2	2.4	4.2
QPM 163	1.6	3.6	6.0
HUZQPM 240	1.4	3.6	6.0
HUZQPM 241	1.6	3.6	6.0
HUZQPM 242	1.2	1.4	2.6
HUZQPM 243	2.2	3.8	5.2
HUZQPM 246	1.6	2.2	3.6
HUZQPM 247	1.2	2.6	4.6

Percent dead heart

Some of the heavily infested plants turned dead heart during the *kharif* season 2010-11 (plate 5,6). Dead heat formation due to *C.Partellus* ranges from 0.2 t0 0.6. The data of randomly selected five plants were taken at 60 days crop stage and mean was calculated. Dead heart formation was least in HUZQPM 246, HUZQPM 242, QPM 193, NMH 9858, HUM 152, CM 119, AH 411, HUZM 217, HUZM 185.

Table No. 2 Showing Data about Dead heart formation

Genotype	Total No. of Plants	Selected No. of Plants	Plant showing dead heart symptom at 60 DAS (Mean Value)
HUZM 217	13	5	0
HUZM 185	13	5	0
HUZM 227	13	5	0.6
HUZM 186	13	5	0.2
AH 411	13	5	0
NMH 9858	13	5	0
HUM 152	13	5	0
CM 119	13	5	0
QPM 466	13	5	0.2
QPM 467	13	5	0.4
QPM 169	13	5	0.6
QPM 193	13	5	0
QPM 163	13	5	0.4
HUZQPM 240	13	5	0.2
HUZQPM 241	13	5	0.4
HUZQPM 242	13	5	0
HUZQPM 243	13	5	0.2
HUZQPM 246	13	5	0
HUZQPM 247	13	5	0.2

Whereas the maximum infestation was observed in HUZM 227, QPM 169 having the mean value "0" under natural infestation. Some genotypes have been denoted as least susceptible in dead heart formation they are HUZQPM 247, QPM 466, HUZQPM 243, HUZM 186 having the mean value 0.2 and some are moderately susceptible showing the mean value 0.4 they are QPM 467, QPM 163. And Genotypes like QPM 169, HUZM 227 are highly susceptible having the mean value 0.6 which is highest in the observed range. Details of data regarding dead hearts was shown in the table no. 2

Mean Tunnel Length

In Maize tunnel length forms due to damage of *C.Partellus* by feeding inside stem. On the basis of tunnel length entire 19 genotypes were classified into three categories. Namely these are least susceptible, Moderate susceptible and Highly susceptible. The Mean tunnel Length was 0-5cm in case of least susceptible genotype, 5-10 cm incase of moderately susceptible genotype where as more than 10 cm for highly susceptible genotype. Least susceptible genotype were HUZM 217, HUZM 185, AH 411, CM 119, QPM 466, HUZQPM 242, HUZQPM 243, HUZQPM 246. Moderately Susceptible genotypes were HUZM 186, NMH 9858, HUM 152, QPM 467, QPM 193, QPM 163, HUZQPM 240, HUZQPM 241, HUZQPM 247.

The data of stem tunneling was shown in table no. 3

Table no. 3 showing stem tunneling data

Genotype	Total Mean Plant height at 120 DAS (in cm) Mean value	Mean stem tunneling length at 120 DAS (in cm) Mean Value
HUZM 217	146.52	0
HUZM 185	148.28	4.56
HUZM 227	122.58	10.31
HUZM 186	134.42	5.78
AH 411	141.64	0
NMH 9858	132.98	7.36
HUM 152	144.46	5.8
CM 119	163.54	0
QPM 466	139.12	2.38
QPM 467	121.52	5.2
QPM 169	129.06	11.32
QPM 193	126.28	4.26
QPM 163	141.66	8.16
HUZQPM 240	142.84	6.56
HUZQPM 241	154.28	5.24
HUZQPM 242	147.32	0
HUZQPM 243	136.12	3.98
HUZQPM 246	152.04	0
HUZQPM 247	136.56	4.86

Highly susceptible genotypes were QPM 169, HUZM 227.

S.NO.	Range of Mean Tunnel length(cm)	Attribute
1	0-5 (Least susceptible)	HUZM 217, HUZM 185, AH 411, CM 119, QPM 466, HUZQPM 242, HUZQPM 243, HUZQPM 246.
2	5-10(Moderately Susceptible)	HUZM 186, NMH 9858, HUM 152, QPM 467, QPM 193, QPM 163, HUZQPM 240, HUZQPM 241, HUZQPM 247.
3	>10 (Highly Susceptible)	QPM 169, HUZM 227

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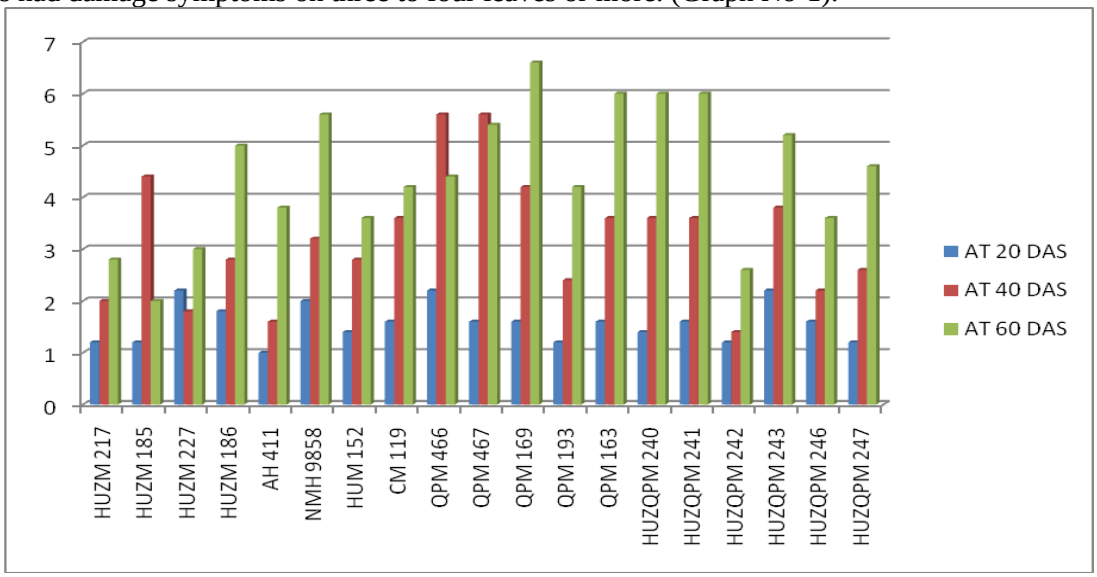
RESULT AND DISCUSSION

The Experiment was conducted to screen 19 maize genotypes against *C.Partellus* in *kharif* season 2010-2011. The performance was determined on the basis of leaf damage, dead heart formation and mean tunnel length. As stem borer is one of the important pests of maize in the eastern part of uttar Pradesh during *kharif* , the present study was aimed to combat this noxious pest through least susceptible genotype . The qualitative and quantitative losses in *kharif* maize are attributed to many reasons of which the stem borer *Chilo partellus* ranks first. Since the incidence of this pest is noticed during the whole cropping period, the management of this pest is found to be difficult.

Leaf Damage

It was proved by the studies that HUZQPM 242, HUZM 185, HUZM 217average leaf ratings of these genotypes were 2.6, 2.8, 3.4 were least susceptible and QPM 169 was most susceptible for leaf damage. Leaf damage is mostly caused by initial instar larvae. They cause pin hole or short holes in the leaf /leaf whorl. A uniform damage on the leaf area observed. In order to measure leaf damage visual rating scale was used. Scales include nine different types of parameters. During initial stage the size of hole was smaller where as with the developmental stage size of hole was increased. Most of the cultivars had damage symptoms on three to four leaves or more. (Graph No-1).



Graph No.1 Showing Leaf Injury Rating on 20, 40, 60 Days after planting
X axis = genotypes Y axis = rating scale

Dead-heart

Since leaf damage was present on the most of the genotype but dead heart symptoms were present on the less plant. Even in case of some genotype the symptom was nil. It means that the larvae started feeding on genotype but majority of them died or left the plants which resulted in lower dead heart symptom. The plant growth and development hamper considerably after a critical level of damage. Some genotypes like QPM169, HUZM 217, HUZM 185, AH 411, NMH 9858, HUM 152, CM 119, QPM 193, QPM 163, HUZQPM 242, HUZQPM 246 had no dead heart symptom but more than one fourth of the sample plant of genotypes QPM 169, HUZM 227, were suffering from such type of damage.(Graph No-2).

Mean Tunnel Length

Considering the tunnel length all the genotypes were classified in to three categories. Tunnel length between 0-5 cm was consider as least susceptible, tunnel length between 5-10cm are moderately susceptible, where as plant with more than 10 cm tunnel were highly susceptible. Two genotypes, HUZM 227, QPM 169 were highly susceptible. Genotypes QPM 163, HUZM 186, NMH 9858, HUM 152, QPM 467, HUZQPM 240, HUZQPM 241 were moderately susceptible. Rest ten cultivars are least susceptible. So the results found through this experiment were coinside with the result brought by the workers Hemanth Swami and Bajpai, N.K. who conducted reaserch on eight selected maize (*Zea mace* L.) varieties were evaluated during 1999 and 2000 at RCA farm for resistance to maize stem borer, *C.partellus*, infestation. (Graph No-3).

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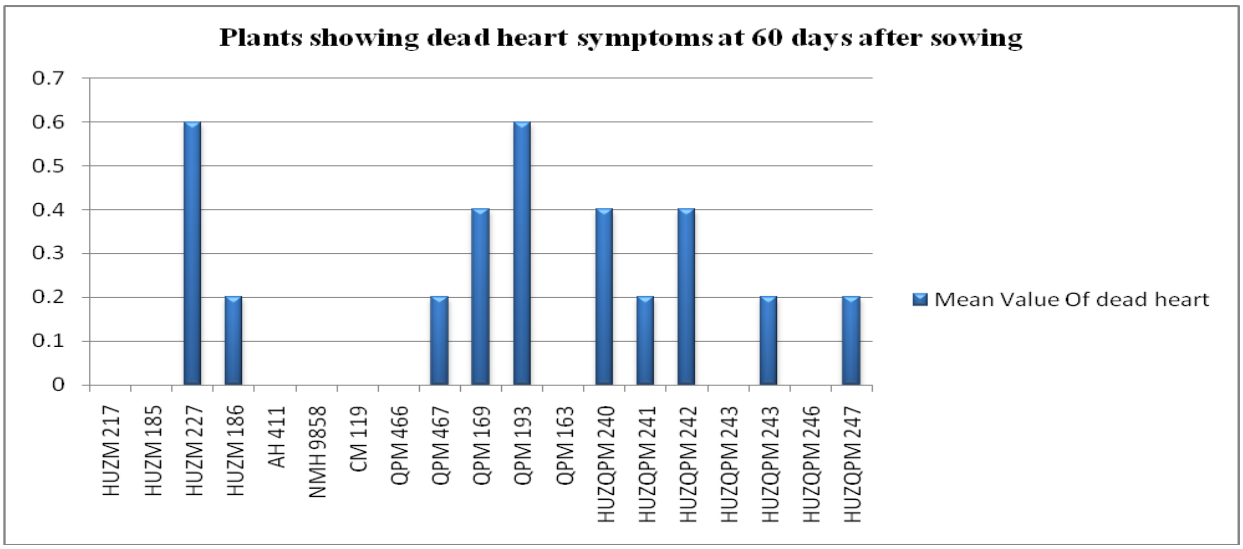

Graph No. 2 showing dead heart symptoms in different genotypes at 60 days after sowing
X-axis – Genotypes Y-axis – Mean value of dead heart

Table No. 4 showing relative plant resistance of 19 selected genotypes against *Chilo partellus* attack

GENOTYPE	LEAF INJURY RATINGS(MEAN VALUE)			Dead Hearts at 60 DAS (Mean Value)	Plant height at 120 DAS (Mean value)	Stem Tunneling Length at 120 DAS (Mean Value)	Relative rating
	AT 20 DAS	AT 40 DAS	AT 60 DAS				
HUZM 217	1.2	2.0	2.8	0	146.52	0	LS
HUZM 185	1.2	2.6	3.4	0	148.28	4.56	LS
HUZM 227	2.2	4	4.8	0.6	122.58	10.31	S
HUZM 186	1.8	3.0	5.6	0.2	134.42	5.78	MS
AH 411	1.0	1.6	3.8	0	141.64	0	LS
NMH 9858	2.0	3.2	5.6	0	132.98	7.36	MS
HUM 152	1.4	2.8	3.6	0	144.46	5.8	MS
CM 119	1.6	3.6	4.2	0	163.54	0	LS
QPM 466	2.2	5.6	4.4	0.2	139.12	2.38	LS
QPM 467	1.6	5.6	5.4	0.4	121.52	5.2	MS
QPM 169	1.6	4.2	6.6	0.6	129.06	11.32	S
QPM 193	1.2	2.4	4.2	0	126.28	4.26	MS
QPM 163	1.6	3.6	6.0	0.4	141.66	8.16	MS
HUZQPM 240	1.4	3.6	6.0	0.2	142.84	6.56	MS
HUZQPM 241	1.6	3.6	6.0	0.4	154.28	5.24	MS
HUZQPM 242	1.2	1.4	2.6	0	147.32	0	LS
HUZQPM 243	2.2	3.8	5.2	0.2	136.12	3.98	LS
HUZQPM 246	1.6	2.2	3.6	0	152.04	0	LS
HUZQPM 247	1.2	2.6	4.6	0.2	136.56	4.86	MS

LS=Least susceptible, MS= moderately susceptible, S=susceptible

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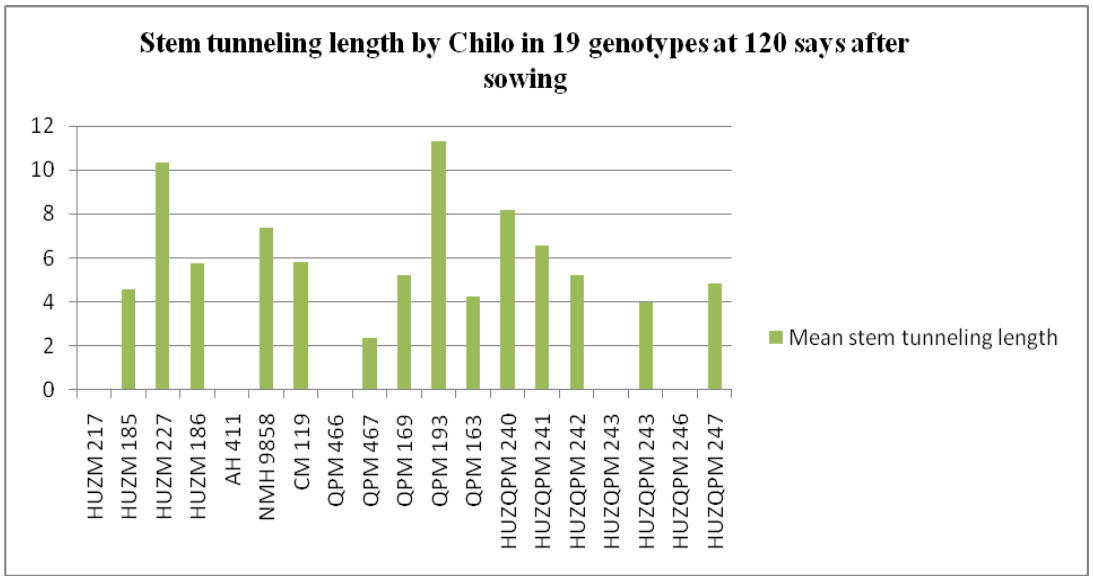

Graph No. 3 Showing stem tunneling length by *Chilo partellus* in 19 genotypes at 120 days after sowing
X-Axis = genotypes Y- Axis = Mean value of tunneling length

ACKNOWLEDGMENT

This study would not have been possible without the help of my supervisor as well as mentor who has been advised me at every step of my research as well as in completing my Master of Science in Entomology programme. It is my immense pleasure and great honor that being a student of him. I am very much thankful to my beloved parents as well as friends who have been given a moral support in writing this paper.

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