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Ovipositional preference of gravid *Chilo partellus* (Swinhoe) females on maize germplasm

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Abstract
Ten different maize germplasm (inbreds) of 15 days old were studied for their oviposition preference to maize stalk borer, *Chilo partellus* (Swinhoe) on the basis of different plant parameters *viz*., i) Average plant height, (ii) Average number of eggs per plant, (iii) Average number of egg masses per plant, (iv) Serial number of leaves received eggs (leaf from the bottom to top of the plant), (v) Average percentage of plant received eggs, (vi) Average percentage of leaves received eggs. Maximum egg laying was observed in HKI-1128 (15.02) and minimum in HKI-161(2.23). It was observed that third leaf (from bottom to top of the plant) was most preferred for oviposition by gravid females of *C. partellus*. Ovipositional preference was not found to be influenced by plant height. Similarly, average number of eggs is more or less the same in each egg mass irrespective of the germplasm. The average percentage of plants received eggs and average percentage of leaves received eggs by *C. partellus* showed significant differences between the resistant and susceptible maize germplasm. The mean egg mass was found maximum in HKI-1128 (1.03) and minimum in HKI-161(0.11), implying that the moths ensured greater survival of the freshly hatched larvae to continue the progeny on susceptible germplasm than to get eliminated on resistant ones.

Keywords: Maize germplasm, *Chilo partellus*, ovipositional preference

1. Introduction

Maize is one of the most important cereal crops in the world agricultural economy, often referred as "*queen of cereals*". Nutritionally maize ranks below wheat and sorghum yet remarkably above the rice. Maize is considered as a miracle crop, due to its immense yield potential. In India, maize is the third most important food crop followed by rice and wheat where over 35% of the total production is consumed as human food. Presently, it occupies 9.23 million hectare area in India with the productivity of 2.56 t/ha which is far behind the global average of 5.52 t/ha [7]. The average productivity of maize is much lower than its potential due to the improper management of biotic and abiotic stress. Among all the insect pests of maize, stem borer *Chilo partellus* (Swinhoe) is the most serious pest found throughout India. *Chilo partellus* attacks and severely damages the wild and cultivated species of Poaceae [14]. Yield losses due to this pest are reported from 20 to 87 % [4, 19, 25].

An essential pre-requisite for characterization of resistant factors and their ultimate utilization in breeding varieties/hybrids resistant to the stalk borer, *Chilo partellus* (Swinhoe) is to comprehend the principal mechanism of resistance involving antixenosis [5, 6] and antibiosis. The term antixenosis indicates a 'non-preference' type of resistance. The concept of antixenosis considers host-plant selection behaviour influenced by allelochemicals as well as morphological defenses. The divergent views on oviposition of *C. partellus* revealed that the site varied from different parts of the same leaf and other leaves [3, 26, 27] to no preference for any particular part of the plant [8]. Also, the linearity of infested plants/dead hearts /apparently healthy plants varied to such an extent that no set pattern of infestation could be evolved [17]. Evidently, these observations masked the clue to the antixenosis mechanism of resistance for oviposition of *C. partellus*. Hence, it is necessary to study the different plant characteristics associated with oviposition response of *C. partellus* in maize. If the germplasm manifest variations in ovipositional preference by female *C. partellus* similar to antibiosis reaction by larval feeding, the elaborate process of germplasm screening by artificial infestation may not be required. Ovipositional preferences are usually measured by counting the number of eggs laid by adult females on different germplasm when the gravid females have given multiple choice. With this brief overview, the present study was conducted to find ovipositional preference as an important and dependable cue to screen the maize germplasm.

2. Materials and methods

2.1. Culture of *Chilo partellus*

The nucleus culture of *C. partellus* was collected from the field of Directorate of Maize Research (DMR), IARI; New Delhi was maintained in the Entomology Laboratory, DMR under the constant rearing environment at a temperature of 26 ± 2.0ºC, and relative humidity of 65 ± 5%. The field collected larvae were reared on fresh cut-stalks of hybrid HQPM1, in 2 L glass jars. The culture was multiplied for two successive generations on artificial diet [24]. The moths obtained from third generation utilized for studying antixenosis mechanism for oviposition of *C. partellus*.

2.2. Experimental procedure

The experiment was conducted in the glasshouse of Indian Institute of Maize Research (DMR), New Delhi. The ovipositional preference of *C. partellus* was studied on the ten germplasm (inbreds) viz., BML-6, BML-7, CM-139, CM-140, HKI-193, HKI-163, HKI-1128, HKI-161, HKI-1105, and HKI-323 were selected for the experiment. Twenty plants of each germplasm were sown in the tray (size 30 cm x 20 cm x 10 cm). Five days after germination trays containing plants of 10 germplasm were enclosed in screening cage (mosquito net) of size 180 cm x 180 cm x 120 cm. Forty pairs of moths were released on 15 day old plants inside the screening cage containing 10 trays of each germplasm, which constitutes one replication. The same set of experiment was replicated thrice. Following observations were recorded five days after adult moth release (i) Plant height, (ii) Average number of eggs per plant, (iii) Average number of egg masses per plant, (iv) Serial number of leaves oviposited (leaf starting from bottom to top of the plant), (v) Average percentage of plant received eggs and (vi) Average percentage of leaves received eggs.

3. Results

The results of the present investigation carried out on the oviposition preference parameters of maize germplasm are presented in Table 1. The data on the number of plants oviposited and number of leaves oviposited is given in percentage. The average number of eggs per plant received by different germplasm in the decreasing order of HKI-1128 (15.02), HKI-193-1 (8.23), HKI-323 (7.28), CM-139 (4.23), BML-7 (3.60) and HKI-161 (2.23). The average number of eggs per plant was found highest in the germplasm HKI-1128 indicating that the plant is most preferred for oviposition while the germplasm HKI-161 receives less number of eggs per plant indicating that the plant is least preferred for oviposition.The height of plants varies from 12.38 cm to 15.81cm. The plant height showed a non-differential reaction of susceptible and resistant germplasm. The average percentage of plant received eggs, average percentage of leaves received eggs revealed significant differences among the test maize germplasm. The average percentage of plant received eggs were greater in the germplasm, HKI-1128 (43.33), and among the germplasm BML-6 (25.00), HKI-193-1 (26.66), HKI-163 (23.33) and HKI-1105 (23.33) were recorded more or less similar egg load, whereas in the germplasm HKI-161 (10.00) and BML-7 (11.66) fewer plants were for chosen for oviposition. The average percentage of leaves received eggs in the order of HKI-1128 (39.55), CM-140 (29.58), HKI-323 (28.65), CM-139 (28.65), HKI-161 (19.38) and BML-7 (18.45). More or less a similar trend was observed for percent plants oviposited and percent of leaves oviposited (Fig.1). The germplasm did not differ significantly amongst themselves with respect to the serial number of leaves oviposited. It was observed that third leaf (from bottom to top of the plant) was most preferred leaf for oviposition by *C. partellus* females on all the germplasm except the germplasm HKI-1105 on which fourth leaf (from bottom to top of the plant) was mostly preferred for oviposition. The average egg masses obtained per plant was higher on the germplasm HKI-1128 (1.03) and the germplasm HKI-193-1(0.45), BML-6 (0.36) and HKI-323 (0.36) had received more or less the equal egg masses per plant while less number of egg masses were laid on germplasm HKI-161 (0.11) and BML-7 (0.15).

The results of the correlation between the different oviposition preference parameters of 10 maize germplasm were presented in Table 2. It clearly showed that the average number of eggs per plant was positively and significantly correlated with the other parameters viz., plant height(r=0.810**), average egg mass/plant(r=0.987**), average percentage of plants received eggs(r=0.969**), average percentage of leaves received eggs(r=0.866**) except the average number of eggs per egg mass(r= -0.560). Average egg mass/plant was positively and significantly related to plant height(r=0.747*), average no. of eggs/plant(r=0.987**), average percentage of plants received eggs(r=0.959**), average percentage of leaves received eggs(r=0.882**) and negatively related to average no. of eggs/egg mass(r= -0.636*). Average percentage of plants received eggs positively related to plant height(r=0.851**), average egg mass/plant(r=0.959**), average no. of eggs/plant(r=0.969**), average percentage of leaves received eggs(r=0.791**) and negatively related to average no. of eggs/egg mass(r= -0.608). The correlation of average number of eggs per plant, percent plants oviposited and percent leaves oviposited were highly significant, indicating significant antixenosis.

Table 1: Ovipositional preference or non-preference of maize germplasm by *C. partellus* moths

Germplasm	Plant height(cm)	Ave. egg masses/plant	Serial no. of leaf oviposited	Average no. of eggs/plant	Average percentage of plants received eggs	Average percentage of leaves received eggs	Average no. of eggs/egg mass
BML-6	15.00±0.28cd	0.36±0.10bc	3	6.58±2.61bcd	25.00±0.0c	25.50±8.40abc	18.00±4.54ab
BML-7	13.50±0.70b	0.15±0.08ab	3	3.60±1.55ab	11.66±2.88a	18.45±3.21a	25.20±3.11b
CM-139	14.31±0.35bc	0.26±0.12abc	3	4.23±2.02abc	15.00±5ab	28.65±4.23bc	15.87±4.64a
CM-140	13.95±0.43b	0.26±0.02abc	3	5.03±0.37abcd	15.00±0.0ab	29.58±3.21c	18.97±1.99ab
HKI-161	12.38±0.42a	0.11±0.02a	3	2.23±0.46a	10.00±0.0a	19.38±4.82ab	19.55±4.72ab
HKI-163	15.03±0.25cd	0.35±0.13bc	3	6.36±1.12bcd	23.33±2.88c	24.67±7.48abc	20.17±8.13ab
HKI-193-1	15.42±0.71d	0.45±0.08d	3	8.23±1.95d	26.66±5.77c	28.65±5.78bc	18.40±3.96ab
HKI-323	14.95±0.08cd	0.36±0.16bc	3	7.28±2.42cd	20.00±8.66bc	28.65±1.59bc	18.24±4.54ab
HKI-1105	14.97±0.36cd	0.33±0.07bc	4	5.96±1.56bcd	23.33±2.88c	24.11±6.62abc	18.24±4.54ab
HKI-1128	15.81±0.69d	1.03±0.18d	3	15.02±2.03e	43.33±2.88d	39.55±2.09d	14.62±0.94a

F-value	13.75	15.12	-	11.78	16.76	3.89	1.27 (NS)
CD	1.83	0.45	-	6.35	17.08	12.40	7.85

Table 2: Correlation between different antixenosis (oviposition preference) parameters

Different oviposition preference parameters	Plant height (cm)	Ave. egg mass/plant	Average no. of eggs/ plant	Average Percentage of plants received eggs	Average Percentage of leaves received eggs	Average no. of eggs/ egg mass
Plant height (cm)	1	0.747*	0.810**	0.851**	0.703*	-0.481
Ave. egg mass/plant		1	0.987**	0.959**	0.882**	-0.636*
Average no. of eggs/ plan			1	0.969**	0.866**	-0.560
Ave.Percentage of plants received eggs				1	0.791**	-0.608
Average Percentage of leaves received eggs					1	-0.756*
Average no. of eggs/ egg mass						1
*. Correlation is significant at the 0.05 level (2-tailed).						
**. Correlation is significant at the 0.01 level (2-tailed).						

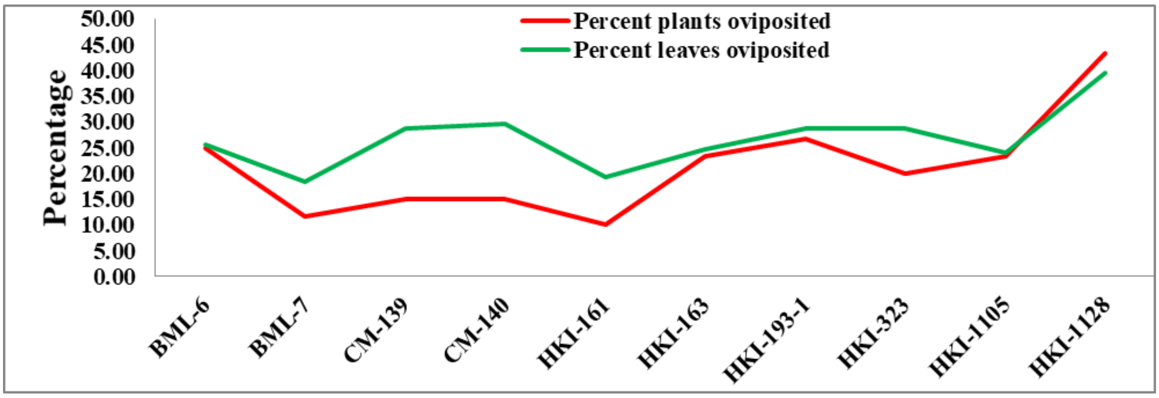

Fig 1: Trend between different oviposition preference parameters

4. Discussion

Host plant selection is a primal function of gravid females [10] and appropriate host plant selection is crucial for survival of the progeny [22]. The selection of a plant for oviposition is made on the basis of a presence of attractants and stimulants and absence of repellents and deterrents [21]. Morphological characters of plants are of paramount importance in host plant selection and recognition [1, 19, 29]. Antixenosis in maize genotypes against *C. partellus* was due to the presence of trichomes and surface waxes [11].

The selection of oviposition site by gravid female moths and larval movement predominantly for neonates is dependent upon morphological and chemical characters of host plants [15, 28, 30]. The oviposition was not influenced by plant height. However, the taller plants preferred more for oviposition in case of *Ostrinia nubilalis* (Hubn.) [16]. The relationship between plant height and oviposition preference of *C. partellus* could not be established [5, 23]. Although, the average height of germplasm such as HKI-1128, HKI-193-1, HKI-163 and BML-6 was more as compared to the germplasm like BML-7, HKI-161 and CM-140. The negative correlation between the average number of eggs per plant and average number of egg per egg mass indicated that the female preferred to oviposit on susceptible host to improve survival chances of their progeny. Both antixenosis and antibiosis contribute to the host plant resistance in terms of restricted larval movement, the low larval establishment in the cultivars MP-704 and V-37 in comparison to the cultivar Poza Rica-7832 [12]. The gravid C. partellus female moths laid more eggs on susceptible germplasm as compared to resistant ones, on the basis of two choice tests [13]. Larval infestation on the maize plants was found responsible for influencing the ovipositional responses of *C. partellus*. Feeding by the larvae and damage to the maize plants increased their suitability for oviposition by *C. partellus* [11].

Significant differences were revealed among the maize germplasm in present investigation for the parameters viz., the average number of eggs per plant, the percentage of plants received eggs and percentage of leaves received eggs. This signifies that the gravid female moths assured the greater survival of their progenies on susceptible hosts than to get eliminated on resistant ones. In general, gravid female moths oviposit on a suitable host for ensuring larval development. On the other hand, females do not invariably prefer an appropriate host. This is why sometimes neonates may reject the host on which the eggs were laid [2]. Non-significant differences were observed for the number of eggs per plant in sorghum and for the number of eggs laid on maize and sorghum landraces by *C. partellus*, on the basis of multiple–choice and two-choice tests, respectively [20].

Present investigation also showed that third leaf (from bottom to top of the plant) was the most preferred leaf for oviposition by gravid *C. partellus* females on all the maize germplasm except HKI-1105 on which fourth leaf (from bottom to top of the plant) was preferred for oviposition. The choice of oviposition site implied to be mediated by tactile stimuli [18]. The third leaf from bottom to the top of the plant received a maximum number of egg masses followed by 4^{th}, 5^{th}, 2^{nd}, 1^{st} and 6^{th} leaf, irrespective of the maize germplasm [6]. The third leaf received the maximum number of egg masses. Such a situation did not exist under field conditions as exemplified by the reports that 41.6 per cent of egg masses on first true leaf (second leaf from bottom to top); 86.7 per cent on first basal leaf [27]; 31.7 per cent on first true leaf (second from bottom to top) [3].

The positive correlation of oviposition preference parameters such as plant height, average egg masses per plant, average number of eggs per plant, average percentage of plants received eggs, average percentage of leaves received eggs were significantly correlated with each other and also, shows poor correlation with the average number of eggs per egg mass indicating that these parameters contributing more to the oviposition preference of the *C. partellus* females. Although the plant height showing significant correlation with the other oviposition preference parameters, the antixenosis for oviposition was clearly evident in the case of the average number of eggs per plant, the average percentage of plants received eggs and average percentage of leaves received eggs.

5. Conclusion

The ovipositional responses of the stem-borer *C. partellus* are higher on the susceptible germplasm than to the resistant one indicating that the moths ensured the greater survival of the freshly hatched larvae to continue their progeny on susceptible germplasm than to get eliminated on resistant ones. No germplasm shows the complete antixenosis mechanism in multiple-choice tests indicating that all the germplasm were more or less preferred for oviposition. Antixenosis mechanism of host plant resistance in terms of ovipositional preference shows that if the plant is not preferred for oviposition indicating that due to the presence of morphological characters or biochemical substances in the plant which imparts resistance to the plant and also, gives cue about the susceptibility of the plant.

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References

1. Ampofo JKO. *Chilo partellus* (Swinhoe) oviposition on susceptible and resistant maize genotypes. Insect Science and its Application, 1985; 6:323-330.
2. Bernays EA, Chapman RF, Host plant selection by phytophagous insects. Chapman & Hall New York, 1994.
3. Brar GS, Studies on the field behaviour of maize borer, *Chilo partellus* (Swinhoe) (Pyralidae: Lepidoptera). M.Sc. Thesis. Punjab Agricultural University, Ludhiana, India, 1972.
4. Chatterji SM, Young WR, Sharma GC, Sayl IV, Chahal BS, Khare BP *et al.* Estimation of loss in yield of maize due to insect pests with special reference to borers. Indian Journal of Entomology. 1969; 31(2):109-115.
5. Durbey Sarup. Preferential plant sites for oviposition of *Chilo partellus* (Swinhoe) moths in different maize germplasms. Journal of Entomological Research, 1982; 6(2):116.
6. Durbey, Sarup. Ovipositional responses of moths of *Chilo partellus* (Swinhoe) on different maize germplasms. Journal of Entomological Research, 1982; 6(1):1-9.
7. IIMR, Annual Report, ICAR-Indian Institute of Maize Research, Punjab Agricultural University Campus, Ludhiana, 2017, 75.
8. Katiyar RN, Variations in the oviposition sites of *Chilo zonellus* (Swinhoe). Indian Journal of Entomology, 1958; 20(3):237-238.
9. Khan ZR, Midega CAO, Hutter NJ, Wilkins RM, Wadhams LJ. Assessment of the potential of Napier grass (*Pennisetum purpureum*) varieties as trap plants for management of Chilo partellus. Entomologia Experimentalis et Applicata, 2006; 119:15-22.
10. Konstantopoulou MA, Krokos FD, Mazomenos BE. Chemical stimuli from corn plants affect host selection and oviposition behavior of *Sesamia nonagrioides* (Lepidoptera: Noctuidae). Journal of Economic Entomology, 2002; 95(6):1289-1293.
11. Kumar H. Enhancement of oviposition by *Chilo partellus* (Swinhoe) (Lepidoptera: Pyralidae) on maize plants by larval infestation. Applied Entomology and Zoology, 1986; 21:539-545.
12. Kumar H, Nyangiri EMO, Asino GO. Colonization responses and damage by *Chilo partellus* (Lepidoptera: Lepidoptera) to four variably resistant cultivars of maize. Journal of Economic Entomology, 1993; 86:739-746).
13. Mohamed HM, Khan ZR, Overholt WA, Elizabeth DK, Behaviour and biology of *Chilo partellus* (Lepidoptera: Pyralidae) on maize and wild gramineous plants. International Journal of Tropical Insect Science, 2004; 24(4):287-297.
14. Moolman J, Van den Berg J, Conlong D, Cugala D, Siebert S, Ru B Le. Species diversity and distribution of lepidopteran stem borers in South Africa and Mozambique. Journal of Applied Entomology, 2014; 138(1-2):52-66.
15. Moore RG, Hanks LM. Aerial dispersal and host plant selection by neonate *Thyridopteryx ephemeraeformis* (Lepidoptera: Psychidae). Ecological Entomology, 2004; 29:327-335.
16. Neiswander CR, Huber LL, Height and silking as factors influencing European corn borer population. Annals of Entomological Society America. 1929; 22:527-542.
17. Panwar VPS, Sarup P. Differential development of *Chilo partellus* (Swinhoe) in various maize varieties. Journal of Entomological Research. 1980; 4(1):28-33.
18. Pats P, Barbara Ekbom B. Distribution of *Chilo partellus* (Lepidoptera: Pyralidae) egg batches on maize. Journal of Insect Behavior. 1994; 7(1):29-41.
19. Rahman KA. Biology and control of maize and jowar borer (*Chilo zonellus* Swinhoe). Indian Journal of Agricultural Sciences, 1944; 14:303-307.
20. Rebe M, Van Den Berg J, Donaldson G. The status of leaf feeding resistance and oviposition preference of *Busseola fusca* (Fuller) (Lepidoptera: Noctuidae) and *Chilo partellus* (Swinhoe) (Lepidoptera: Crambidae) for sweet sorghum (*Sorghum bicolor*) landraces. International Journal of Pest Management, 2004; 50(1):49-53.
21. Renwick JAA, Chew FS. Oviposition behaviour in Lepidoptera. Annual Review of Entomology, 1994; 39:377-400.
22. Schoonhoven LM, Van Loon JJA, Dicke M. Insect-plant biology (2nd ed). Oxford University Press, USA, 2005.
23. Sharma VK, Chatterji SM. Survival and developmental behaviour of *Chilo zonellus* (Swinhoe) in some selected germplasms of maize under laboratory conditions Indian Journal of Entomology., 1971; 33(4):384-395.
24. Siddiqui KH, Sarup P, Panwar VPS, Marwaha KK. Evaluation of base ingredients to formulate artificial diets

for the mass rearing of *Chilo partellus* (Swinhoe). Journal of Entomological Research, 1977; 1(2):117-131.
25. Singh BU, Rana BS, Reddy BB, Rao NGP. Host plant resistance to stalk borer, *Chilo partellus* (Swinhoe) in sorghum. Insect Science and its Application, 1983; 4:407-413.
26. Singh G, Sandhu GS, Oviposition behaviour of maize borer, *Chilo partellus* (Swinhoe), in the field. Indian Journal of Entomology, 1978; 40:191-196.
27. Singh SP. Studies on the development, oviposition and appearance of different broods of maize borer, *Chilo partellus* (Swinhoe) (Lepidoptera: Crambidae) with a view to timing the insecticidal application. M.Sc. (Ag.) Thesis, Punjab Agricultural University, Ludhiana, Punjab, 1963.
28. Tamiru A, Bruce TJA, Richter A, Woodcock CM, Midega CAO, Degenhardt J *et al*., A maize landrace that emits defense volatiles in response to herbivore eggs possesses a strongly inducible terpene synthase gene. Ecology and Evolution, 2017; 7(8):2835-2845.
29. Van den Berg J, Oviposition preference and larval survival of *Chilo partellus* (Lepidoptera: Pyralidae) on Napier grass (*Pennisetum purpureum*) trap crops. International Journal of Pest Management, 2006; 52:39-44.
30. Zalucki MP, Clarke AR, Malcolm SB. Ecology and behavior of first instar larval Lepidoptera. Annual Review of Entomology, 2002; 47:361-393.