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Response of different maize accessions to pink stem borer *Sesamia inferens* Walker (Lepidoptera: Noctuidae)

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Abstract
Sesamia inferens (Walker) is the most important *Rabi* pest of maize causing serious losses in India. The objective of the study was to identify maize landraces with high levels of resistance to *S. inferens* by screening 427 maize land races sourced from different agro-ecological regions, along with CM 500 and CML 451 as resistant and susceptible checks, respectively under natural conditions during *Rabi*, 2012-13. The range of average per cent dead hearts observed in land races was 0.0 to 57.14%. The most resistant land races were IC258225, IC319533, IC321053, IC321110, IC321111, IC321119, IC326886, IC331795, IC 338827 and IC 350198 which showed no dead hearts infestation while the susceptible were IC331939, IC340368, IC369174, IC369184, IC406420, IC549985, IC549989, IC549990, IC569669 and IC547811 suffered to the extent of 46.15 to 57.14 % dead hearts. There was no dead hearts infestation on resistant check CM 500 while susceptible check CML 451 showed 50 - 100 % dead hearts. These resistant land races identified are recommended for use in the development of *S. inferens* resistant maize.
Key words: Dead hearts, land races, maize, resistance, *S. inferens*, screening

Introduction

Maize is the most important cereal crop for food and feed accounting for about 20 % of the global area under cereals (FAO, 2005). In India, maize recorded an impressive annual growth (6.4%) during the period (2007-2011), the highest among all food crops in (Kumar *et al*., 2013).More than sixty species of insects have been reported to attack maize crop during its different stages of growth (Anon. 1998). Among them *Sesamia inferens* is the principal insect pest of maize particularly during *Rabi* season in India. The larvae feed on immature cobs, silks and tassel and severe infestation result in stunted plant growth and appearance of cob and tassel at one place, causing yield losses of 25.7 % to 78.9 % (Chatterjee *et al*., 1969) which can be greatly reduced by using resistant/least susceptible genotypes. The strategy of host plant resistance for the management of insect pests is environmentally safe, economically feasible and socially acceptable (Mugo *et al*., 2002). Landraces with the best adaptation to natural and anthropological environment (Maxted *et al*., 1997) are the real sources of genetic diversity, variability for maize improvement programmes. This implies that local landrace materials could be a repository for resistance genes to the biotic and other abiotic stresses for maize enhancement that needs to be exploited (Pressoir and Berthoid, 2004). Maize germplasm with improved levels of resistance against stem borers is clearly in high demand in tropical countries (Bergvinson, 2000). It is noted that less than 10% local maize landraces have been exploited for breeding programmes indicating much of the genetic diversity remains to be effectively utilized (Prasanna, *et al*., 2005); their traits have not been fully exploited or documented (Chapman *et al*., 2003). Keeping in view of the above aspects and Hyderabad being one of the hotspots for screening for *S. inferens* in winter, the present study was taken up to identify new sources of resistance to pink stem borer from among the landraces conserved in the National Gene Bank (NGB) of India at National Bureau of Plant Genetic Resources (NBPGR).

Materials and Methods

A field trial was carried out at Winter Nursery Centre, Indian Institute of Maize Research, Hyderabad during *Rabi*, 2012-13 season to screen 427 maize land races sourced from NBPGR gene bank, along with resistant check CM 500 and susceptible check CML 451 against *S. inferens* under natural conditions. The experiment was laid out in augmented design by repeating resistant and susceptible check randomly in each block. The size of each plot was 1 row of 2.5 m length with 75 cm × 20 cm spacing between row and plants within row respectively. Recommended agronomic practices including weeding, irrigation and fertilizer application were followed. Migration is common in *S. inferens* hence the number of larvae per plant was not used for selecting resistant genotypes. Galal *et al.* (2002) indicated that natural infestation was suitable for studying the genetic behavior of resistance to the pink stem borer. Data was recorded on total number of plants and per cent dead hearts at 30 days after

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germination. The data in per cent was transformed using angular transformation before subjected to statistical analysis to normalize the distribution. Augmented block design analysis was done by using the IASRI design resources server. http://stat.iasri.res.in/sscnarsportal/main.do. Contrast analysis was used to separate means relative to the mean of checks.

Results and Discussion

The present study resulted in identification of ten least susceptible landraces. No dead hearts infestation was observed on these landraces namely IC258225, IC319533, IC321053, IC 321110, IC321111, IC321119, IC326886, IC331795, IC338827 and IC350198 (Table 1).These are the land races obtained from geographical areas of Himachal Pradesh, Arunachal Pradesh, Kerala, Jammu & Kashmir, Chhattisgarh and Madhya Pradesh. This indicated the ability of these land races to resist the attack of *S. inferens*. The range of average per cent dead hearts observed on all landraces was 0.0 to 100.0% (Table 1). Minimum per cent dead hearts (<10%) was observed on 124 landraces. 283 land races showed per cent dead hearts ranging between 10.1 to 45%. Ten landraces IC331939, IC340368, IC369174, IC369184, IC406420, IC549985, IC549989, IC549990, IC 569669, IC547811 showed maximum susceptibility by suffering to the extent of 46.15 to 57.14 % dead hearts. Out of these, land races sourced from Mizoram IC549989 and IC549990 showed maximum per cent dead hearts (57.14). There were no dead hearts recorded on resistant check CM 500 while susceptible check CML 451 showed 50 - 100 % dead hearts. Analysis of variance revealed no significant difference (p>0.05) among treatments and the blocks (Table 2) with respect to host plant reaction to *S. inferens* infestation. Contrast analysis (Table 3) showed significant difference between controls and between controls and treatments. Identification of resistance sources to stem borers and their use in breeding programme has earlier been attempted by several workers. Varying degrees of resistance to *Chilo partellus* in land races were reported by Munyiri *et al.*, (2013) with 75 tropical maize land races in Africa through artificial infestation. Based on number of exit holes, tunnel length, ear diameter, ear length, plant height, stem diameter, stem lodging and grain yield selection index was computed. GUAT 1050 was identified as the most resistant landrace with selection index of 0.56 while BRAZ 2179 was most susceptible with an index of 1.66. More recently Khalifa *et al.*, (2013) determined resistance to the pink stem borer *Sesamia cretica* in twenty exotic maize populations with different genetic background level and found that populations Tamps 23 and Antigua have relatively good level of resistance to infestation by larvae of *S. cretica*. Similarly Santosh *et al.* (2012) evaluated 48 exotic inbred lines for resistance to *S. inferens* and found that only 8 inbred lines (16%) were resistant. Similar work has been done by Pavani *et al*., (2011) who screened twenty maize genotypes against *S. inferens* and reported that the genotype HQPM 1 was moderately resistant with a mean LIR nearer to resistant check, CM 500. Further Sekhar *et al*. (2008) 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-B*4 and CML 426 x CML 470 crosses as highly susceptible to *S. inferens* based on 1-9 scale of LIR. Shahzad *et al*., (2006) screened ten maize cultivars namely EV-5098, Sahiwal-2002, Golden (full season yellow), EV-6 098, EV-6089, Sadaf, Pak Afgoyee (full season white), EV-1098, Agaiti-2002, Agaiti-85 against *C. partellus* during spring season and observed lowest borer infestation on V-5098, EV-6098, Agaiti-2002 and EV-1098 genotypes. Burton *et al*. (1999) screened 121 exotic maize inbred lines representing seven germplasm groups and they found that only 7 inbred lines (6%) were considered resistant to *S. nonagrioidis.* In the present study least susceptible sources belonged to different maturity groups as the anthesis time varied from 56.8 days (IC258225) to 73.5 days (IC321053 and IC321111) this is in contrast to the findings of Malvar *et al*., (1993), who reported that early or extra early suffered less loss to *Sesamia nonagrioides* than late and mid season material. The significant role of the landraces/ populations from different origins of populations in differentiating more and less resistant groups was highlighted by Malvar *et al.*, (2004), who evaluated the European Union maize core collection against *Sesamia nonagrioides*, they found that southern and eastern populations from Spain showed less tunnel length and were hence were more resistant than the populations from other regions of Spain. The least susceptible accessions in the present from diverse agro-ecological regions *viz.* Himachal Pradesh, Arunachal Pradesh, Kerala, Jammu & Kashmir, Chhattisgarh and Madhya Pradesh may serve as contributors for allelic forms of the genes governing resistance to *Sesamia inferens*. Thus evaluation of germplasm, particularly well adapted and established landraces, could detect resistant populations to stem borer attack with different mechanism of resistance or/and resistance alleles, and then composite populations would enhance the resistance showed by each landrace by pyramiding

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mechanisms and/or alleles of resistance. This followed by Identification and characterization genes and its allelic forms conferring resistance and means to introduce them into improved hybrids/varieties would be the breeding goal for stem borer resistance.

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Table 1. Classification of maize land races based on reaction to *Sesamia inferens*

Category	Land races
Dead hearts < 10%	IC 258225, IC 319533, IC 321053, IC 321110, IC 321111, IC 321119, IC 326886, IC 331795, IC 338827, IC 350198, IC 320605, IC 320607, IC 320893, IC 321115, IC 321117, IC 321121,IC 321128, IC 321130, IC 321134, IC 325992, IC 326080, IC 326865, IC 326883,IC 326887, IC 326891, IC 328539, IC 328588, IC 328602, IC 328609, IC 328613,IC 328623, IC 329214, IC 329335, IC 330111, IC 330939, IC 330966, IC 331028,IC 331086, IC 331107, IC 331126, IC 331153, IC 331412, IC 332070, IC 332191,IC 332212, IC 332237, IC 332259, IC 332264, IC 332265, IC 332283, IC 332310,IC 332320, IC 332663, IC 333268, IC 333286, IC 333334, IC 333339, IC 334237,IC 334238, IC 334242, IC 335917, IC 336781, IC 336969, IC 336982, IC 336989,IC 337006, IC 337008, IC 337016, IC 337024, IC 337035, IC 337038, IC 337046,IC 337060, IC 338825, IC 338854, IC 338859, IC 338926, IC 338953,IC 338954,IC 338962, IC 340264, IC 340276, IC 340294, IC 340323, IC 340324, IC 340346,IC 342526, IC 342529, IC 342536, IC 342538, IC 344015, IC 344017, IC 344678,IC 344692, IC 344701, IC 344716, IC 344721, IC 344794, IC 347133, IC 354430,IC 362121, IC 362123, IC 362125, IC 362132, IC 363739, IC 363745, IC 363772,IC 363776, IC 363780, IC 363786, IC 363787, IC 369185, IC 369188, IC 370761,IC 381150, IC 381193, IC 383645, IC 392283, IC 392297, IC 392301, IC 395739,IC 396068, IC 396673, IC 397310, IC 397315, IC 397921, IC 406424, IC 410330,IC 410339, IC 410417, IC 410476, IC 410497, IC 552825,
Dead hearts 10.1 – 45%	IC258224, IC 258226, IC 258227, IC 258228, IC 319441, IC 319490, IC 319512, IC 321116, IC 321118, IC 321124, IC 326004, IC 326063, IC 326090, IC326863, IC 326866, IC 328546, IC 328547, IC 328552, IC 328586, IC 328587, IC328603, IC 328604, IC 328605, IC 328611, IC 328616, IC 328624, IC 328632, IC 28640, IC 330007, IC 330130, IC 330941, IC 330965, IC 330994, IC 331005, IC 31018, IC 331093, IC 331141, IC 331144, IC 331164, IC 331193, IC 331198, IC 31205, IC 331361, IC 331385, IC 331388, IC 331399, IC 331417, IC 331678, IC 31679, IC 331796, IC 331797, IC 331961, IC 332069, IC 332072, IC 332073, IC 32238, IC 332261, IC 332271, IC 332276, IC 332322, IC 332619, IC 333260, IC 33295, IC 333305, IC 333328, IC 334236, IC 334240, IC 334241, IC 334243, IC334246, IC 334350, IC 334373, IC 336396, IC 336397, IC 336398, IC 336400, IC 36402, IC 336729, IC 336730, IC 336752, IC 336823, IC 336991, IC 336994, IC 37001, IC 337004, IC 337023, IC 337025, IC 337033, IC 337042, IC 337057, IC 37068, IC 337090, IC 338807, IC 338816, IC 338823, IC 338842, IC 338851, IC 38878, IC 338940, IC 338967, IC 339677, IC 340259, IC 340265, IC 340313, IC 40337, IC 340339, IC 340342, IC 342277, IC 342281, IC 342525, IC 342528, IC342530, IC 342531, IC 342532, IC 342533, IC 342534, IC 342535, IC 344635,IC344658, IC 344661, IC 344720, IC 344729, IC 344775, IC 344788, IC 347136,IC 347137, IC 347138, IC 347883, IC 350191, IC 350242, IC 350773, IC 350779,IC 350784, IC 351616, IC 351632, IC 351660, IC 351681, IC 351685, IC 351694,IC 351703, IC 351729, IC 352966, IC 352967, IC 352975, IC 352982, IC 354446,IC 354473, IC 361709, IC 361710, IC 361716, IC 361719, IC 361724, IC 361725,IC 362116, IC 362118, IC 362119, IC 362120, IC 362127, IC 362129, IC 362130,IC 362133, IC 363751, IC 363791, IC 369177, IC 369179, IC 369187, IC 369190,IC 369195, IC 369198, IC 369200, IC 369867, IC 370762, IC 373451, IC 381113,IC 381149, IC 381164, IC 381176, IC 381189, IC 381198, IC 383121, IC 385872,IC 385878, IC 392280, IC 392303, IC 392350, IC 395724, IC 395766, IC 395774,IC 395794, IC 396000, IC 396001, IC 396002, IC 396003, IC 396069, IC 396071,IC 397329, IC 397336, IC 397389, IC 397398, IC 397446, IC 397466, IC 397499,IC 397566, IC 397569, IC 397602, IC 397609, IC 397881, IC 397943, IC 397969,IC 398057, IC 398098, IC 400594, IC 400596, IC 400597, IC 400598, IC 400599,IC 406414, IC 406417, IC 406418, IC 406419, IC 406422, IC 406423, IC 410294,IC 410303, IC 410304, IC 410329, IC 410336, IC 410343, IC 410353, IC 410364,IC 410382, IC 410395, IC 410403, IC 410414, IC 410419, IC 410420, IC 410451,IC 410540, IC 411747, IC 417089, IC 417643, IC 423246, IC 423279, IC 423322,IC 423346, IC 430586, IC 430587, IC 430635, IC 447627, IC 447631, IC 447650,IC 447651, IC 447662, IC 541064, IC 541067, IC 541068, IC 296013, IC 549986,IC 549987, IC 549988, IC 569668, IC 569670, IC 569671, IC 447147, IC 547816,IC 82864, IC 552823, IC 552824, IC 552828, IC 552829, IC 552831, IC 552832,IC 552834, IC 552835, IC 552836, IC 420901
Dead hearts > 45%	IC331939, IC 340368, IC 369174, IC 369184, IC 406420, IC 549985, IC 549989, IC 549990, IC 547811, IC 569669

Table 2. The Anova of screening maize land races under natural infestation against *Sesamia inferens*
ANOVA, Treatment Adjusted

Source	Df	SS	MS	F	Prob>F
Block	11	3317.57	301.59	1.000000	0.500000
Treatments	428	47634.85	111.29	0.369023	0.997823
Error	11	3317.57	301.59		
Total	450	53073.572692			

Table 3. Contrast analysis of screening maize land races under natural infestation against *Sesamia inferen*

Source	Df	SS	MS	F	Prob>F
Among-Controls	1	20168.262364	20168.262364	66.871418	0.000010
Among-Tests	426	18998.203154	44.596721	0.147868	0.999990
Test-vs-Control	1	8567.519082	8567.519082	28.407115	0.000241