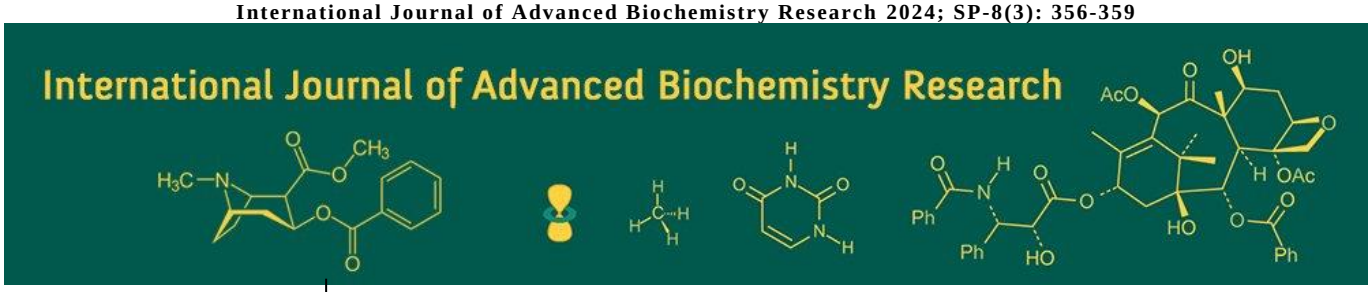

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A comprehensive study on maize germplasm resistance: To screened out promising germplasm/varieties of maize against *Chilo partellus*

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Abstract
The germplasm/varieties of maize raised during Rabi season of 2020-2021 at oil seed farm, Kalyanpur and insectary department of entomology, C. S. Azad University of Agriculture And Technology Kanpur (U. P.). The soil of experimental field was study loam with homogenous average fertility level. The topography of the site of experiment was fairly prevented from the water logging condition. Geographical location of Kanpur district falls at 26.29° North longitude and 80.18 °C East longitude at an altitude of 125.9 m from the sea level. Observation on pink stem borer was recorded at 15 days intervals on five randomly selected plants, started from sowing to harvesting of the crop. In study we found that Azad Kanti, Azad PC-3, Azad BC-14, REHBC 1413-2, and Azad BC-5 were found resistant and HPC-5 more susceptible against stem borer, *Chilo partellus.*

Keywords: Germplasm, maize, borer, kharif

Introduction
Maize, (*Zea mays* Linn.), is a new world graminaceous crop. Which holds the world's third most important place after rice and wheat. This is grown in all developing countries. In some places maize is grown and harvested every month of the year (Sharma and Dass, 2012) [1]. Maize flour and grains are staple food for poor people while maize stalks provide dry season feed for farm animals in the form of hay hydroponic fodder and silage as well as it is used in several forms like, maize grain, poultry feeds, baby foods, popcorn, maize flour, corn oil, starch products, forage for animals and many more. Maize stalks also used as a soil mulch and preparation of huts for shelter. Maize silage is used as animal feed in temperate regions and stored as fodder balls. Maize (*Zea mays* L.) is one of the most versatile emerging crops having wider adaptability under varied agro-climatic conditions. It has been referred as the "Queen of cereals" due to its highest yield potential among all the cereals. (Singh *et al.* 2004) [2].

Maize is known as miracle crop because of its wide contribution in global economy and use in industries (Singh *et al.* 2012) [2].

Maize has tremendous utility for homegrown and industrial purposes. Mostly maize is used in the production of industrial products like starch, alcohol, dyes, lactic acid, glucose, paper, rayon, plastics, textiles, adhesive, acetic acid, tooth pastes, synthetic rubber *etc*. (Bibi *et al.* 2010) [3].

There are several insect pest and non-insect pests interrupted maize production in India, among which the maize stalk borer *Chilo partellus* (Swinhoe), *Sesamia inferens* walker, Maize leaf aphid, *Rhopalosiphum maidis (Fitch).* The damage by stalk borer ranges from 22.5% to 29%. The average yield loss in Kharif season is estimated to be 11.05 million rupees by *Chilo partellus* alone (Kumar and Mihm, 1995, 1996 and Kumar, 2002) [5, 4]. About 15.6% loss of yield in maize is due to the biotic stress caused by the various kind of insect pest (Dhaliwal and Arora, 2006) [6]. Apart from this only maize stem borer, *Chilo partellus* causes 8-10% yield loss (Songa *et al.* 2001) [7] peninsular India throughout the year and across the country (Santosh *et al*. 2012) [8], pink stem borer, *Sesamia inferens* (Walker) is one of the major borer pests recorded mainly during *Rabi* season (Jalali and Singh, 2002) [9].

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 (Reddy *et al.*, 2003) [10] pink stem borer, *Sesamia inferens* is major insect pest of maize in Peninsular India during *Kharif* and *Rabi*. The loss 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% (Sekhar *et al*. 2009) [11].

Materials and Methods

The screening of maize germplasm/varieties against maize stem borer, *Chilo partellus*, pink stem borer, was carried out during 2020-2021 in oil seed farm, Kalyanpur and insectary department of entomology, C. S. Azad University of Agriculture and Technology Kanpur, 208002. The various maize germplasm/varieties were obtained from the Department of Genetics and plant breeding of the university. These germplasm are used for screening against the major insect-pest of maize crop. (Table 1).

Table 1: List of maize germplasm/varieties

S. No.	Genotypes	S. No.	Genotypes
G1	Azad Kamal Blanded	G10	Azad PC - 3
G2	Azad Kanti'	G11	Azad Baby 7
G3	REHBC 1413-2	G12	Azad Baby 3
G4	Azad Baby 2	G13	Azad Baby 4
G5	Azad BC-5	G14	Azad Baby
G6	Azad Rosting	G15	Azad K-PC
G7	Azad Single	G16	Azad BC-12
G8	Azad PC-20	G17	Azad –PC-9
G9	Azad BC-14	G18	Azad Bunchy
G19	Azad Baby 6	G28	TSK 19
G20	Azad PC- 4	G29	TSK 24
G21	DKC 9108+	G30	HPC 3
G22	TMMH 804	G31	HPC 5
G23	KD 1 BOLD	G32	KD 7
G24	KD 5	G33	D 7
G25	Local 3- 20	G34	GP 20 -1
G26	Local 2-20	G35	Popcorn 7052-1
G27	HPC 2	G36	GP 20-2

Sowing was done on 27 November 2020, the crop was fully germinated after 7th days of sowing i.e. on 3-4 December 2020. The basal doses of fertilizer NPK were applied under recommended agronomical practices at the time of sowing and urea applied at stand crop, irrigation was given when required.

The plant were randomly selected as required in each plot and tagged for the observations of stem borer, pink stem borer, and corn leaf aphid. The observation of pest infesting maize were recorded in the morning hours. To record the percent of damaged stems, for which the total number of healthy stem and total number of damaged was calculated. Three observations were recorded at vegetative, flowering and fruiting stage of the crop.

$$\text{Percent plant infestation} = \frac{\text{Number of dead heart plant per plot}}{\text{Total number of plants per plot}} \times 100$$

Kumar *et al*. (2017) [12]

The maize germplasm were categorized in the five grades, on the basis of percent stem damage table – 2. Grading for stem borer *Chilo partellus* damage was categorized in the five grades, on the basis of percent stem damage.

Table 2: Below parameters used for checking germplasm/varieties against Stem borer, *Chilo partellus*

S. No.	Grading	Symbol	Percent stem damage
1	Resistant	R	0.00
2	Moderately resistant	M. R.	1-5
3	Moderately susceptible	M. S	6-15
4	Susceptible	S	16-30
5	Highly susceptible	H. S.	>30

Source: Lella *et al*, 2013 [13]

Pink stem borer (*Sesamia inferens*)

Observation on pink stem borer was recorded at 15 days intervals on five randomly selected plants, started from sowing to harvesting of the crop.

Observation was taken as

Leaf injury rating scale (1 to 9) (by Reddy *et al*. 2003) [10] In order to study, the leaf injury rating the number of pin holes on leaves were recorded on randomly five selected plants from each genotypes. The data related to leaf injury rating were grouped under following categories.

Table 3: Below parameters used for checking maize germplasm/varieties against pink stem borer, *Sesamia inferens*

Rating scale	Description	Category
1	1-5 pin holes/plant	Resistant
3	>5-10 pin holes/plant	Moderately resistant
5	>10-20 pin holes/plant	Moderately susceptible
7	>20-30 pin holes/plant	Susceptible
9	>30 pin holes/plant	Highly susceptible

Reddy *et al*., 2003 [10]

The following material were used for setting up the experiments and for recording the observation: hand lens (10x). plastic vials, scissors, elastic bands, aspirator, glass vials, making tags, glass marking pencils, digital camera (high zoom), glass jars, petri dishes, stereoscopic zoom binocular microscope, ocular micrometer, poly ethylene bags, muslin cloth, needle, brush, ovipositional cages and potted maize plant.

Oil seed farm, Kalnyanpur farm was considered as a potential spot to this study where the winter maize is highly infested every year by maize pest. Study was conducted during the winter of 2020 and 2021.

Yield loss was estimated by obtaining the yield difference between the reported yield and obtained yield from maize plants. No insecticide was applied in the maize plants. Every plot was of 2 rows of 4 m length with plant to plant spacing of 2o cm and row to row spacing of 60 cm. Grain yield and 1000 grain weight were taken when the moisture level in the grains was below 14% after sun drying.

$$\text{Percent yield loss} = \frac{\text{Yield obtained after infestation from germplasm}}{\text{Reported yield of varieties/germplasm}} \times 100$$

Experimental Finding

Screening of maize germplasm/against stem/stalk borer

The germplasm having zero infestation during the whole crop period were placed under resistance category. Moderately resistant germplasm were kept under 1-5 percent infestation level, moderately susceptible germplasm under 6-15 percent infestation level.

Below observation were taken 15 day interval from the germination of crop plants. These are shown in to Table-4.

Table 4: Data of taken observation for *Chilo partellus* during the field experiment

Germplasm/varieties	Vegetative stage	Cob formation stage	Maturity stage	Mean
Azad Kanti	00	00	00	0.0
Azad PC-3	00	00	00	0.0
Azad BC-14	00	00	00	0.0
REHBC 1413-2	00	00	00	0.0
Azad BC-5	00	00	00	0.0
Azad PC-20	2.2	3.2	4.2	3.2
Azad Baby 6	5.6	3.7	2.88	4.6
Azad PC-4	6.2	2.0	4.1	4.1
Azad Baby 7	3.5	2.6	4.4	3.5
Azad Baby-4	1.3	3.5	1.5	2.1
Azad Baby	4.5	2.5	2.3	3.1
Azad BC-12	5.6	8.0	3.2	5.0
Azad Baby 2	3.6	5.4	4.2	4.4
Azad Single	2.5	3.6	3.5	3.2
Azad Bunchy	1.25	1.75	2.7	1.9
TSK 19	5.3	6.2	8.0	6.5
D7	5.4	7.2	6.3	6.3
Azad Rosting	6.3	9.2	7.3	7.6
Azad K-PC	8.5	9.6	6.2	8.1
Azad-PC-9	9.3	9.5	10.6	9.8
Azad Baby 3	6.5	7.5	10.9	8.3
Azad Kamal Blanded	9.5	11.0	10.4	10.3
DKC 9108	7.5	8.5	9.5	8.5
TMMH 804	8.5	7.9	5.2	7.2
KD 1 BOLD	6.3	5.9	7.9	6.7
KD 5	15.5	15.6	18.4	16.5
TSK 24	17.3	18.6	16.0	17.3
Local 3-20	18.3	17.3	21.1	18.9
Local 2-20	12.9	15.6	21.0	16.5
KD 7	18.4	15.9	19.0	17.8
PoPCorn 7052-1	19.2	17.0	22.0	19.4
GP 20-1	16.1	22.8	16.0	18.3
GP 20-2	21.5	24.6	15.4	20.5
HPC 2	25.9	29.0	35.7	30.2
HPC3	32.5	34.6	25.0	30.7
HPC 5	39.5	45.9	24.1	36.5

Resistance against stem/stalk borer, *Chilo partellus* in maize germplasm

According to Table-4, out of 36 strains the following five were found resistant against *Chilo partellus* on maize crops. Resistant varieties are shown in Table- 5.

Table 5: Resistant line of maize germplasm/varieties against stem borer *Chilo partellus*

S. No.	Germplasm/Varieties	Percent stem damage
1	Azad Kanti	0.00
2	Azad PC-3	0.00
3	Azad BC-14	0.00
4	REHBC 1413-2	0.00
5	Azad BC-5	0.00

Moderately resistant

According to table-4, under moderately resistant group of maize germplasm/varieties against the stem borer infestation varied from 1-5 percent damage, 10 lines were grouped in this category. These lines are shown in Table- 6.

Table 6: Moderately resistant line of maize germplasm/varieties against stem/stalk borer, *Chilo partellus*

S. No.	Germplasm/varieties	Percent stem damage
1	Azad PC-20	3.2
2	Azad Baby 6	4.6
3	Azad PC-4	4.1
4	Azad Baby 7	3.5
5	Azad Baby-4	2.1
6	Azad Baby	3.1
7	Azad BC-12	5.0
8	Azad Baby 2	4.4
9	Azad Single	3.2
10	Azad Bunchy	1.9

Moderately susceptible

According to table-4, under moderately susceptible group of maize germplasm/varieties against the stem borer infestation varied from 6-15 percent damage, 10 lines were grouped in this category. These lines are shown in the table- 7.

Table 7: Moderately susceptible line of maize germplasm/varieties against stem/stalk borer, *Chilo partellus*

S. No.	Germplasm/varieties	Percent stem damage
1	TSK 19	6.5
2	D7	6.3
3	Azad Rosting	7.6
4	Azad K-PC	8.1
5	Azad-PC-9	9.8
6	Azad Baby 3	8.3
7	Azad Kamal Blanded	10.3
8	DKC 9108	8.5
9	TMMH 804	7.2
10	KD 1 BOLD	6.7

Susceptible

According to table-6, under susceptible group of maize germplasm/varieties against the stem borer infestation varied from 16-30 percent damage, 8 lines were grouped in this category. These lines are shown in the table- 8.

Table 8: Susceptible line of maize germplasm/varieties against stem/stalk borer, *Chilo partellus*

S. No.	Germplasm/varieties	Percent stem damage
1	KD 5	16.5
2	TSK 24	17.3
3	Local 3-20	18.9
4	Local 2-20	16.5
5	KD 7	17.8
6	Popcorn 7052-1	19.4
7	GP 20-1	18.3
8	GP 20-2	20.5

Highly susceptible

According to table-4, under highly susceptible group of maize germplasm/varieties against the stem borer infestation varied from >30 percent damage, 3lines were grouped in this category. These lines are shown in the table- 9.

Table 9: Highly Susceptible line of maize germplasm/varieties against stem/stalk borer, *Chilo partellus*

S. No.	Germplasm/varieties	Percent stem damage
1	HPC 2	30.2
2	HPC3	30.7
3	HPC 5	36.5

Conclusion

In study we found that Azad Kanti, Azad PC-3, Azad BC-14, REHBC 1413-2, and Azad BC-5 were found resistant and HPC-5 more susceptible against stem borer, *Chilo partellus*, Among screened germplasm/varieties we found that Azad Kanti and Azad K-PC was the best cultivars which give more yield under natural condition in comparison with the other germplasm/varieties without any spray of insecticide and pesticides in the field.

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