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Sneha Tiwari
Department of Entomology, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

Sonali Deole
Department of Entomology, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

Nandan Mehta
Department of Genetics and Plant Breeding, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

Corresponding Author:
Sneha Tiwari
Department of Entomology, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

Field screening of maize genotypes against fall armyworm, *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera: Noctuidae)

Sneha Tiwari, Sonali Deole and Nandan Mehta

Abstract
The field experiment was conducted at Research-Cum-Instructional Farm at College of Agriculture, IGKV, Raipur (C.G) during *kharif* 2021 to screen out thirty-three maize genotypes against fall armyworm, Spodoptera frugiperda. Out of thirty-three maize genotypes, ADV-768 (2.72) genotype recorded with minimum leaf damage. However, SWEET GLORY (8.52) genotype was recorded with maximum leaf damage. Maximum kernel damage was noticed in HT-520015 (4.96), while minimum kernel damage was observed in genotype HT-520169 (1.41). Significant but negative correlation was observed between leaf damage and leaf length with ‘r’ value -0.947. Leaf width has negative impact (r = -0.968) on leaf damage. Leaf trichome density showed significant but negative impact (r = -0.992) on leaf damage. Whereas kernel damage showed significant but negative correlation with cob length (cm) (r = -0.925).

Keywords: Correlation, genotypes, kernel, screening, *Spodoptera frugiperda*

Introduction

Maize or corn (*Zea mays* L.) belongs to the grain family poaceae, is one of the major cereal crop due to its high importance as a staple food (Abebe and Feyisa, 2017) [1]. Maize is a stable cereal due to its high nutritional significance enriched with abundant amount of macronutrients like starch 72 percent, protein 10 percent, fat 4 percent and fibre 2 percent along with micronutrients like vitamin B complex, β- carotene and essential minerals, i.e. magnesium, phosphorus, zinc and copper etc. (Ranum *et al*., 2014) [5]. It is rich in “zein” protein, while deficient in tryptophane and lysine.

Recent maize production is below to its potential. Insects are among the key factor contributing to low yields facing maize production today. Fall armyworm (FAW), *Spodoptera frugiperda* (J.E. Smith), commonly named as is now considered as a major insect which causes significant yield losses to maize crop.

The use of insect resistance cultivar is an important component of Integrated Pest Management (IPM) which provides an economic, stable and environmentally sound approach to minimize damage from insect pests (Rasool *et al.*, 2017) [6]. The morphological traits play important role in host plant resistance. Morphological traits are responsible for suitability/ preference of cultivar for feeding and oviposition. Looking to the above facts regarding practical utility of morphological screening in managing the fall armyworm of maize crop, the present investigation conducted.

Materials and Methods

The maize hybrids developed for screening tests were examined for various morphological traits analysis at various growth stages to confirm the built-in mechanism of host plant resistance to the fall armyworm. The data were collected from the beginning of crop growth until the crop was harvested.

Morphological traits of maize genotypes

Morphological characters *viz.*, leaf length, leaf width, trichome density, cob length etc. were recorded on three randomly selected plants in 33 genotypes and data were correlated with damage caused by *S. frugiperda*. The procedures adopted for the estimation of morphological parameters are described as under:

1. Leaf length (cm)
Leaf length was measured by using a plastic measuring scale of 30 cm. For the estimation of leaf length, five leaves were collected from randomly selected plants at 30 DAS. Mean leaf length was expressed in 'cm'.

2. Leaf width (cm)
Leaf width was measured by using a plastic measuring scale of 30 cm. For the estimation of leaf width, five leaves were collected from randomly selected plants at 30 DAS. The leaf width was measured from where the leaf width was found maximum. Mean leaf length was expressed in 'cm'.

3. Trichome density or number of macro-hairs per square mm of leaf area
For the density of trichomes, three leaves were collected from top, middle and bottom canopies of five randomly selected plants of each genotype at 20 and 40 DAS, kept overnight in to acetic acid : alcohol (2:1). After the chlorophyll had been removed, leaf was put into small vials containing 90 percent lactic acid, in order to take the observation. For the microscopic evaluation, the leaf was put on a slide in a drop of lactic acid, and it was viewed using a stereo microscope at a magnification of 40X. The number of trichomes in randomly selected microscopic field was counted and reported as trichome density (no. /$mm^{2)}$.

4. Cob length (cm)
Cob length was measured by using a plastic measuring scale of 30 cm. For the estimation of cob length, five cobs were collected from randomly selected plants. Mean cob length was expressed in 'cm'.

5. Cob width (cm)
Cob width was measured by using a plastic measuring scale of 30 cm. For the estimation of cob width, five cobs were collected from randomly selected plants. Mean cob width was expressed in 'cm'.

Result and Discussion
Relationship between plant characters and leaf damage caused by *S. frugiperda*
The effect of various leaf characters (such as leaf length, leaf width and trichome density) on maize leaf damage caused by fall armyworm was evaluated on thirty-three genotypes and correlation between them was worked out (Table 1).

A. Leaf length (cm)
During *kharif* 2021, the leaf length per plant of thirty-three maize genotypes differed significantly from 18.76 (SWEET GLORY) to 40.32 (ADV-768). The highest leaf length was observed in least susceptible genotype *viz*., ADV-768 (40.32) followed by NMH-777 (40.02), VMH 45 (39.07) and RAINA-7 (37.19) and were statistically on par with each other. Comparatively lowest leaf length was recorded in the genotype SWEET GLORY (18.76) being on par with DMRH-1410 (19.47), which were assumed to be as highly susceptible genotypes (Table 1).

Correlation of leaf damage caused by fall armyworm with leaf length
During *kharif* 2021, leaf length (r= -0.947) showed significant but negative correlation with leaf damage caused by fall armyworm. The regression equation being Y= -4.187x + 49.70, where x= leaf length and y= leaf damage caused by fall armyworm (Fig 1A).
These findings were followed to Somasekhar (2020) [7], who also reported the same result as negative correlation between leaf length and leaf damage rating caused by fall armyworm.

B. Leaf width (cm)
During *kharif* 2021, the leaf width per plant of thirty-three maize genotypes differed significantly from 1.70 (SWEET GLORY) to 7.43 (ADV-768). The highest leaf width was observed in least susceptible genotype *viz*., ADV-768 (7.43) followed by NMH-777 (7.06), VMH 45 (6.86) and RAINA-7 (6.79) and were statistically on par with each other. Comparatively lowest leaf width was recorded in the genotype SWEET GLORY (1.70) being on par with DMRH-1410 (2.00), which were assumed to be as highly susceptible genotypes (Table 1).

Correlation of leaf damage caused by fall armyworm with leaf width
During *kharif* 2021, leaf width (r= -0.968) showed significant but negative correlation with leaf damage caused by fall armyworm. The regression equation being Y= -1.180x + 10.48, where x= leaf width and y= leaf damage caused by fall armyworm (Fig 1B).
On this aspect, Madhu (2021) [8] recorded negative correlation between leaf width and leaf damage rating caused by fall armyworm. The width of maize leaf in the current investigation noticed as an important character for determining the resistance; as the least susceptible genotypes observed comparatively higher leaf width.

C. Leaf trichome density (Number of trichomes per sq. mm of leaf area)
During *kharif* 2021, the leaf trichome density per plant of thirty-three maize genotypes differed significantly from 5.74 (SWEET GLORY) to 57.33 (ADV-768) per sq mm. The maximum leaf trichome density was observed in least susceptible genotype *viz*., ADV-768 (57.43) followed by NMH-777 (53.03), VMH 45 (52.56) and RAINA-7 (50.20) and were statistically on par with each other. Comparatively lowest leaf trichome density was recorded in the genotype SWEET GLORY (5.74) being on par with DMRH-1410 (9.49), which were assumed to be as highly susceptible genotypes (Table 1).

Correlation of leaf damage caused by fall armyworm with leaf trichome density
During *kharif* 2021, leaf trichome density (r= -0.992) showed significant but negative correlation with leaf damage caused by fall armyworm. The regression equation being Y= -9.162x + 80.97, where x= leaf trichome density and y= leaf damage caused by fall armyworm (Fig 1C).
Similar work has been done by Deole and Paul (2020) at Raipur and reported a significant negative correlation between leaf trichome density and leaf damage caused by fall armyworm. They revealed that the increased density of leaf trichomes was unfavorable for larvae population.

Relationship between plant characters and kernel damage caused by *S. frugiperda*
The effect of various plant characters (such as cob length and

cob width) on maize kernel damage caused by fall armyworm was evaluated on thirty-three genotypes and correlation between them was worked out (Table 2).

A. Cob length (cm)

During *kharif* 2021, the cob length per plant of thirty-three maize genotypes differed significantly from 10.25 (HT-520015) to 25.00 (HT-520169). The highest cob length was observed in least susceptible genotype *viz*., HT-520169 (25.00) followed by NMH-777 (22.65), PAC-751 (21.25) and VMH 45 (21.19) and were statistically on par with each other. Comparatively lowest cob length was recorded in the genotype HT-520015 (10.25) being on par with DMRH-1410 (11.28), which were assumed to be as moderately susceptible genotypes (Table 2)

Correlation of leaf damage caused by fall armyworm with cob length

During *kharif* 2021, cob length (r= -0.925) showed significant but negative correlation with kernel damage caused by fall armyworm. The regression equation being Y= -2.422x + 25.45, where x= cob length and y= kernel damage caused by fall armyworm (Fig 1D).

The present investigation is more or less in conformity with the work done by Deole and Paul (2020) [2]. They were also reported a significant negative correlation between cob length and kernel damage caused by fall armyworm on maize.

B. Cob width (cm)

During *kharif* 2021, the cob width per plant of thirty-three maize genotypes ranged from 3.27 (MM-2033) to 6.50 (DMRH-1308). The highest cob width was observed in genotype *viz*., DMRH-1308 (6.50) followed by LG-36609 (6.43). Comparatively lowest cob width was recorded in the genotype MM-2033 (3.27) followed by PAC-751 (3.57) (Table 2).

No correlation was found significant on cob width and kernel damage caused by fall armyworm. Thus, the cob width did not play any role in kernel infestation and making the plant resistant or susceptible. On this aspect, Madhu (2021) [8] also reported no correlation between cob width and kernel damage caused by fall armyworm.

Table 1: Leaf damage rating and response of maize genotypes to different morphological traits during *kharif* 2021

S.N.	Genotype	Leaf damage	Morphological traits		
			Leaf length	Leaf width	Leaf trichome density
1.	RASI-3499	4.40	29.79	5.24	40.78
2.	IAHM 2020-35-2	5.36	25.71	3.57	32.68
3.	NK-30	4.47	29.07	5.01	40.06
4.	MM-2033	3.48	37.02	6.72	50.02
5.	TA-5084	4.36	30.31	5.34	41.33
6.	LG-36511	4.44	29.13	5.06	40.12
7.	IAQPMH-2021-100	6.33	22.93	2.57	22.83
8.	AMRIT-1	3.56	36.15	6.62	49.14
9.	IAHM 2020-19	3.45	37.09	6.76	50.09
10.	CoH(M)-8	5.47	24.25	3.29	31.26
11.	RAINA-7	3.41	37.19	6.79	50.20
12.	LG-36609	3.47	37.05	6.75	50.05
13.	HT-520607	4.43	29.18	5.08	40.18
14.	MM-9333	6.49	21.77	2.48	21.32
15.	DMRH-1410	7.64	19.47	2.00	9.49
16.	SWEET GLORY	8.52	18.76	1.70	5.74
17.	PRO-4212	7.25	20.51	2.04	13.12
18.	HT-520015	5.76	23.54	3.15	28.38
19.	DKC-9226	4.73	26.58	4.17	37.61
20.	ADV-768	2.72	40.32	7.43	57.33
21.	HT-520169	3.70	35.73	6.45	47.74
22.	DMRH-1308	6.34	22.66	2.51	22.35
23.	HT-520182	4.69	27.81	4.25	38.82
24.	RMH-4602	3.54	36.83	6.68	49.79
25.	MM-9366	4.40	29.27	5.17	40.28
26.	DKC-9228	4.62	27.93	4.88	38.95
27.	DMRH-1419	5.43	24.54	3.46	31.52
28.	IAHM 2020-51	7.24	20.66	2.18	13.93
29.	IAHM 2020-35-1	7.39	20.35	2.01	12.35
30.	PAC-751	4.33	30.61	5.86	41.63
31.	VIJETA	4.40	29.23	5.15	40.22
32.	VMH 45	3.28	39.07	6.86	42.56
33.	NMH-777	3.12	40.02	7.06	53.03
	SE (m)	0.485	0.067	0.018	1.725
	CD at 5%	0.171	0.191	0.051	4.884

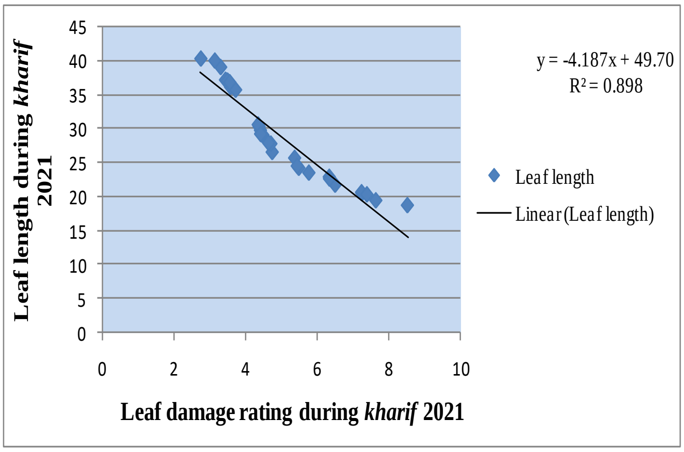
Table 2: Kernel damage rating and response of maize genotypes to different morphological traits during *kharif* 2021

S.N.	Genotype	Kernel damage	Morphological traits	
			Cob length	Cob width
1.	RASI-3499	2.32	19.56	4.47
2.	IAHM 2020-35-2	4.75	14.16	5.65
3.	NK-30	2.30	20.04	5.56
4.	MM-2033	2.66	18.36	3.27
5.	TA-5084	4.77	13.49	4.37
6.	LG-36511	1.69	20.88	4.55
7.	IAQPMH-2021-100	4.54	15.28	6.13
8.	AMRIT-1	2.52	18.66	5.33
9.	IAHM 2020-19	2.57	18.43	4.67
10.	CoH(M)-8	4.43	15.93	5.47
11.	RAINA-7	3.20	17.95	5.02
12.	LG-36609	3.25	17.86	6.43
13.	HT-520607	4.47	15.66	6.37
14.	MM-9333	4.57	15.06	4.69
15.	DMRH-1410	4.90	11.28	6.17
16.	SWEET GLORY	4.80	11.86	5.26
17.	PRO-4212	4.77	12.51	5.57
18.	HT-520015	4.96	10.25	6.41
19.	DKC-9226	3.71	17.65	6.29
20.	ADV-768	1.74	20.49	3.64
21.	HT-520169	1.41	24.27	4.74
22.	DMRH-1308	4.42	16.76	6.50
23.	HT-520182	4.42	16.05	5.35
24.	RMH-4602	2.36	19.21	5.42
25.	MM-9366	4.62	14.43	4.97
26.	DKC-9228	2.51	18.77	5.17
27.	DMRH-1419	4.38	16.84	4.69
28.	IAHM 2020-51	4.28	16.94	5.75
29.	IAHM 2020-35-1	2.41	19.05	4.24
30.	PAC-751	1.47	21.25	3.57
31.	VIJETA	2.79	18.26	5.67
32.	VMH 45	1.63	21.19	4.46
33.	NMH-777	1.45	22.65	4.61
	SE (m)	0.671	0.075	0.135
	CD at 5%	0.237	0.213	0.382

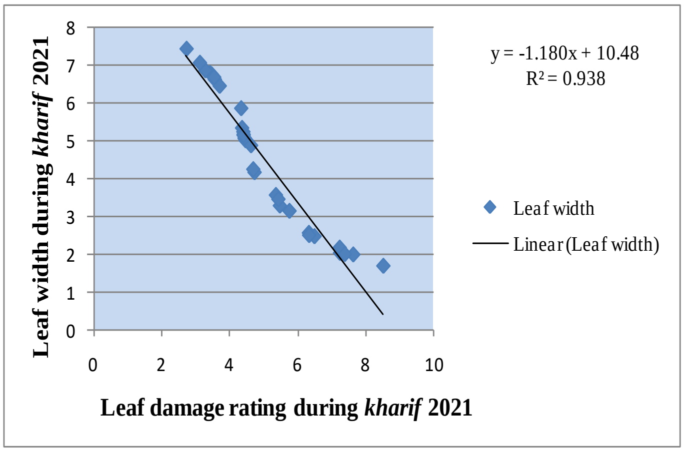
Table 3: Correlation of various morphological traits of different maize genotypes in relation to damage caused by fall armyworm, *S. frugiperda*

S.N.	Morphological Parameter	Leaf damage	Kernel damage
1.	Leaf length	-0.947*	-
2.	Leaf width	-0.968*	-
3.	Leaf trichome density	-0.992*	-
5.	Cob length	-	-0.925*
6.	Cob width	-	0.267

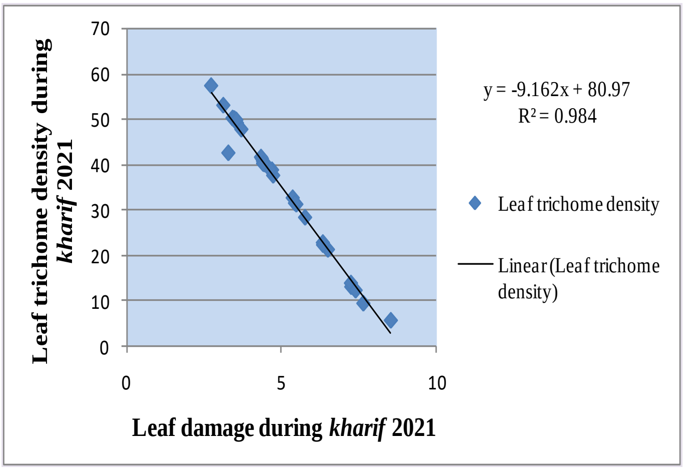
Significant at 5 % level of significance



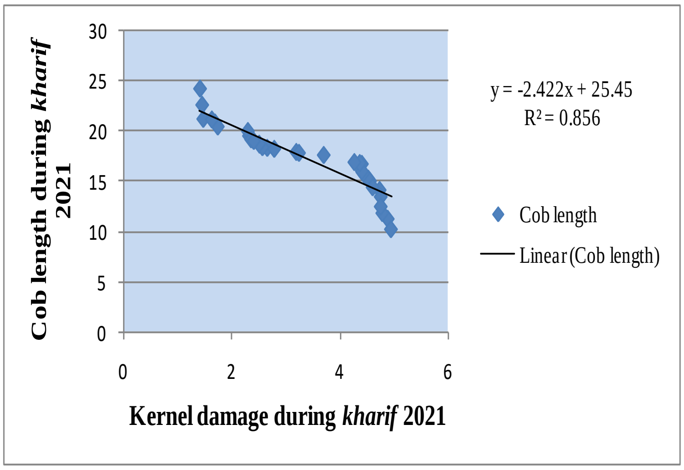
A: leaf length and leaf damage



B: leaf length and leaf damage



C: Leaf trichome density and leaf damage



D: Cob length and kernel damage

Fig 1: Regression equation between plant morphological characters and leaf/kernel damage caused by fall armyworm during *Kharif* 2021.

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Conclusion

Leaf length, leaf width and leaf trichome density of maize have a negative impact on the leaf damage caused by fall armyworm. Cob length of maize has a negative impact of kernel damage caused by fall armyworm.

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