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Screening of maize genotypes against fall army worm, *Spodoptera frugiperda* (Smith) with reference to plant morphological characters at Raipur (Chhattisgarh)

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Abstract

The field experiment were conducted at Research Cum Instructional Farm at IGKV, Raipur (C.G.) during kharif 2018, to know the screening of maize genotypes against fall army worm, *Spodoptera frugiperda* (Smith) at Raipur (Chhattisgarh). Out of twenty five maize genotypes it was seen that, based on the basis of leaf damage rating, ear damage rating and kernel damage rating, DKC-9190 (2.36) genotype recorded minimum leaf damage. However, the genotype NK-30 (8.21) was on the crop with maximum leaf damage. The leaf damage rating showed non-significant correlation with total number of leaves/plant ($r = 0.368$). While, Significant correlation was recorded with the leaf area (cm^2) of the leaves ($r = 0.442$). Whereas, highly significant but negatively correlation with leaf trichomes ($r = -0.609$) at 45 DAS. While, Heera-1122 (1.91) genotype recorded minimum ear damage. Whereas, NMH-707 (5.91) genotype recorded with maximum ear damage on the crop. Ear damage rating showed significant correlation with length of central spike ($r = -0.446$). Among the twenty five cultivars NMH-707 (1.59) genotype recorded minimum kernel damage. While, LG-34.06 (4.31) genotype was recorded with maximum kernel damage on the crop. Whereas, kernel damage rating showed significant correlation with cob length (cm) ($r = 0.403$). While, significant but negative correlation with height of the cob (cm) ($r = -0.412$).

Keywords: *Spodoptera frugiperda*, fall army worm, Maize genotypes, plant morphological characters, correlation, screening

Introduction

Maize or corn (*Zea mays* L.) is a crop of global importance, which holds a unique position in world agriculture. Maize belongs to the family of Poaceae, originated from South America, from where it was taken to all parts of the world. 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. 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. Insects attack maize throughout the cropping cycle and during storage, resulting in as little as 10 percent to complete loss.

Even though 139 insect pests cause different degree of damage to maize crop, only about a dozen of these are entirely serious and require control measures like the moth group (which includes cutworms, armyworms, earworms, borers and grain moths) is the most damaging to corn worldwide. The fall army worm is a lepidopteran pest that feeds in large numbers on leaves and stems of more than 80 plant species, causing major damage to economically cultivated grasses such as maize, rice, sorghum, sugarcane but also other vegetable crops and cotton. The literature on this pest is extensive (Ashley *et al*, 1989) [1]. On maize, if 5% of seedlings are cut or 20% of whorls of small plants (during the 1st 30 days) are infested, it is recommended that an insecticide be applied (King and Saunders, 1984); on sorghum the pest threshold level is regarded as one (or two) larvae per leaf whorl and two per head (Pitre, 1985) [2]. Studies on screening of insect pests of maize germplasm to find out the source of resistance and susceptibility. This provides an opportunity for the development for the resistancy of germplasm for the control of these pests.

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2. Materials and Methods

Study was carried out to screen twenty five genotypes Heera-1122, DKC-9182, I-CORN-369, Penna gold-1188, NMH-731, NK-30, Pro-4212, HISHELL, KMH-Profit, NK-6240, NMH-707, INDAM-1122, HY-P 3505, LG-35.02, LG-34.06, KMH-2589, VMH-150, NMH-8352, JKMH-1701, DKC-9198, AHC-2040, S-6217, DKC-9190, MOTI-155 and ADV-9293 in the experimental area of Research Cum Instructional Farm at IGKV, Raipur (C.G.) during kharif 2018. The hybrids were sown in Randomized Block Design (RBD) in plot size of 3m x 1.5m with three replications. Observation on fall armyworm was recorded at weekly intervals on five randomly selected plants started from sowing to harvesting of the crop. The fall army worm infestation on different maize genotypes was recorded at phonological stage of plants on different basis Leaf, ear and kernel damage under natural infestation. A numerical scale (1-9), also known as the Davis scale, will be used to evaluate leaf damage, maize ear and kernal damage. (As per Davis and williams, 1992) [3].

Table 1: Indicating maize leaf rating scale

| Explanation/definition of damage | Rating |
|--|--------|
| No visible leaf damage; | 0 |
| Only pin-hole damage; | 1 |
| Pin-hole and small circular hole damage to leaves. | 2 |
| Pinholes, small circular lesions and a few small elongated (rectangular shaped) lesions of up to 1.3 cm in length present on whorl and furl leaves. | 3 |
| Several small to mid-sized 1.3 to 2.5 cm in length elongated lesions present on a few whorl and furl leaves | 4 |
| Several large elongated lesions greater than 2.5 cm in length present on a few whorl and furl leaves and/or a few small to mid-sized, uni-form to irregular shaped holes (basement membrane consumed) eaten from the whorl and/or furl leaves. | 5 |
| Several large elongated lesions present on several whorl and furl leaves and/or several large uniforms to irregular shaped holes eaten from furl and whorl leaves. | 6 |
| Many elongated lesions of all sizes present on several whorl and furl leaves and/or several large uniform to irregular shaped holes eaten from the whorl and furl leaves. | 7 |
| Many elongated lesions of all sizes present on most whorl and furl leaves plus many mid to large sized uniform to irregular shaped holes eaten from the whorl and furl leaves. | 8 |
| Whorl and furl leaves almost totally destroyed. | 9 |

Table 2: Indicating leaf damage rating scale/classification

| Explanation/definition of damage | Rating scale |
|--|--------------|
| Minimal visible leaf damage; (Least susceptible) | 1-4 |
| Marginal leaf damage; (Moderately susceptible) | >4-7 |
| Extensive leaf damage; (Highly susceptible) | >7-9 |

Table 3: Indicating maize ear and kernel rating scale

| Explanation/definition | Rating |
|---|--------|
| No damage to any ears; | 1 |
| Tip (<3cm) damage to 1-3 ears | 2 |
| Tip damage to 4-7 ears | 3 |
| Tip damage to 7 and more ears and damage to 1-3 kernels below ear tips on 1 to 3 ears | 4 |
| Tip damage to 7 and more ears and damage to 1-3 kernels below tips of 4 to 6 ears | 5 |
| Ear tip damage 7-10 ears and damage to 1-4 kernels below tips of 7 to 10 ears | 6 |
| Ear tip damage to 7-10 ears and damage to 4-6 kernels destroyed on 7-8 ears. | 7 |
| Ear tip damage to all ears and 4-6 kernels destroyed on 7-8 ears | 8 |
| Ear tip damage to all ears and 5 or more kernels destroyed below tips of 9-10 ears | 9 |

Table 4: Indicating corn ear and kernel rating scale/ classification

| Explanation/definition | Rating scale |
|--|--------------|
| Minimal damage to any ears (Least susceptible) | 1-4 |
| Kernels and ears damaged (Moderately susceptible) | >4-7 |
| Ear and kernels extensively destroyed (Highly susceptible) | >7-9 |

The morphological plant characters were recorded during sowing to harvest of the crop from 5 randomly selected plants on each genotype. Above ground plant height was recorded with the help of a measuring tape. The stem diameter was taken with the help of Vanier caliper by measuring from the centre of the 3rd inter node. Leaf length and leaf width were taken from the leaf with the help of a measuring tape. Leaf trichomes were counted under a binocular microscope from an area of 1 cm of a leaf selected randomly. Length of central spike recorded with the help of measuring tape from five randomly selected maize plants then average to get mean length for each hybrid genotypes. Cob height above the soil level and cob length from five randomly selected plants was measured with the help of measuring tape up to the node position of cob and then average was calculated.

The data analyzed statistically.

Results and discussion

The data regarding fall army worm damage recorded during 2018 is given in the table 5. The mean leaf damage of *Spodoptera frugiperda* among twenty five maize genotypes DKC-9190 (2.36) genotype found minimum leaf damage. While, NK-30 (8.21) genotype was recorded with maximum leaf damage on the crop. The descending order of mean leaf damage was NK-30 (8.29) >VMH-150 (7.28) >NMH-707 (7.24) > INDAM 1122 (7.05) > KMH-Profit (6.09) >HY-P-3505 (5.91) >Penna gold-1188 (5.83) > LG-34.06 (5.20) >NMH-8352 (5.19) >Pro-4212 (5.13) >KMH-2589 (4.36%) >NK-6240 (4.36) >LG-35.02 (4.34) >ADV-9293 (4.31) >DKC-9198 (4.14) >I-CORN-369 (4.02) >MOTI-155 (3.72) >AHC-2040 (3.57) >HISHELL (3.42) >KMH-2589 (3.35) >JKMH-1701 (3.28) >DKC-9182 (3.16) >Heera-1122 (2.70) > S-6217 (2.61) >DKC-9190 (2.36).

After examining ear-colonizing pest resistance, 20 maize lines from the USDA- ARS Germplasm Enhancement of Maize (GEM) Program were evaluated for whorl-feeding fall armyworm (FAW) (*Spodoptera frugiperda*) resistance using 4 maize inbred lines as theresistant and susceptible controls.

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More or less the present findings are in agreement with the Xinzhi *et al.* (2016) [4] who examined ear-colonizing pest resistance, 20 maize lines from the USDA- ARS Germplasm Enhancement of maize (GEM) Program were evaluated for whorl-feeding fall armyworm (FAW) *Spodoptera frugiperda* resistance using 4 maize inbred lines as the resistant and susceptible controls. Crubelati- mulati *et al.* (2014) [5]. The

goal of the study was to evaluate the damage caused by *S. frugiperda* on single-cross popcorn hybrids under field conditions with natural infestation as well as to study the effect of 11 popcorn hybrids on the *S. frugiperda* life cycle under laboratory conditions. A completely randomized block design with 4 replicates was used for the field experiment, and a completely randomized design with 10 replicates was used for the laboratory experiment.

Table 5: Damage caused by fall army worm, *Spodoptera frugiperda* observed on different maize genotypes during Kharif, 2018.

| S. No. | Genotype | Leaf damage rating (1-9 scale) | Ear damage rating (1-9 scale) | Kernel damage rating (1-9 scale) |
|--------|-----------------|--------------------------------|-------------------------------|----------------------------------|
| 1 | Heera-1122 | 2.70 | 1.91 | 1.63 |
| 2 | DKC-9182 | 3.16 | 2.92 | 2.36 |
| 3 | I-CORN369 | 4.02 | 2.69 | 2.13 |
| 4 | Penna gold-1188 | 5.83 | 3.76 | 3.17 |
| 5 | NMH-731 | 3.79 | 1.96 | 2.59 |
| 6 | NK-30 | 8.21 | 5.61 | 2.17 |
| 7 | Pro-4212 | 5.13 | 2.59 | 2.33 |
| 8 | HISHELL | 3.42 | 3.87 | 2.81 |
| 9 | KMH-Profit | 6.09 | 2.94 | 2.48 |
| 10 | NK-6240 | 4.36 | 4.87 | 3.09 |
| 11 | NMH-707 | 7.24 | 5.91 | 1.59 |
| 12 | INDAM 1122 | 7.05 | 5.13 | 2.98 |
| 13 | HY-P 3505 | 5.91 | 3.58 | 1.60 |
| 14 | LG-35.02 | 4.34 | 4.76 | 3.31 |
| 15 | LG-34.06 | 5.20 | 4.54 | 4.31 |
| 16 | KMH-2589 | 3.35 | 3.21 | 3.07 |
| 17 | VMH-150 | 7.28 | 4.19 | 2.98 |
| 18 | NMH-8352 | 5.19 | 3.40 | 2.02 |
| 19 | JKMH-1701 | 3.28 | 2.77 | 2.43 |
| 20 | DKC-9198 | 4.14 | 3.83 | 1.88 |
| 21 | AHC-2040 | 3.57 | 2.94 | 1.87 |
| 22 | S- 6217 | 2.61 | 3.77 | 3.18 |
| 23 | DKC-9190 | 2.36 | 2.79 | 2.41 |
| 24 | MOTI-155 | 3.72 | 2.87 | 2.48 |
| 25 | ADV-9293 | 4.31 | 2.09 | 1.62 |
| S.E.m | | 0.059 | 0.216 | 0.091 |
| CD | | 0.167 | 0.615 | 0.26 |

Correlation coefficients of the data regarding fall army worm damage rating with some morphological characters are given in the table. During the year 2018 fall army worm leaf

damage were found non-significant correlated with number of leaves per plant.

Table 6: Classification of maize hybrids against fall army worm based on leaf damage rating (1-9 scale).

| Maize hybrid | Rating scale | Classification |
|--|--------------|------------------------|
| Heera-1122, DKC-9182, NMH-731, HISHELL, KMh-2589, JKMH-1701, AHC-2040, S-6217, DKC-9190, MOTI-155, | 1-4 | Least susceptible |
| KMH-Profit, Pro-4212, I-Corn-369, Penna gold-1188, NK-6240, HY-P 3505 LG-35.02, LG-34.06, NMH-8352, DKC-9198, ADV-9293 | >4-7 | Moderately susceptible |
| NK-30, NMH-707, INDAM-1122, VMH-150 | >7-9 | Highly susceptible |



Fig 1: Leaf damage caused by *Spodoptera frugiperda* observed on maize crop.

Relationship between leaf characters and leaf damage rating caused by *Spodoptera frugiperda*.

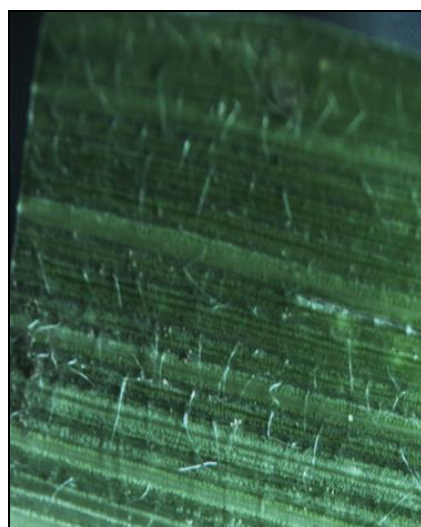
The effect of various leaf characters such as number of leaves per plant, leaf trichome (cm²), leaf area (leaflet length and leaflet width in cm) on leaf damage of maize by fall armyworm was recorded on twenty five genotypes and their correlations between them were worked out. (Table 7)

Table 7: Leaf damage rating and various morphological leaf characteristics in selected maize genotypes (45 days old).

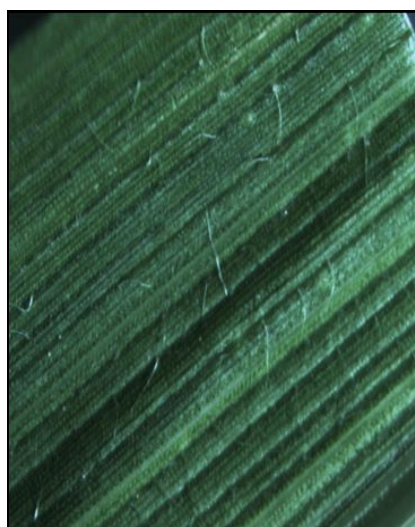
| Hybrids | Leaf morphological characteristics | | | |
|------------------------------------|------------------------------------|---------------------|------------------------------|-----------------------------------|
| | Leaf damage rating | No. of leaves/plant | Leaf area (cm ²) | Leaf trichomes /(cm) ² |
| Heera-1122 | 2.70 | 9.08 | 548.98 | 49.65 |
| DKC-9182 | 3.16 | 5.98 | 298.67 | 39.87 |
| I-CORN-369 | 4.02 | 8.63 | 376.23 | 42.98 |
| Penna gold-1188 | 5.83 | 8.45 | 432.87 | 44.36 |
| NMH-731 | 3.79 | 5.98 | 476.98 | 45.67 |
| NK-30 | 8.21 | 9.76 | 456.87 | 29.06 |
| Pro-4212 | 5.13 | 7.65 | 653.87 | 26.98 |
| HISHELL | 3.42 | 7.89 | 456.98 | 46.98 |
| KMH-Profit | 6.09 | 9.77 | 432.87 | 48.87 |
| NK-6240 | 4.36 | 7.89 | 498.98 | 32.87 |
| NMH-707 | 7.24 | 5.98 | 675.43 | 49.76 |
| INDAM1122 | 7.05 | 9.65 | 732.54 | 34.98 |
| HY-P 3505 | 5.91 | 8.67 | 565.98 | 52.34 |
| LG-35.02 | 4.34 | 9.76 | 422.87 | 29.09 |
| LG-34.06 | 5.20 | 9.23 | 549.09 | 27.98 |
| KMH-2589 | 3.35 | 5.34 | 348.09 | 54.98 |
| VMH-150 | 7.28 | 6.45 | 675.43 | 55.12 |
| NMH-8352 | 5.19 | 6.98 | 543.87 | 56.23 |
| JKMH- 1701 | 3.28 | 5.35 | 565.87 | 62.87 |
| DKC-9198 | 4.14 | 9.34 | 567.87 | 57.89 |
| AHC-2040 | 3.57 | 8.76 | 598.98 | 65.43 |
| S- 6217 | 2.61 | 6.45 | 459.98 | 34.98 |
| DKC-9190 | 2.36 | 5.45 | 632.76 | 65.34 |
| MOTI-155 | 3.72 | 7.65 | 345.87 | 68.34 |
| ADV-9293 | 4.31 | 5.98 | 345.76 | 73.68 |
| Correlation coefficient values (r) | | 0.368 | 0.442* | -0.609** |
| S.E.m | | 0.033 | 0.65 | 0.039 |
| CD | | 0.095 | 1.855 | 0.112 |

*Significant at 5% level, ** Significant at 1% level

Number of leaves per plant (45 DAS)



Leaf trichome observed on genotype ADV-9293



Leaf trichome observed on genotype LG-34.06

Fig 2: Leaf trichome observed on genotypes of maize crop.

The number of leaves per plant of twenty five maize genotypes differed significantly (Table.7). The maximum number of leaves was recorded in the genotype KMH-Profit (9.77), followed by NK-30 (9.76), LG-35.02 (9.76), INDAM-1122(9.65), LG-34.06 (9.23) and Heera-1122 (9.08) which were at par with each other. Whereas, the minimum number of leaves was recorded in genotype KMH-2589 (5.34) followed by JKMH-1701(5.35) and DKC-9190 (5.45) which were at par with each other.

Leaf area (cm²) 45 days after sowing

The leaf area of twenty five maize genotypes differed significantly. The highest leaf area (732.45 cm²) was observed in the genotype INDAM-1122. Whereas, the lowest leaf area was observed in Pro-DKC-9182 (298.67cm²) followed by ADV-9293 (345.76cm²), MOTI-155 (345.87cm²) which were at par with each other. (Table.7)

The fall armyworm, *Spodoptera frugiperda* was significant correlation between leaf area (cm²) and leaf damage rating. However, it was positive indicating that with increase in leaf area (cm²) there will be increase in infestation level. The 'r' value being 0.442 and regression equation being Y= 0.768+0.006x indicating that with increase in one unit of leaf area i.e. there was increasing the infestation by 0.006 percent.

Leaf trichome (cm²) 45 days after sowing

The Leaf trichome of twenty five maize genotypes differed significantly. The highest leaf trichomes (73.68 cm²) were observed in the genotype ADV-9293. Whereas, the lowest leaf trichomes were observed in LG-34.06 (27.98 cm²) followed by NK-30 (29.06cm²), LG-35.02(29.09cm²), INDAM-1122 (34.98cm²), S-6217 (34.98cm²), DKC-9182(39.87cm²), I-CORN-369(42.98 cm²) and Penna gold-1188 (44.36cm²) which were at par with each other. (Table 7). The fall armyworm, *Spodoptera frugiperda* incidence had highly significant correlation between trichome density (cm) at 45 DAS and leaf damage rating. But it was negative indicating that with increase in leaf trichome (cm) there will be decrease in infestation level. The 'r' value being -0.609 and regression equation being Y= 7.309-0.072x indicating that with increase in one unit of leaf trichome i.e. there was decreasing the infestation by 0.072 percent.

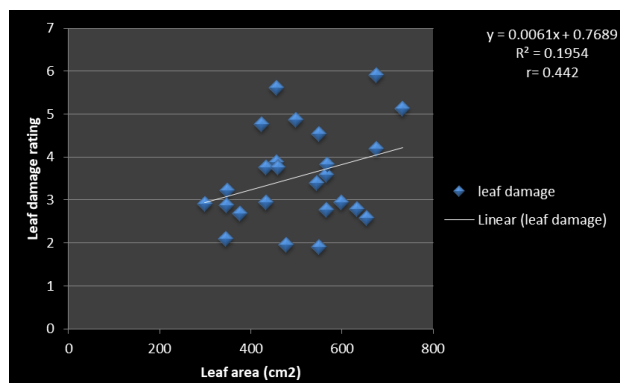


Fig 3: Regression line between leaf area (cm²) and leaf damage caused by fall armyworm, *Spodoptera frugiperda*

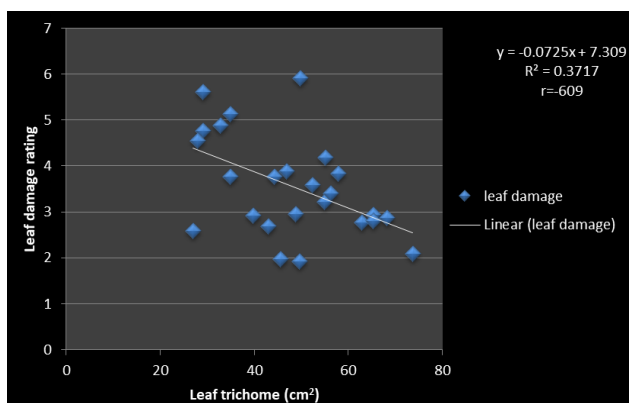


Fig 4: Regression line between leaf trichome (cm²) and leaf damage caused by fall armyworm, *Spodoptera frugiperda*

Ear damage caused by fall armyworm, *Spodoptera frugiperda*.

The mean ear damage of *Spodoptera frugiperda* in twenty five maize genotypes is shown in (table 5). Among the twenty five genotypes Heera-1122 (1.91) genotype recorded minimum ear damage. While, NMH-707 (5.91) genotype was recorded with maximum ear damage on the crop. The descending order of mean ear damage rating were NMH-707 (5.91) >NK-30 (5.61) >INDAM-1122 (5.13) >NK-6240 (4.87) >LG-35.02 (4.76) >LG-34.06 (4.54) >VMH-150 (4.19) >HISHELL (3.87) >DKC-9182 (3.83) >S-6217 (3.77) >Pennagold-1188 (3.76) >HY-P-3505 (3.58) >NMH-8352 (3.40) >KMH-2589 (3.21) >KMH-Profit (2.94) >DKC-9182 (2.92) >DKC-9190 (2.79) >JKMH-1701 (2.77) >I-CORN-369 (2.69) >Pro-4212 (2.59) >ADV-9293 (2.09) >NMH-731 (1.96) >Heera-1122 (1.91).

Table 8: Classification of maize hybrids against fall army worm based on ear damage rating (1-9 scale).

| Maize genotypes | Categories | Rating scale |
|--|------------------------|--------------|
| Penna gold-1188, Heera-1122,DKC-9182,I-CORN-369,NMH-731, Pro-4212, KMH-Profit, HY-P-3505, NMH-8352, JKMH-1701, DKC-9198, AHC-2040, S-6217, DKC-9190, ADV-9293, MOTI-155, KMH-2589, HISHELL | Least susceptible | 1-4 |
| NK-30, NK-6240, NMH-707, INDAM-1122, LG-35.02, LG-34.06, VMH-150 | Moderately susceptible | >4-7 |
| - | Highly susceptible | >7-9 |



Fig 5: Ear damage caused by *Spodoptera frugiperda* observed on maize crop

Relationship between plant characters and ear damage rating caused by *Spodoptera frugiperda*.

The effect of various plant characters such as length of central

spike (cm) on the ear damage of maize fall armyworm were recorded on twenty five genotype was studied and their correlations between them were worked out. (Table 9)

Table 9: Ear damage rating and various morphological plant characteristics in selected maize genotypes (60 days old).

| Hybrids | Plant morphological characteristics | |
|------------------------------------|-------------------------------------|------------------------------|
| | Ear damage rating | Length of central spike (cm) |
| Heera-1122 | 1.91 | 26.4 |
| DKC-9182 | 2.92 | 23.23 |
| I-CORN -369 | 2.69 | 24.34 |
| Penna gold-1188 | 3.76 | 19.78 |
| NMH-731 | 1.96 | 15.87 |
| NK-30 | 5.61 | 26.56 |
| Pro-4212 | 2.59 | 26.82 |
| HISHELL | 3.87 | 23.76 |
| KMH-Profit | 2.94 | 21.87 |
| NK-6240 | 4.87 | 23.56 |
| NMH-707 | 5.91 | 29.78 |
| INDAM 1122 | 5.13 | 28.76 |
| HY-P 3505 | 3.58 | 24.65 |
| LG-35.02 | 4.76 | 29.67 |
| LG-34.06 | 4.54 | 27.54 |
| KMH-2589 | 3.21 | 29.65 |
| VMH-150 | 4.19 | 28.76 |
| NMH-8352 | 3.40 | 20.34 |
| JKMH- 1701 | 2.77 | 21.45 |
| DKC-9198 | 3.83 | 26.87 |
| AHC-2040 | 2.94 | 16.98 |
| S- 6217 | 3.77 | 20.56 |
| DKC-9190 | 2.79 | 22.45 |
| MOTI-155 | 2.87 | 23.87 |
| ADV-9293 | 2.09 | 28.09 |
| Correlation coefficient values (r) | | 0.447* |
| S.E.m | | 0.051 |
| CD | | 0.147 |

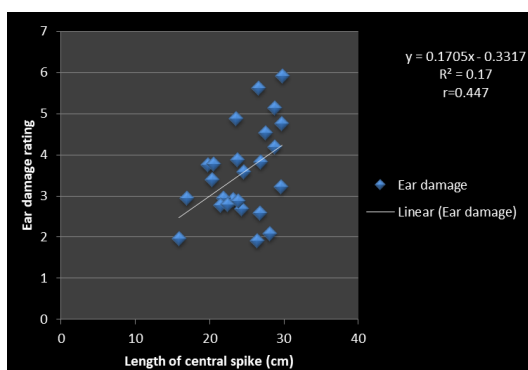
*Significant at 5% level,

** Significant at 1% level

Length of central spike (cm)

The length of central spike of maize showed significant difference in different genotypes. Significantly highest length central spike was observed in the genotype NMH-707(29.78 cm). Whereas, the lowest length central spike was observed in NMH-731(15.87 cm) followed by AHC-2040 (16.98 cm), Penna- gold-1188 (19.78), NMH-8352 (20.34 cm), S-6217 (20.56cm), and JKMH-1701 (21.45 cm) which were at par with each other.(Table.9)

The fall armyworm, *Spodoptera frugiperda* recorded significant correlation between central spike (cm) and ear damage rating. However, it was positive indicating that with increase in central spike (cm) there was increase in infestation level. The 'r' value being 0.447 and regression equation being $Y = 0.331 + 0.170x$ indicating that with increase in one unit of central spike i.e. there was increasing the infestation by 0.170 percent.

**Fig 6:** Regression line between length of central spike (cm) and ear damage rating caused by fall armyworm, *Spodoptera frugiperda*.**Kernel damage caused by fall armyworm, *Spodoptera frugiperda*.**

The mean kernel damage of *Spodoptera frugiperda* among twenty five maize genotypes is shown in (table 5). Among the twenty five genotypes NMH-707(1.59) genotype recorded minimum kernel damage rating. While, LG-34.06 (4.31) genotype recorded maximum kernel damage rating on the crop. The descending order of mean kernel damage rating were LG-34.06 (4.31) >LG-35.02 (3.31) >S-6217 (3.18) >Penna gold-1188 (3.17) >NK-6240 (3.09) >KMH-2589 (3.07) >VMH-150 (2.98) >INDAM 1122 (2.98) >HISHELL (2.81) >NMH-731 (2.59) >MOTI-155 (2.48) >KMH-Profit (2.48) >JKMH-1701 (2.43) >DKC-9190 (2.41) >DKC-9182 (2.36) >NK-30 (2.17) >I-CORN-369 (2.13) >NMH-8352 (2.02) >DKC-9182 (1.88) >AHC-2040 (1.87) >Heera-1122 (1.63) >ADV-9293 (1.62) >HY-P-3505 (1.60) >NMH-707 (1.59).

Table 10: Classification of maize hybrids against fall army worm based on kernel damage rating (1-9 scale).

| Maize genotypes | Categories | Rating scale |
|---|------------------------|--------------|
| Heera-1122,I-CORN-369,Penna gold-1188,NK-30, Pro-4212,HISHELL, KMH-Profit, NK-6240, NMH-707, INDAM-1122, HY-P-3505, LG-35.02, KMH-2589, VMH-150, NMH-8352, JKMH-1701, DKC-9198, AHC-2040, S-6217, DKC-9190, MOTI-155, ADV-9293, DKC-9182, NMH-731 | Least susceptible | 1-4 |
| LG-34.06 | Moderately susceptible | >4-7 |
| - | Highly susceptible | >7-9 |

Relationship between plant characters and kernel damage rating caused by *Spodoptera frugiperda*.

The effect of various plant characters such as cob length (cm) and cob height (cm) on the kernel damage of maize fall armyworm were recorded on twenty five genotype and their correlations between them were worked out. (Table.11)

Table 11: Kernel damage rating and various morphological plant characteristics in selected maize genotypes (90 days old).

| Hybrids | Plant morphological characteristics | | |
|------------------------------------|-------------------------------------|-----------------|-----------------|
| | Kernel damage rating | Cob length (cm) | Cob height (cm) |
| Heera-1122 | 1.63 | 24.98 | 97.67 |
| DKC-9182 | 2.36 | 22.65 | 95.54 |
| I-CORN -369 | 2.13 | 18.59 | 90.54 |
| Penna gold-1188 | 3.17 | 23.65 | 91.34 |
| NMH-731 | 2.59 | 17.67 | 88.99 |
| NK-30 | 2.17 | 24.09 | 94.09 |
| Pro-4212 | 2.33 | 21.98 | 92.87 |
| HISHELL | 2.81 | 19.67 | 90.76 |
| KMH-Profit | 2.48 | 18.83 | 94.87 |
| NK-6240 | 3.09 | 22.67 | 98.76 |
| NMH-707 | 1.59 | 16.87 | 96.09 |
| INDAM 1122 | 2.98 | 18.78 | 97.76 |
| HY-P 3505 | 1.60 | 14.76 | 85.87 |
| LG-35.02 | 3.31 | 21.76 | 89.87 |
| LG-34.06 | 4.31 | 24.76 | 86.76 |
| KMH-2589 | 3.07 | 19.98 | 92.14 |
| VMH-150 | 2.98 | 12.56 | 85.56 |
| NMH-8352 | 2.02 | 17.87 | 99.87 |
| JKMH- 1701 | 2.43 | 14.56 | 87.43 |
| DKC-9198 | 1.88 | 20.87 | 97.65 |
| AHC-2040 | 1.87 | 11.34 | 95.99 |
| S- 6217 | 3.18 | 21.98 | 85.34 |
| DKC-9190 | 2.41 | 13.45 | 97.65 |
| MOTI-155 | 2.48 | 21.3 | 84.09 |
| ADV-9293 | 1.62 | 12.87 | 98.09 |
| Correlation coefficient values (r) | | 0.403* | -0.412* |
| S. E.m | | 0.231 | 0.009 |
| CD | | 0.66 | 0.027 |

Significant at 5% level, ** Significant at 1% level

Cob length (cm)

The length of cob of maize showed significant difference in different genotypes. Significantly highest length of cob (24.98cm) was observed in the genotype Heera-1122. Whereas, the lowest length of cob was observed in AHC-2040(11.34cm), followed by VMH-150 (12.56cm), ADV-9293 (12.87cm), DKC-9190 (13.45cm), JKMH-1701 (14.56cm), HY-P-3505 (14.76 cm) ADV-9293 (15.98cm), NMH-731 (17.67cm), NMH-8352 (17.87 cm) and INDAM-1122 (18.78 cm) which were at par with each other (Table.11) The fall armyworm, *Spodoptera frugiperda* was significant correlation between cob length (cm) and kernel damage rating. However, it was positive indicating that with increase in cob length (cm) there was increase in infestation level. The 'r' value being 0.403 and regression equation being $Y = 1.238 + 0.066x$ indicating that with increase in one unit of cob length (cm) i.e. there was increasing the infestation by 0.066 percent.

Cob height (cm)

The height of cob (cm) of maize showed significant difference in different genotypes. Significantly highest height of cob (99.87 cm) was observed in the genotype NMH-8352.

Whereas, the lowest height of cob was observed in MOTI-155 (84.09cm) followed by S-6217 (85.34cm), VMH-150 (85.56cm), LG-34.06 (86.76cm) and JKMH (87.43cm) which were at par with each other (Table.11).

The fall armyworm, *Spodoptera frugiperda* was significant correlation between cob height (cm) and kernel damage rating. But it was negative indicating that with increase in cob height (cm) there was decrease in infestation level. The 'r' value being -0.412 and regression equation being $y = 6.726 - 0.058x$ indicating that with increase in one unit of cob height (cm) i.e. there was decreasing the infestation by 0.058 percent.

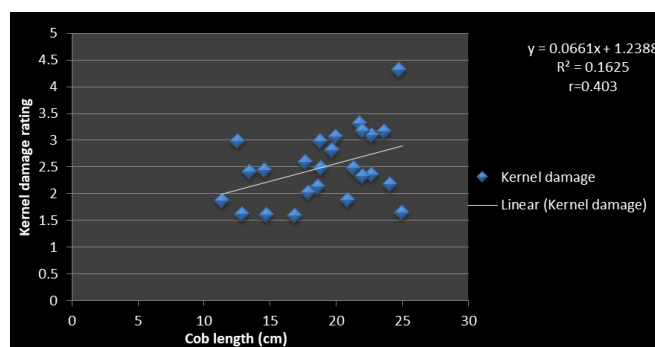


Fig 7: Regression line between cob length (cm) and kernel damage rating caused by fall armyworm, *Spodoptera frugiperda*.

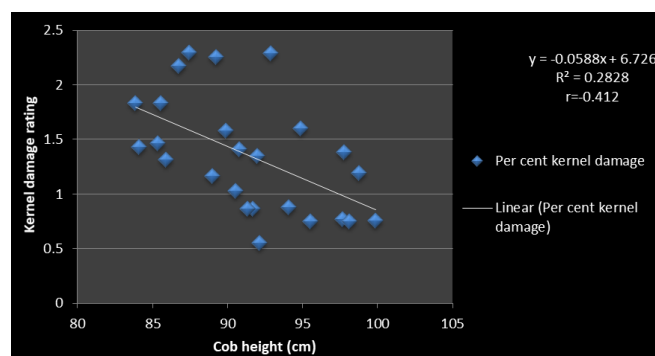


Fig 8: Regression line between cob height (cm) and kernel damage rating caused by fall armyworm, *Spodoptera frugiperda*

Conclusion

Screening of twenty five hybrid maize genotypes against the fall army worm was also done. On the basis of leaf damage rating, ear damage rating and kernel damage rating of maize genotypes. DKC-9190 (2.36) genotype recorded minimum leaf damage. However, the genotype NK-30 (8.21) was on the crop with maximum leaf damage. The leaf damage rating showed non-significant correlation with total number of leaves/plant ($r = 0.368$). While, Significant correlation was recorded with the leaf area (cm^2) of the leaves ($r = 0.442$). Whereas, highly significant but negatively correlation with leaf trichomes ($r = -0.609$) at 45DAS. While, Heera-1122 (1.91) genotype recorded minimum ear damage. Whereas, NMH-707 (5.91) genotype recorded with maximum ear damage on the crop. Ear damage rating showed significant correlation with length of central spike ($r = -0.446$). Among the twenty five cultivars NMH-707 (1.59) genotype recorded minimum kernel damage. While, LG-34.06 (4.31) genotype was recorded with maximum kernel damage on the crop. Whereas, kernel damage rating showed significant correlation with cob length (cm) ($r = 0.403$). While, significant but negative correlation with height of the cob (cm) ($r = -0.412$).

References

1. Ashley TR, Wiseman BR, Davis FM, Andrews KL. 1989. The fall armyworm: a bibliography. Florida entomologist. 72: 152-202.
2. Pitre HN, Hogg DB. Development of the fall armyworm on cotton, soybean and corn. Journal of the Georgia Entomological Society. 1985; 18:182-187.
3. Davis FM, Wiseman BR, Williams WP, Windstrom NW. Insect colony, planting date and plant growth stage effects on screening maize for leaf- feeding resistance to fall army worm (Lepidoptera: Noctuidae), USDA, ARS, Crop Science Research Laboratory Mississippi State, MS, 1992, 39762.
4. Xinzhi Ni, Wenwei Xu², Michael Blanco H, Paul W. Evaluation of fall army worm resistance in maize germplasm lines using visual leaf injury rating & predator survey, insect science. 2014; 21:541-555.
5. Crubelati- Multati NCS, Scapim CA, Albuquerque FA, Amaral Junior AT, Vivas Rodovalho M. Genetics and molecular research. 2014; 13(3):6539-6547.