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Studies on varietal screening of maize hybrids against pink stem borer, *Sesamia inferens* (Walker)

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Abstract
The study was conducted on 22 hybrids of maize *i.e*., NMH-589, NK-30, Rasi-4212, Super-36, IAHM-2013-12, HISHELL, Yashoda gold, Big boss, Don-1588, MM-2255, IAHM-2013-97, KMH-5-2020, 262(DKC-9154), Aditya-303, Laxmi-207, NMH-731, Raja ji, IAHM-2013-33, Rasi 359, IAHM-2013-11, IAHM-2013-09 and IAHM-2013-26 against maize pink stem borer *Sesamia inferens* (Walker) during *Kharif* 2014-2015. The results revealed significant differences among hybrids regarding Number of pin hole, leaf injury rating, dead hearts per cent and grain yield recording HISHELL lowest no of 13.07 pin holes, 2.70 leaf injury rating, 26.67 per cent dead hearts,0.40 exit holes plant-^{1}and maximum of 45.33 q ha-^{1} grain yield proved to be the most tolerant variety. IAHM-2013-09 and IAHM-2013-26 with maximum number of pin holes 33.00 and 31.87, leaf injury rating plants-^{1} 5.13 and 5.33, per cent dead hearts 66.67, exit holes 1.40 and 1.60 and minimum of 24.17 q ha-^{1}and 23.83 q ha-^{1}grain yields was rated as least tolerant.

Keywords: Varietal, screening, maize hybrid, pink stem borer, dead hearts

1. 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 [1]. In India, maize is emerging as third most important crop after rice and wheat. Its importance lies in the fact that it is not only used as human food and animal feed but at the same time it is also widely used in corn starch industry, corn oil production, and as baby corn in different recipes [2]. The leafy stalk produces ears which contain the grain, which are seeds called kernels. Maize kernels are often used in cooking as a starch. The six major type of maize are dent, flint, pod, popcorn, flour, and sweet corn [3].
Insects attack maize throughout the cropping cycle and during storage, resulting in as little as 10% to complete loss [4].
In India, maize production is greatly affected by the infestation of two insect pests, spotted stem borer *Chilo partellus* (Swinhoe) and pink borer *Sesamia inferens* (Walker). Spotted stem borer is restricted to the northern part of the country during rainy season, pink borer causes extensive damage to the crop in the peninsular India throughout the year and across the country [5], pink stem borer, *Sesamia inferens* (Walker) is one of the major borer pests recorded mainly during *rabi* season [6]. Larvae are found feeding on immature cobs, silks and tassel and severe infestation result in stunted plant growth and appearance of cob and tassel at one place [7].
Insects attack on the maize crop throughout the cropping season and pink stem borer, *Sesamia inferens* major insect pest of maize in Peninsular India during *Kharif* and *Rabi*. The loss is primarily due to *S. inferens* in *Kharif* varies from 60 to 81.7% and in *Rabi* (winter) it varies from 25.7 to 78.9% [8].
Keeping in view the importance of the maize crop and the damages caused *Sesamia inferens* to it, the present experiments aimed to studies on varietal screening of maize hybrids against pink stem borer.

2. Material and Methods

The present studies on the screening of Maize genotypes against Maize pink stem borer *Sesamia inferens* in *kharif* season were conducted on the agricultural farm of the institute of College of agriculture, IGKV, Raipur (C.G.) during *kharif* season of 2014-2015 to screen the relative resistance /susceptibility of 22 genotypes of maize to the insect pest, maize pink stem borer (*Sesamia inferens*).

The experiment was conducted in randomized block design (RBD) and replicated in thrice. The maize varieties which are commonly cultivated in this area were grown in plots having 22rows, plot size 3x2 m. The plant spacing between rows and plants were maintained 60 cm and 20 cm, respectively. The crop was grown as per the normal agronomic practices during the *kharif* season of 2014-2015. Weekly observations of pink stem borer will be recorded on five randomly selected plants, starting from 15 DAG to harvesting of the crop. Number of pin holes, leaf injury rating and dead hearts produced by *Sesamia inferens* (Walker) was recorded at weekly interval. The effect of natural infestation was studied. The crop was sown on July 2014 and harvested on November 2014.

2.1 Selection of genotypes

In order to screen the relative susceptibility of different maize genotypes to maize pink stem borer the following genotypes were screened under field conditions. The symbols T1 to T22 have been used to represent the following cultivars of maize (Table 1). The data related to leaf injury rating were grouped under following categories as given in Table 2.

Table 1: List of tested maize genotypes

S.NO	Genotype	S.NO	Genotype
G1	261(DKC-9154)	G12	Rasi-3591
G2	IAHM-2013-33	G13	IAHM-2013-97
G3	IAHM-2013-26	G14	MM-2255
G4	Aditya-303	G15	Big boss
G5	Yashoda Gold	G16	IAHM-2013-09
G6	KMH-5-2020	G17	IAHM-2013-11
G7	Rajati	G18	NMH-731
G8	Don-1588	G19	Laxmi-207
G9	NMH-589(Sovarna)	G20	Super-36(SNH-36)
G10	HISHELL	G21	IAHM-2013-12
G11	NK-30	G22	Rasi 4212

Table 2: Leaf injury rating scale (1 to 9) by Lella *et al.,* [9]

Category	Description
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.

The percentage of dead heart damage and grain yield kg ha^{-1} was recorded with the help of following formula.

$$\text{Per cent of Dead heart} = \frac{\text{No. of dead heart plants}}{\text{Total no. of plants}} \times 100$$

$$\text{Grain yield (kg/ha)} = \frac{\text{Weight of grains in kg/plot}}{\text{Plot area in } m^2} \times 1000$$

3. Results and Discussion

3.1 Number of pinholes

Based on observations recorded for *Sesamia inferens* infestation, the mean number of pinholes per five plants showed significant differences among the tested genotypes which varied from 13.07 to 33.00pinholes per five plants (Table 3). Minimum mean number of pinholes (13.07 $plants^{-1}$) was observed in genotypes HISHELL followed by per five plants which was found at par with NMH-589, NK-30, Rasi-4212, Super-36, IAHM-2013-12, Yashoda gold, Big boss, Don-1588,MM-2255, IAHM-2013-97 and KMH-5-2020 with 14.13, 14.33, 15.33, 15.47, 16.67, 16.87, 16.87, 17.00, 17.40, 17.47 and 17.60 followed by 262(DKC-9154), Aditya-303, Laxmi-207, NMH-731, Raja ji, IAHM-2013-33, Rasi 3591 and IAHM-2013-11 with 17.56, 17.80, 17.80, 18.07, 18.67, 18.67, 20.47 and 23.93 pinholes per five plants, respectively. The highest mean numbers of pinholes were observed in genotypes IAHM-2013-09 and IAHM-2013-26 with 33.00 and 31.87 pinholes per five plants. During this period the maximum numbers of pin holes were recorded at vegetative stage to tasseling stage of the crop (Table 3).

The mean numbers of pinholes were significantly lower in CP- 828 and higher in Bioseed (34.67) and Rajkumar (31.33). These results are in accordance with the findings of Kanta and Sekhon [10] who reported varied levels of resistance in maize hybrids, owing to the genetic variation. Reddy and Sekhar [11] and Biradar *et al*., [12] also reported varying levels of resistance in maize hybrids to stem borer.

Table 3: Showing relative plant resistance of 22 selected genotypes against *Sesamia inferens* attack.

S. No.	Genotype	Mean no. of pinholes plant^{-1}	leaf injury rating plant^{-1}	Dead* heart (%)	Total Mean Plant height at 110 DAS (in cm) Mean value	Mean stem tunneling length at 110 DAS (in cm) Mean Value	Stem exit holes (in cm) mean value	Grain yield (q ha^{-1})
1	261 (DKC-9154)	17.56 (4.41)	4.00 (2.23)	40.00 (39.2)	134.10	2.835 (1.92)	0.80 (1.34)	38.83
2	IAHM-2013-33	18.67 (4.43)	4.73 (2.39)	53.33 (46.9)	118.00	3.216 (2.04)	1.13 (1.45)	30.83
3	IAHM-2013-26	31.87 (5.73)	5.33 (2.51)	66.67 (54.9)	121.00	10.013 (3.31)	1.60 (1.61)	23.83
4	Aditya-303	17.80 (4.33)	3.93 (2.22)	40.00 (39.2)	131.00	2.432 (1.84)	0.80 (1.34)	37.50
5	Yashoda Gold	16.87 (4.21)	3.93 (2.22)	40.00 (39.2)	144.20	2.815 (1.95)	0.73 (1.31)	37.00
6	KMH-5-2020	17.60 (4.26)	4.53 (2.34)	53.33 (46.9)	156.80	4.553 (2.34)	1.07 (1.43)	30.50
7	Raja ji	18.67 (4.42)	4.67 (2.38)	46.67 (42.6)	140.00	3.780 (2.18)	1.40 (1.54)	35.33
8	Don-1588	17.00 (4.19)	4.73 (2.38)	53.33 (47.2)	141.00	5.707 (2.58)	1.07 (1.43)	31.67
9	NMH-589 (Sovarna)	14.13 (3.88)	2.73 (1.93)	33.33 (30.7)	146.00	2.133 (1.73)	0.53 (1.23)	40.00
10	HISHELL	13.07 (3.74)	2.70 (1.92)	26.67 (34.9)	148.80	1.699 (1.64)	0.40 (1.17)	45.33
11	NK-30	14.33 (3.91)	2.80 (1.94)	33.33 (34.9)	152.00	1.872 (1.69)	0.53 (1.23)	40.33
12	Rasi-3591	20.47 (4.62)	4.87 (2.42)	40.00 (38.8)	153.40	2.538 (1.88)	0.80 (1.33)	34.00
13	IAHM-2013-97	17.47 (4.29)	4.80 (2.40)	60.00 (51.1)	145.40	5.026 (2.45)	1.00 (1.40)	28.00
14	MM-2255	17.40 (4.28)	3.87 (2.20)	60.00 (51.1)	160.60	5.287 (2.49)	1.27 (1.49)	29.00
15	Big boss	16.87 (4.22)	3.87 (2.20)	40.00 (39.2)	157.00	2.507 (1.87)	0.87 (1.36)	36.67
16	IAHM-2013-09	33.00 (5.82)	5.13 (2.47)	66.67 (54.9)	146.40	10.533 (3.38)	1.40 (1.54)	24.17
17	IAHM-2013-11	23.93 (4.99)	4.73 (2.39)	60.00 (50.7)	143.40	4.957 (2.44)	1.27 (1.49)	27.50
18	NMH-731	18.07 (4.36)	4.53 (2.35)	53.33 (46.9)	149.80	3.440 (2.10)	1.13 (1.44)	32.67
19	Laxmi-207	17.80 (4.33)	3.73 (2.17)	40.00 (39.2)	142.80	2.587 (1.89)	1.00 (1.41)	34.33
20	Super-36 (SNH-36)	15.47 (4.05)	4.13 (2.26)	40.00 (39.2)	138.20	2.603 (1.89)	0.87 (1.36)	36.67
21	IAHM-2013-12	16.67 (4.20)	4.20 (2.27)	53.33 (46.9)	148.00	4.095 (2.25)	1.20 (1.47)	30.17
22	Rasi 4212	15.33 (4.03)	3.87 (2.19)	46.67 (43.0)	139.00	2.633 (1.89)	0.93 (1.39)	35.00
	SEm ±	0.204	0.066	4.75		0.115	0.077	
	CD at 5%	0.573	0.190	13.6		0.330	0.220	

*Figures in parentheses are angular transformed values
Figures in parentheses are square root transformed values

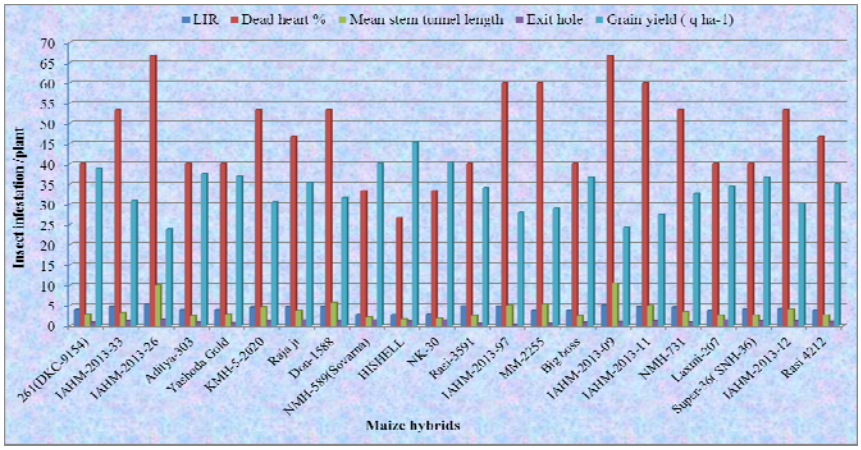

Fig 1: Evaluation of maize hybrids for their reaction against *Sesamia inferens*.

3.2 Leaf injury rating

Leaf injury symptom which was evaluated on the basis of leaf injury rating scale. All the 22 genotypes were examined on the basis of leaf injury rating (LIR). Under natural conditions of infestation the range of leaf injury rating was 2.70 to 5.33 per five plants (Table 3) and (Fig 1). Minimum mean number of leaf injury rating was observed in genotypes HISHELL (2.70) per five plants. Which was found at par with NMH-589 (2.73) and NK-30 (2.80) per five plants and followed by Laxmi-207, Rasi-4212, MM-2255, Big boss, Aditya303, Yashoda gold, 261(DKC-9154), Super-36, IAHM-2013-12, KMH-5-2020, NMH-731, Raja ji, Don-1588, IAHM-2013-11, IAHM-2013-33, IAHM-2013-97 and Rasi-3591 with 3.73, 3.87, 3.87, 3.87, 3.93, 3.93, 4.00, 4.13, 4.20, 4.53, 4.67, 4.73, 4.73, 4.73, 4.80 and 4.87 respectively. The highest mean number of leaf injury rating was observed in genotypes IAHM-2013-09 and IAHM-2013-26 with 5.13 and 5.33 leaf injury rating per five plants. During this period the average maximum numberof leaf injury rating was recorded at vegetative stage to tasseling stage of crop.

Present findings are in confirm with the results of Pavani *et al*., [13] who reported that the lowest mean LIR (2.80)among the twenty maize genotypes. Also reported by Satyanarayana *et al*., [14] and Sekhar *et al*., [15] categorized CML 421, CAO 3141, CAO 3120 and CAO 0106 inbred lines and Single crosses - CML 429 x CML 474 and CML 421 x CML 470 as highly resistant and CML 427 x Pop 147-F2-105-2-1-B-1-Bx4 and CML 426 x CML 470 crosses as highly susceptible to *S. inferens* based on 1-9 scale of LIR.

3.3 Per cent dead hearts

Heavily infested plants were turned into dead heart per cent during the *Kharif* season 2014-15. Dead heart per cent formation due to *Sesamia inferens* ranges from 26.67 to 66.67 percentage per five plants. The observations of randomly selected five plants were reported at 60 days crop stage and mean was calculated. Minimum dead heart per cent was observed in genotypes HISHELL (26.67) per five plants. Which was found at par with NMH-589, NK-30, 261(DKC-9154), Aditya-303,Yashodha gold, Raja ji, Rasi-3591, Big boss, Laxmi-207 and Super 36 followed by MM-2255, IAHM-2013-11,NMH-731, IAHM-2013-12, Rasi 4212, IAHM-2013-33, KMH-5-2020, Don-1588 and IAHM-2013-97. The maximum dead heart per cent was observed in IAHM-2013-26 and IAHM-2013-09 (66.67%). During this period the average dead heart per cent was recorded from vegetative stage to tasseling stage of crop (Table 3) and (Fig 1).

Present findings are in confirmation with findings of Nagarjuna [16] who reported that the occurrence of dead hearts per cent in different hybrids varied significantly the lowest being in CP-828 and highest in Bioseed-9544. These results differ slightly from the findings of Khan and Amjad [17] and Biradar *et al*., [12] who also recorded varying levels of resistance in maize hybrids against stem borer. Also worked Pavani *et al*. [13] there were significant differences in per cent dead hearts among the genotypes. Maximum per cent dead hearts was found to be 100.0, 94.5 and 93.8 percent in the genotypes CM 132, DMRQPM 58 and CM 137 respectively. No dead hearts were formed in the resistant check, CM 500 while susceptible check Basilocal recorded 93.8 per cent dead hearts.

3.4 Stem tunnel length

In maize, stem tunnel length was formed due to the damage of *Sesamia inferens* by feeding inside the stem. On the basis of stem tunnel length entire 22 genotypes were classified into three categories namely *viz.,* least susceptible, moderate susceptible and highly susceptible. The mean stem tunnel length was 0-5cm in case of least susceptible genotypes, 5-10 cm incase of moderately susceptible genotypes whereas, more than 10 cm was found in highly susceptible genotype. Least susceptible genotypes were HISHELL, NK-30, NMH-589, 261(DKC-9154), Aditya-303, NMH-589, Yashoda gold, KMH-5-2020, Raja ji, Big boss, Rasi-3591, NMH-731, Laxmi-207, Super-36, Rasi-4212, IAHM-2013-12 and IAHM-2013-33. Moderately Susceptible genotypes were Don-1588, IAHM-2013-97, MM-2255 and the highly susceptible genotypes were IAHM-2013-26 andIAHM-2013-09 (Table 4) and (Fig 1).

Table 4: Showing stem tunnel length relative plant resistance of 22 selected genotypes against *Sesamia inferens* attack

S. No.	Range of mean stem tunnel length(cm)	Attribute
1	0-5 (Least susceptible)	HISHELL, NK-30, NMH-589, 261(DKC-9154), Aditya-303, NMH-589, Yashoda gold, KMH-5-2020, Raja ji, Big boss, Rasi-3591, NMH-731, Laxmi-207, Super-36, Rasi-4212, IAHM-2013-33, IAHM-2013-12.
2	5-10(Moderately Susceptible)	Don-1588, IAHM-2013-97, MM-2255.
3	>10 (Highly Susceptible)	IAHM-2013-26, IAHM-2013-09.

3.5 Stem exit holes

In maize, stem exit holes were formed by *Sesamia inferens*. On the basis of observations recorded for stem exit holes. The minimum no. of stem exit holes was found in the genotypes HISHELL (0.40) per five plants. However, it was found to be at par with NMH 589 (0.53), NK-30 (0.53), Yashoda gold (0.73), Rasi-3591(0.80), Aditya (0.80), 261 DKC-9154 (0.80), Big boss (0.87), Super-36 (0.87) and Rasi 4212 (0.93) average stem exit holes per five plants followed by IAHM-2013-97 (1.00), Laxmi-207 (1.00), KMH-5-2020 (1.07), Don-1588 (1.07), NMH-731 (1.13), IAHM-2013-23 (1.13), IAHM-2013-12 (1.20), IAHM-2013-9 (1.27), MM-2255 (1.27), Raja ji (1.40) and IAHM-2013-09 (1.40). The maximum stem exit holes were recorded inIAHM-2013-26 (1.60) per five plants. During this period the average maximum numbers of stem exit holes were recorded after harvesting the crop (Table 3) and (Fig 1).

3.6 Grain yield

All hybrids differed significantly with respect to Grain yield potential. The Grain yield (q ha^{-1}) was significantly higher in HISHELL (45.33q ha^{-1}) which was at followed by NK-30 (40.33q ha^{-1}), NMH-589 (40.00q ha^{-1}), 261 (DKC-9154) (38.83q ha^{-1}), Aditya-303 (37.50 q ha^{-1}), Yashoda gold (37.00 q ha^{-1}), Super-36(36.67q ha^{-1}), Big boss (35.67q ha^{-1}), Rajaji (35.33q ha^{-1}), Rasi-4212 (35.00q ha^{-1}), Laxmi-207 (34.33q ha^{-1}), Rasi-3591(34.00q ha^{-1}), NMH-731 (32.67q ha^{-1}), Don-1588 (31.67 q ha^{-1}), IAHM-2013-33 (30.83q ha^{-1}), KMH-5-2020 (30.50 q ha^{-1}), IAHM-2013-12 (30.17q ha^{-1}), MM-2255 (29q ha^{-1}), IAHM-2013-97(28q ha^{-1}) and IAHM-2013-11 (27.50q ha^{-1}). However, significantly lower grain yield (q ha^{-1}) was noticed in IAHM-2013-09 (24.17 q ha^{-1}) and IAHM-2013-26 (23.83q ha^{-1}) (Table 3) and (Fig 1).

Present findings are in confirmation with finding of Nagarjuna [16] who reported that the grain yield was

significantly higher in CP-828 (44.69 q ha^{-1}) which was at par with NAH 2049 (43.66 q ha^{-1}) and significantly lower in Rajkumar (23.50 q ha^{-1}).

4. Conclusion

On the base of current studies, it is concluded that the least susceptible genotypes was HISHELL which gave minimum number of pinholes, minimum leaf injury rating, minimum dead hearts damage, minimum stem tunnel, minimum stem exit holes and maximum grain yield. The other genotypes in their increasing order of pink stem borer susceptibility over NMH-589, NK-30, 261(DKC- 9154), Aditya-303, Yashodha gold, Raja ji, Rasi-3591, Bigboss, Laxmi-207, Super 36, Raja ji, Rasi 4212, IAHM-2013-33, KMH-5-2020, Don-1588, NMH-731, IAHM- 2013-12, IAHM-2013-97, MM-2255, IAHM-2013-26 and IAHM-2013-09.

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