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Susceptibility of okra to major insect pests under open field conditions

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Abstract
Okra [*Abelmoschus esculentus* (L.) Moench] is an important vegetable crop cultivated for its nutrition content and potential for economic return. A study was carried out to investigate the susceptibility of okra cultivars to insect pests under open field conditions. Insect infestation varied in cultivars (F=1516.0, $P\leq$0.01). For *Aphis gossypii* (Glover) cvs. Nirmal 101 (8.99/leaf) and Nirmal 303 (13.27/leaf) had the fewest insects. For *Amrasca biguttula biguttula* (Ishida) cvs. Nirmal 303 (0.06/leaf) and Pabhani Kranti (0.12/leaf) had among the fewest insects. For *Dysdercus koenigii* F. cv. Nirmal 303observed lowest population (1.69/plant) as compared to other cultivars. For *Nodostoma* spp., cv. Nirmal 101 had the fewest number of insects (7.24/plant). For *Mylabris pustulata* (Thunb) cv. Parbhani Kranti recorded lowest population (0.14/plant) than other cultivars. For *Alcidodes affaber* Auriv. cv. Green Challenger had the fewest insects (0.22/plant). Nirmal 303 (292.5g/plant), Crystel Seed-151 (306.3g/plant) and Green Challenger (305.0 g/plant) had among the highest yield and these cultivars had relatively few insects. Host susceptibility is probably influenced by host plant age and climatic conditions. There is potential for use of 'Nirmal-303', 'Crystel Seed-151' and 'Green Challenger', especially in areas where there is a persistent pest problem. Economic analyses must be conducted before ultimate conclusions are drawn.

Keywords: *Abelmoschus esculentus*, cultivars, varietal response, yield, eastern Himalaya

Introduction
Okra is an important vegetable crop due to its nutrition content and potential for economic return. India is the largest producer of okra in the world with a productivity ranged 15-20 t/ha. The crop is attacked by many insect pests [1-3]. The pest problem is the main limiting factor in okra production, which causes more than 40% yield loss. In integrated management use of resistant varieties forms the basis with which other methods of control can be combined [4-8]. Breeders try to develop a resistant variety against most insects. Anene [9], Ogbalu and Ekweozor [10] and Thul *et al*. [11] screened promising okra cultivars against *Podagrica* spp. Jalgaonkar *et al*. [12] reported the reaction of okra germplasm against the flea beetle and shoot and fruit borer *Earias vitella* (Fab.), *Monolepta signata* Olivier. Mahal *et al*. [13] screened okra cultivars against *Amrasca biguttula biguttula* (Ishida). The present investigation was carried out to determine suitability of promising okra cultivars challenged by the insect pests *Aphis gossypii* (Glover), *A. biguttula biguttula*, *Dysdercus koenigii* Fabr., *Nodostoma* spp., *Mylabris pustulata* (Thunb) and *Alcidodes affaber* Auriv. under field conditions.

Materials and Methods
An Experiments were conducted at the experimental farm, ICAR Research Complex for NEH Region, Mizoram Centre, Kolasib, Mizoram, India at 650 m above mean sea level at 24.12ºN latitude and 92.40ºE longitude, and has a mild-tropical agroclimate. The experimental field was tilled 3 times with a power tiller, pulverized, and prepared. Average daily temperatures in the open field during two seasons ranged between 20.8 and 32.3 °C with relative humidity ranging between 74 and 85.0%. The cvs. Crystel Seed-151, Green Challenger, Nirmal-101, Nirmal-303, Parbhani Kranti and OH-597 were sown on 15 April 2014. Plot size was 4 × 5 m with a plant spacing of 30 × 60 cm with treatments arranged in a randomized complete block design with 4 replications. Weeding, application of manure and fertilizers, irrigation and other cultural operations were followed as per crop production guidelines [14]. Furrow irrigation (approximately 500-600 L/plot) was applied every 2-3 weeks in the absence of rain.

No plant protection measures were applied throughout the crop season. Observations on incidence of insect pests were recorded weekly in the morning hours starting at initial insect appearance, and continuing to final insect disappearance, or up to final harvest. Numbers of insect/plant for *A. gossypii*, *A. biguttula biguttula*, *D. koenigii*, *Nodostoma* spp. and *M. pustulata* were determined. Numbers of plants infested with *A. affaber* were determined on tagged plants. The periodic mean incidence was determined based on populations in all cultivars. The yield data was determined in all cultivars.

Data analysis

The data was subjected to analysis of variance followed by a least squares means [15]. Data analysis was with Randomized Complete Block Design (RCBD) using SAS Statistical Software Version 9.3 [16]. Data were analyzed using two-way ANOVA for susceptibility of okra cultivars against major insect pests. All ANOVA were performed on original values and the means were analyzed with Least Squares Means and means separated using Tukey's HSD test at $P<0.05$. If interactions were significant they were used to explain the results. If interactions were not significant means were separated using Tukey's HSD test.

Results and Discussion

Reaction of okra cultivars to major insect pests

Cultivar (F=1516.0, $P\leq0.01$), insect pest (F=108.4, $P\leq0.01$) and the cultivars × insect pest interaction (F=93.6, $P\leq0.01$) affected the incidence of insect pests (Table 1). The cultivar(s) with the most or least insects varied (Table 2). When *A. gossypii* was the insect 'Green Challenger' had the most insects (58.22/leaf) and 'Nirmal 303' (13.27/leaf) and 'Nirmal 101' (8.99/leaf) had the least. When *A. biguttula biguttula* was the insect 'Crystel Seed-151' (0.39/leaf) and 'Green Challenger' (0.30/leaf) had among the most insects, 'Pabhani Kranti' (0.12/leaf) and 'Nirmal 303' (0.06/leaf) had among the least and the others were intermediate between the two extremes. When *D. koenigii* was the insect 'Pabhani Kranti' had the most insects (4.37/plant) and 'Nirmal-303' had among the least (1.69/plant). When *Nodostoma* spp. was the insect 'OH-597' had the most insects 14.89/plant), 'Nirmal 101' had the least (7.24/plant) and the other cultivars were intermediate between the two extremes. When *M. pustulata* was the insect 'Nirmal-303' had among the most insects (0.80/plant) and 'Parbhani Kranti' had among the least (0.14/plant). When *A. affaber* was the insect 'OH-597' had among the most insects (0.82/plant), 'Green Challenger' had the least (0.22/plant) and the others were intermediate between the two extremes.

The pooled data revealed that Nirmal-101 was found to be least susceptible cultivar to all insect pests (13.452 plant^{-1}) compared to other cultivars (Fig 1). Green Challenger (41.760 plant^{-1}) and Crystel Seed-151 (37.250 plant^{-1}) were found to be highly susceptible cultivars to insect pests (*A. gossypii*, *A. biguttula biguttula*, *D. koenigii*, *Nodostoma* spp., *M. pustulata* and *A. affaber*).

The degree of plant susceptibility is based on numbers of insects, with plants having higher numbers being more susceptible than those having lower numbers. The data agrees with Lertrusdachakul *et al*. [17], Suzuki *et al*. [18], Wanja *et al*. [19], Shannang *et al*. [20] and Boopathi *et al*. [2] who worked with other okra cultivars challenged with aphids indicating that the response is wide spread over cultivars. Boopathi and Pathak [3] observed that the number of aphids was highest near the end of the okra growing season. It may be that the insect is susceptible to high temperature [21], or due to an increasing hormonal level in the plant, and enhanced defense mechanisms against insects [22]. In the present investigation, 'Nirmal-303' was the least susceptible to *A. biguttula biguttula* and *D. koenigii*. These results were similar to Mahal *et al*. [13] with the other okra cultivars, 'IC 7194', 'Pb. Padmani', 'New selection' and 'IC 13999' resistant to *A. biguttula biguttula*.

Yield of okra cultivars

Cultivars Crystel Seed-151 (306.3g/plant), Green Challenger (305.0g/plant) and Nirmal-303 (292.5g/plant) produced the highest yield; 'Nirmal-101'(242.5g/plant), 'OH-597' (240.5g/plant) and 'Parbhani Kranti' (235.0g/plant) had the lowest yield (Table 3).

Table 1: Analysis of variance (ANOVA) for insect pest number

Source	Insect pest number			
	***F* value**	**SEd**	**CD (*P* = 0.01)**	**Probability**
Cultivar (C)	1516.0	0.4685	1.2290	0.000**
Insect pests (I)	108.4	0.4685	1.2290	0.000**
Interaction				
C × I	93.6	1.1475	3.0105	0.000**

** significant at $P\leq0.01$, ANOVA.

Table 2: Interaction response of cultivars and insect for numbers of insects per plant

Insect	×	Cultivar	Mean number
Aphis gossypii (no. per leaf)		Green Challenger	58.22^{a}
		OH-597	48.47^{b}
		Pabhani Kranti	36.86^{c}
		Crystel Seed-151	31.14^{d}
		Nirmal-303	13.27^{e}
		Nirmal-101	8.99^{e}
Amrasca biguttula biguttula (no. per leaf)		Crystel Seed-151	0.39^{a}
		Green Challenger	0.30^{ab}
		Nirmal-101	0.17^{bc}
		OH-597	0.17^{bc}
		Pabhani Kranti	0.12^{c}
		Nirmal-303	0.06^{c}
Dysdercus koenigii (no. per plant)		Pabhani Kranti	4.37^{a}
		OH-597	2.72^{b}
		Nirmal-101	2.35^{bc}
		Green Challenger	2.17^{bc}
		Crystel Seed-151	2.12^{bc}
		Nirmal-303	1.69^{c}
Nodostoma spp. (no. per plant)		OH-597	14.89^{a}
		Nirmal-303	12.68^{b}
		Parbhani Kranti	11.46^{bc}
		Crystel Seed-151	10.72^{c}
		Green Challenger	10.37^{c}
		Nirmal-101	7.24^{d}
Mylabris pustulata (no. per plant)		Nirmal-303	0.80^{a}
		Nirmal-101	0.53^{ab}
		Green Challenger	0.39^{bc}
		OH-597	0.35^{bc}
		Crystel Seed-151	0.21^{bc}
		Parbhani Kranti	0.14^{c}
Alcidodes affaber (no. per plant)		OH-597	0.82^{a}
		Crystel Seed-151	0.51^{b}
		Nirmal-303	0.47^{bc}
		Nirmal-101	0.33^{cd}
		Parbhani Kranti	0.33^{cd}
		Green Challenger	0.22^{d}

Data analyzed with Least Squares Means and values separated with Least Significant Difference with values in the column followed by the same letter being not significantly different, $P<0.05$.

Table 3: Yield of okra cultivars

Cultivar	Yield (g/plant)
Crystel Seed-151	306.3[a]
Green Challenger	305.0[a]
Nirmal-303	292.5[a]
Nirmal-101	242.5[b]
OH-597	240.5[b]
Parbhani Kranti	235.0[b]

Means in columns followed by the same letter are not significantly different, LSD, $P \leq 0.05$.

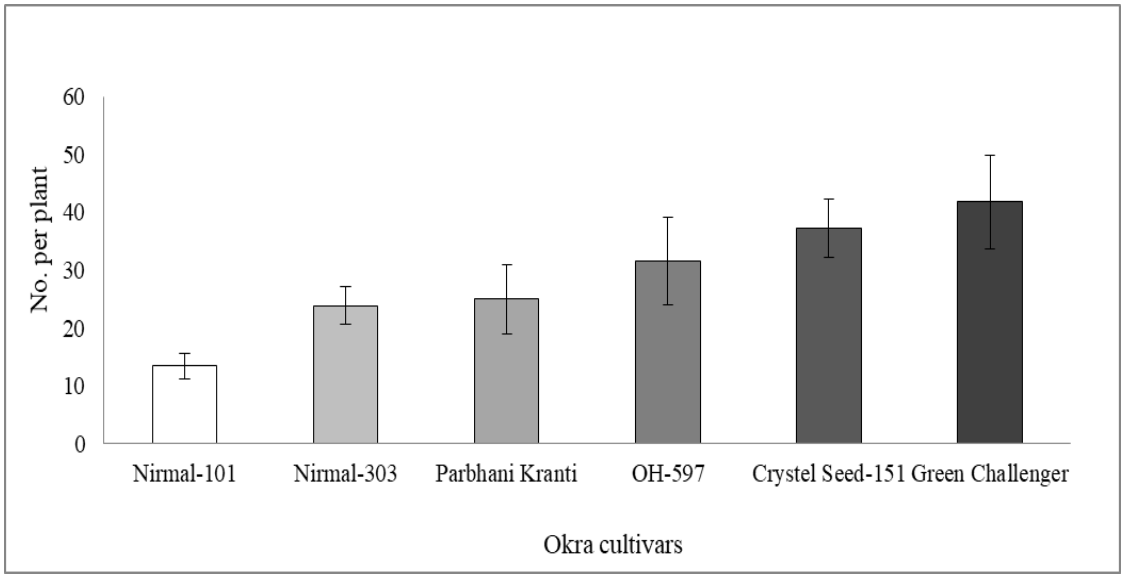

Fig 1: Reaction of different okra cultivars against major insect pests of okra

Conclusion

Cultivar, Nirmal-303 produced the highest yield and was less susceptible to insect pests *A. gossypii*, *A. biguttula biguttula*, *D. koenigii*, *Nodostoma* spp. and *A. affaber*. There is potential for use for 'Nirmal-303', especially in areas where there is a persistent pest problem. Since the susceptibility of a host plant is probably influenced by age of host plant and climatic conditions, it may be worthwhile to look for insect pests-induced growth changes in okra plants under field conditions by an infestation of plants at different growth stages and under different environmental conditions. Economic analyses must be conducted before ultimate conclusions are drawn.

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