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Response of Brinjal (*Solanum melongena* Guen.) varieties for the resistant reaction against Brinjal shoot and fruit borer (BSFB) and red spider mites (RSM)

Amit Kumar, Virender Kaul and Uma Shankar

Abstract
An experiment was conducted to evaluate the response of twenty five brinjal varieties against brinjal shoot and fruit borer (*Leucinodes orbonalis*) and red spider mite (*Tetranychus cinnabarinus*) during 2014 and 2015 at research farm of Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, Chatha. The pooled data for the both the years of the study revealed that the ten varieties were showed tolerance, the five varieties were found moderately tolerant, the eight varieties were susceptible and the two varieties found highly susceptible reaction against brinjal shoot and fruit borer. Similarly, the response of brinjal varieties against red spider mite showed that the three varieties were moderately tolerant, the four varieties had low resistance, five varieties were found susceptible and thirteen varieties of brinjal were recorded as highly susceptible. The present research findings advocate that the varieties showed promise against these dreaded pests helped the farmers to fetch more remuneration from the crops and provide security for subsistence and livelihood.

Keywords: Response, resistance, Brinjal shoot and fruit borer, *Leucinodes orbonalis*, Red spider mite, *Tetranychus cinnabarinus*

Introduction
India has progressed as one of the leading vegetable producers in the world with a total annual production of 162.18 million tonnes with 17.6 MT/ha productivity from an area of 8.99 million hectares [1]. Jammu and Kashmir State accounts for 1395.5 MT total vegetable production from 631 ha land with 22.1 MT/ha productivity [1]. Among the vegetable crops, Brinjal (*Solanum melongena* Guen.) is an important and demand driven vegetable crop grown throughout the world and cultivated in all the tropical, sub-tropical and temperate zones. It is one of the most common and popular vegetables cultivated in approximate 7.11 lakh hectare area with the annual production of 13.56 mt with productivity of 19.1 t/ha in India [2]. Insect pest and disease infestation is one of the major constraints in increasing the yield potential in brinjal [3]. However, in recent years the production of brinjal has been seriously affected due to a steady increase in insect pest infestation, especially the fruit and shoot borer (BSFB), *Leucinodes orbaonalis* Guenn. (Pyralidae: Lepidoptera) which reduce the productivity as well as quality of the fruits. BSFB is practically monophagous but other plants belonging to family Solanaceae are reported to be the hosts of this pest. Due to concealed mode of life, BSFB is the most serious pest of brinjal [4] and hard to control with the repeated application of insecticides. The yield losses caused by *Leucinodes orbonalis* have been estimated up to 70-92 percent [5, 3, 6]. Besides BSFB attack, brinjal crops are also susceptible to a large magnitude of insect pests and non insect pest such as red spider mites (*Tetranychus cinnabarinus*) which pose a heavy toll to brinjal cultivation by continuous sucking the sap, formation of web and depletion of chlorophyll contents and thereby inflicting losses ranging from 30 to 40 percent [7].

Materials and Methods
An experiment was conducted to evaluate the response of twenty five brinjal varieties against brinjal shoot and fruit borer (*Leucinodes orbonalis*) and red spider mite (*Tetranychus cinnabarinus*) during 2014 and 2015 at research farm of Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, Chatha. The experiment was laid out in a randomized block design with three replication to evaluate the response of twenty five

varieties of brinjal against fruit and shoot borer (*Leucinodes orbonalis*) and red spider mite.

Brinjal Shoot and Fruit Borer (BSFB)

In every observation, five plants was selected from different varieties (Table 1) randomly and tagged. The incidence of the larval population of BFSB was recorded from infested twigs and fruits at weekly intervals. Relative tolerance for brinjal fruit and shoot borer was determined on the basis of grade index, suggested by Mukhopadhyay and Mandal [8] classified the brinjal varieties on the basis of number of larvae per five plants and categorized four grades i.e.,

1. Tolerant (< 2.0 larvae)
2. Moderately tolerant (2.1-3.0)
3. Susceptible (3.1-5.0)
4. Highly susceptible (> 5.0 larvae)

Red Spider Mite (RSM)

Observations on Red Spider Mite (RSM) incidence were recorded at the weekly interval on different varieties (Table 1) in every observation wherein, five plants was selected randomly and tagged. The number of mites was counted on three leaves from each plant on top, middle and bottom portions of the plants. The adult population per 4 cm^2 leaf area was recorded and finally the mean population was worked out on the basis of newly developed scale as follows-.

1. Resistant (0.00)
2. Moderately Resistant (1-5.00)
3. Low Resistant (5.1-10.00)
4. Susceptible (10.1-15.00)
5. Highly Susceptible (> 15.00)

Results and Discussions

Response of brinjal varieties for the resistance reaction against BSFB during 2014 and 2015 (Pooled)

The result showed that the ten varieties RCMBL- 01, PLP-1, IBH-3, IBL-116, Rajindra brinjal, KS-356, JB-24, JBH-8, IBH-02 and CHBR-1 were showed tolerance between the score of 0-2.0 (larvae/5plants), the five varieties Arka Sree, DRNKU-03-26, JB-6, BCB-464 and JB-64 were found moderately tolerant with score of 2.1-3.0, the eight varieties JB-18, HIC-13311, Ramnagar Gaint, MDV-01, Swarn Pratibha, Brinjal Round Green, KS-331 and PBL-24 and were susceptible with score of 3.1-5.0 and the two varieties DBR-31and Keshmiri Brinjal were highly susceptible with score of 5.1- above found (Table-2).

Pooled data on screening of brinjal varieties against red mite revealed that the three varieties RCMBL-01, Ramnagar Gaint, and Swarn Pratibha were moderately tolerant with score of 0-5.00, the four varieties CHBR-1, MDV-01, Arka Sree and JB-24 were Low Resistance with score of 5.10-10.00, the five varieties, IBH-3, JB-18, Rajindra brinjal, DBR-31and BCB-464 were susceptible with score of 10.10-15.00 and thirteen varieties PLP-1, KS-331, HIC-13311, IBL-116, PBL-24, Brinjal Round Green, JBH-8 DRNKU-03-26, IBH -02, KS-356, JB-06, JB-64 and Kahmiri Brinjal were highly susceptible with score of 15.10 - above were found (Table-3).

Our findings were also supported by the work done on similar lines and reported by Dash and Singh, Panda, Soans *at el.* [9, 10, 11] and Parker *et al*. [12] showed that comparative susceptibility of 12 aubergine cultivars to *L. orbonalis* and observed the lowest percentage of shoot infestation in Pusa Purple Long (4.0%), while, the highest infestation on shoots (11.11%) was recorded in HYK. Further, Mandal *et al*. [13] screened 31 brinjal cultivars for resistance to *L. orbonalis* and observed that none of the cultivars was resistant. Only three cultivars *i.e.* BBS 103, BB-112 and Pusa Purple Cluster were moderately resistant. Parker *et al*. [12] also found resistant or moderately resistant cultivars against red spider mite were found such as EG058, Pusa Purple Long, Pusa Purple Cluster, Pusa Purple Round, H- 128, H-129, Aushey, Thorn Pendy, Black Pendy, H- 165, H-407, Dorley, PPC-17-4, PVR-195, Shyamla Dhepa, Banaras Long Purple, Arka Kesav, Arka Kusmakar, Punjab Barsati, Punjab Chamkila, Kalyanpur-2 and Gote-2 have been tolerant or resistant.

Our results on the screening of 25 brinjal varieties against BSFB and red spider mite coincide with the studies reported earlier by Amin *et al*., Khan and Singh, Rameash *et al*., Habib *et al.* [14, 15, 16, 17]. They found that fruit infestation by *L. orbonalis* was significantly lower (35 infested fruits/100) for Shamli and higher (53 infested fruits/100 fruits) for Black Beauty. BSFB produced significantly higher number of holes (7.7 holes/fruit/week) on Black Beauty and lower number (2.6 holes/fruit/week) on Shamli. Whereas, Kumar *et al*. [18] screened twenty one brinjal varieties against spider mite wherein, the three varieties namely Pechiparai, Pusa-5, Pusa Purple Cluster were categorized as low in resistance. The other entries *viz*., Palur–2, Arka Kusumakar, Elavambady, MBH-114, Round Beauty Black, Pusa–6, Pusa Kranti and Pusa Anmol were recorded under the category susceptible. Rest of the varieties was found under the highly susceptible categories.

Table 1: List of screened brinjal varieties against BSFB and Red Spider Mite

S. No.	Varieties	S. No.	Varieties
1	JB-18	14	Brinjal round green
2	RCMBL-01	15	JBH-8
3	PLP-1	16	Ramnagar Gaint
4	IBH-3	17	Rajindra brinjal
5	KS-331	18	KS-356
6	MDV-01	19	JB-24
7	CHBR-1	20	Swarn Pratibha
8	DBR-31	21	DRNKU-03-26
9	HIC-13311	22	IBH-02
10	IBL-116	23	BCB-464
11	PBL-24	24	JB-6
12	Arka Sree	25	Kashmiri Brinjal (Control)
13	JB-64		

Table 2: Pooled data on larval Population of brinjal shoot & fruit borer (BSFB) on brinjal varieties per 5 plants

Brinjal varieties	Vegetative Stage								Fruiting Stage														
	Standard Weeks																						
	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	Over all Mean	Response
JB-18	0.03	0.57	1.00	1.53	1.73	2.10	2.57	3.13	3.70	4.99	5.77	3.00	2.79	3.36	7.37	8.43	8.80	8.39	6.73	5.35	4.43	4.08	Susceptible
RCMBL-01	0.00	0.28	0.43	0.80	1.10	1.06	1.00	1.43	1.56	1.73	1.76	0.89	0.90	1.30	1.66	1.77	1.40	0.99	0.73	0.66	0.40	1.04	Tolerant
PLP-1	0.00	0.09	0.29	0.63	0.93	0.99	1.26	1.30	1.39	2.16	2.60	1.47	1.52	2.09	2.53	2.60	2.79	1.76	1.06	0.73	0.50	1.37	Tolerant
IBH-3	0.00	0.13	0.56	1.16	1.67	1.83	2.07	2.49	2.73	2.89	2.36	1.29	1.83	2.19	2.29	2.46	2.23	1.33	0.79	0.43	0.365	1.58	Tolerant
KS-331	0.00	0.77	0.39	1.13	1.83	2.26	2.86	3.99	7.69	10.33	7.39	3.33	1.89	2.56	3.53	6.33	5.39	4.07	2.96	1.86	1.29	3.42	Susceptible
MDV-01	0.03	0.46	1.19	1.56	1.96	2.19	3.06	3.89	5.66	7.60	8.36	4.29	2.33	3.26	4.79	5.89	4.13	3.36	2.66	2.03	1.29	3.34	Susceptible
CHBR-1	0.00	0.13	0.57	0.53	0.73	1.33	1.73	2.09	2.29	2.63	3.06	2.16	1.86	2.46	2.83	3.23	2.89	2.56	1.93	1.43	0.76	1.77	Tolerant
DBR-31	0.06	0.46	1.10	1.86	2.20	2.86	3.33	6.93	7.60	9.29	8.53	6.03	4.96	7.99	12.33	9.4	8.99	8.09	7.03	4.13	2.93	5.53	Highly Susceptible
HIC-13311	0.03	0.36	0.56	1.10	1.49	1.70	3.36	4.96	7.73	11.19	11.96	5.16	3.06	2.23	4.63	7.00	4.29	2.86	2.03	1.13	0.70	3.69	Susceptible
IBL-116	0.00	0.20	0.53	0.86	1.26	1.63	2.23	2.36	2.60	2.76	2.89	1.59	1.76	1.86	2.09	2.43	2.09	1.26	0.90	0.53	0.43	1.54	Tolerant
PBL-24	0.06	0.46	0.89	1.36	2.13	2.99	3.31	4.29	5.13	8.73	9.56	3.16	2.46	4.06	6.20	10.06	12.20	6.80	5.80	4.83	3.79	4.68	Susceptible
Arka Sree	0.00	0.19	0.46	0.93	1.60	2.19	2.89	3.03	3.46	4.03	4.56	2.19	1.83	2.19	4.06	4.46	4.89	3.86	3.40	1.89	1.16	2.54	Moderately Tolerant
Brinjal round green	0.03	0.53	1.03	1.49	1.89	2.26	3.69	4.50	6.83	7.83	8.93	7.86	3.69	4.29	4.40	4.33	2.86	1.96	1.43	1.30	0.70	3.42	Susceptible
JBH-8	0.00	0.43	0.79	1.16	1.33	1.73	1.86	2.13	1.71	2.36	2.63	1.26	1.53	1.93	2.09	2.19	2.63	1.61	1.40	0.96	0.66	1.54	Tolerant
Rampur Gaint	0.00	0.09	0.23	0.36	1.40	2.53	3.60	7.06	8.49	9.76	11.63	6.26	5.09	2.33	1.43	1.60	1.96	1.23	1.03	0.59	0.29	3.19	Susceptible
Rajindra brinjal	0.00	0.09	0.26	0.63	0.76	1.23	1.30	2.96	4.03	4.36	5.26	3.39	3.16	1.49	1.63	1.76	1.60	1.26	1.06	0.53	0.33	1.77	Tolerant
KS-356	0.00	0.09	0.39	0.89	0.93	1.19	1.26	1.29	1.16	1.03	1.63	1.70	1.76	1.66	1.76	1.89	1.46	1.29	1.09	0.63	0.39	1.12	Tolerant
JB-24	0.00	0.09	0.29	0.29	0.33	0.89	1.26	1.63	1.66	1.86	1.96	1.16	1.06	1.20	1.83	1.76	1.59	1.10	0.93	0.79	0.36	1.05	Tolerant
Swarn Pratibha	0.00	0.03	0.27	1.26	1.98	3.83	4.90	6.09	7.07	10.51	9.09	7.97	4.24	2.02	2.28	2.07	1.45	0.71	1.86	2.15	1.87	3.41	Susceptible
DRNKU-03-26	0.03	0.30	0.66	1.30	2.30	2.49	3.06	3.40	3.93	4.76	3.50	3.39	3.03	3.66	3.79	4.38	3.26	2.39	1.93	1.10	0.66	2.54	Moderately Tolerant
IBH-02	0.00	0.23	0.50	0.73	0.93	1.16	1.26	1.36	1.59	1.79	1.89	0.96	1.10	1.39	1.56	1.63	1.83	1.23	1.06	0.70	0.43	1.11	Tolerant
BCB-464	0.00	0.16	0.33	0.73	0.90	0.90	2.06	2.39	4.29	5.36	6.16	3.86	1.49	1.80	2.70	2.83	2.46	2.19	1.49	0.90	0.66	2.08	Moderately Tolerant
JB-6	0.06	0.43	0.70	1.03	1.41	1.99	2.56	4.33	4.66	9.16	10.59	3.19	2.33	1.795	2.26	2.83	2.93	2.49	2.00	1.63	0.93	2.83	Moderately Tolerant
JB-64	0.03	0.23	0.50	0.89	1.43	2.16	2.73	3.43	4.36	4.53	4.86	1.86	1.96	3.03	3.26	3.56	3.83	1.98	1.49	1.13	1.00	2.23	Moderately Tolerant
Kashmiri Brinjal (Control)	0.59	1.26	1.60	2.23	3.06	3.73	4.53	5.40	7.50	8.40	11.63	11.30	12.18	10.99	12.83	14.79	16.83	10.49	6.96	5.93	4.83	7.48	Highly Susceptible

Table 3: Pooled data on population of red mite (adult) on brinjal varieties (4 cm^2 per leaf area)

Brinjal varieties	Vegetative Stage								Fruiting Stage														
	Standard Weeks																						
	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	Over all Mean	Response
JB-18	0.00	0.09	1.135	1.425	2.66	4.98	3.56	5.77	5.23	18.64	25.16	19.18	20.12	27.02	34.33	28.71	21.98	26.50	16.62	11.4	7.00	13.40	Susceptible
RCMBL-01	0.00	0.01	0.11	0.79	1.23	2.50	3.95	2.98	2.89	3.95	2.33	5.55	3.56	4.83	7.59	9.86	4.26	5.60	3.32	3.78	2.39	3.40	Moderately Resistance
PLP-1	0.05	1.98	3.36	3.85	5.59	5.78	6.18	9.73	11.94	21.51	25.95	13.01	16.75	33.13	40.71	42.69	27.35	24.95	19.30	15.55	12.40	16.27	Highly Susceptible
IBH-3	0.02	1.25	1.37	3.48	4.09	6.69	8.34	9.87	11.86	18.46	22.83	29.3	19.46	29.99	31.94	30.22	19.52	18.61	24.13	14.19	5.47	14.81	Susceptible
KS-331	0.06	0.62	2.44	6.23	7.42	9.24	12.04	17.15	20.29	27.67	24.55	23.09	28.88	26.7	44.15	37.08	18.80	15.5	26.63	23.97	8.24	18.13	Highly Susceptible
MDV-01	0.03	0.5	2.15	3.20	4.23	5.23	5.36	6.67	8.41	9.21	11.68	9.86	8.89	18.05	22.45	20.01	12.26	11.98	13.01	13.19	5.30	9.13	Low Resistance
CHBR-1	0.00	0.00	0.36	2.07	3.03	3.33	4.37	6.03	5.73	5.66	5.10	4.56	8.35	14.50	13.02	9.31	6.85	8.85	5.21	6.71	1.72	5.46	Low Resistance
DBR-31	0.19	0.59	2.56	5.03	4.48	4.32	5.56	7.95	8.51	13.61	15.48	15.35	9.66	15.07	24.70	25.85	19.89	13.21	16.01	10.98	5.07	10.67	Susceptible
HIC-13311	0.40	1.55	3.47	4.50	8.06	9.52	12.41	17.78	20.52	30.24	33.96	23.29	33.1	42.43	52.32	45.11	26.05	29.08	26.66	20.97	7.57	21.38	Highly Susceptible
IBL-116	0.23	2.58	3.92	4.52	6.31	7.115	10.43	13.74	16.49	28.41	37.76	27.43	28.56	48.91	49.65	43.17	32.64	32.37	18.77	12.81	11.27	20.81	Highly Susceptible
PBL-24	0.38	1.40	2.47	5.65	6.44	5.86	5.03	12.21	10.97	24.22	31.18	24.64	21.16	29.80	39.25	38.05	33.33	19.1	16.77	13.31	6.22	16.54	Highly Susceptible
Arka Sree	0.00	0.22	1.75	3.14	3.57	4.40	4.93	5.78	7.73	8.29	7.65	7.23	7.76	14.45	14.84	12.24	8.78	11.72	8.41	9.74	4.26	6.99	Low Resistance
Brinjal round green	0.24	2.61	3.67	5.23	9.08	9.59	9.98	13.65	16.83	29.36	29.25	22.04	25.94	38.94	35.78	36.21	27.90	27.36	18.58	12.49	11.73	18.40	Highly Susceptible
JBH-8	0.26	1.27	1.69	2.91	4.25	6.66	6.75	8.33	12.90	26.79	35.71	26.02	35.78	38.91	42.23	37.68	31.45	24.58	18.58	10.74	6.95	18.11	Highly Susceptible
Rampur Gaint	0.02	0.26	0.59	1.46	2.09	3.12	3.57	4.62	4.93	5.36	5.26	4.78	9.09	10.69	12.91	8.63	6.70	9.13	4.54	5.33	1.58	4.98	Moderately Resistance
Rajindra brinjal	0.19	2.07	3.41	3.41	33.02	3.87	6.31	7.25	10.05	18.34	23.79	11.27	14.72	27.50	33.23	29.90	22.94	25.91	14.65	11.56	9.89	14.92	Susceptible
KS-356	0.31	0.97	3.16	5.24	7.44	9.68	13.23	18.19	18.56	24.93	24.85	22.07	26.78	24.03	38.93	29.79	17.23	13.53	22.42	19.30	7.03	16.55	Highly Susceptible
JB-24	0.45	1.65	2.61	2.89	4.06	5.01	5.26	8.29	10.49	12.09	12.78	8.99	13.27	19.77	22.29	13.98	9.36	15.66	11.31	6.78	2.75	9.03	Low Resistance
Swarn Pratibha	0.00	0.25	0.95	1.20	1.74	2.30	3.99	2.88	3.18	3.51	2.39	5.65	4.28	3.73	6.00	7.61	3.73	3.58	1.91	1.37	0.77	2.90	Moderately Resistance
DRNKU-03-26	0.63	2.29	3.51	4.98	7.45	7.76	7.47	13.63	15.35	30.80	35.54	14.49	26.08	46.48	48.65	47.96	41.04	43.07	28.22	17.26	12.69	21.68	Highly Susceptible
IBH-02	0.49	1.43	2.64	4.28	8.03	10.92	12.52	15.12	20.92	34.40	39.41	32.63	39.29	42.00	53.18	41.99	28.05	26.46	29.67	25.76	7.66	22.70	Highly Susceptible
BCB-464	0.17	0.42	2.03	3.65	4.72	4.05	5.81	10.17	9.26	13.71	14.73	16.92	9.79	15.56	22.62	26.36	22.87	14.76	13.28	10.91	5.37	10.82	Susceptible
JB-6	0.43	1.035	3.68	5.37	8.03	10.78	14.62	14.67	20.14	31.01	36.48	38.57	40.51	41.82	38.51	45.07	22.04	27.68	27.80	12.79	7.28	21.35	Highly Susceptible
JB-64	0.20	1.27	2.90	3.91	5.00	5.24	6.39	8.56	12.53	17.08	22.85	15.44	16.65	29.37	36.45	34.6	31.03	28.07	19.48	10.93	9.37	15.11	Highly Susceptible
Kashmiri Brinjal (Control)	0.65	0.72	2.63	3.87	6.68	8.58	11.29	11.82	18.2	23.67	24.43	28.24	42.78	50.87	46.90	34.49	25.08	21.33	27.74	15.80	6.60	19.63	Highly Susceptible

Conclusion

Out of 25, some ten varieties of brinjal like RCMBL- 01, PLP-1, IBH-3, IBL-116, Rajindra brinjal, KS-356, JB-24, JBH-8, IBH-02 and CHBR-1 were found tolerant in response against BSFB infestation and showed promise to be incorporated in Bio-intensive Integarted Pest Management (BIPM) programme. Use of tolerant varieties like Pusa Purple Cluster, Pant Samarat and Pusa Purple Round is also an ecologically sound alternative for management of BSFB [19]. Although, none of the brinjal varieties performed the resistance response against red spider mites, but some of the varieties like RCMBL-01, Rampur Gaint and Swarn Pratibha showed promise as moderately resistance in the field condition. The varieties showed the tolerant and moderately resistance response could be exploited for the areas which are prone to BSFB and mites infestation. The usefulness of host plant resistant to pest control strategy and breeding of BFSB-resistant brinjal cultivars need to be pursued with more focused research in future.

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