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Screening of soybean genotypes/varieties for resistance and/or tolerance against major insect-pests (*kharif* 2016 and *kharif* 2017)

Aftarika Azmi and Amar Nath Sharma

Abstract
Screening studies in *kharif*-2016 and *kharif*-2017 of 51 and 50 genotypes/varieties, respectively was analyzed. During kharif-2016, based on stem tunnelling due to stem fly infestation was below ETL (≤ 26%) in EC 100027 (15.63%), EC 241309 (13.02%), EC 242072 (23.21%), EC 309509 (17.01%), EC 309537 (24.39%), EC 309538 (13.26%) and EC 34057 (24.31%) but less genotypes found *Spodoptera litura* larvae per meter. Compared to other line, some genotypes i.e., EC 14476 (1462 kg/ha) and EC 383165 (1422 kg/ha) gave reasonably good yield despite showing high infestation of major insects and maturity duration have less than 95 days. Hence, these lines could be considered as tolerant lines. During *kharif* – 2017, because of unfavorable weather conditions the yield levels in all the genotypes were very less, which did not reflect yield potential. Based on above criteria we have found girdle beetle infestation, genotypes SPC 174, EC-333860, VP-1143, VP-1147, EC-390981, EC 114573, DSB 1, NRC 78, SQL 89 and EC 1619 exhibited no plant damage despite showing infestation symptoms of girdle beetle. Stem tunnelling due to stem fly infestation was below ETL (≤ 26%) in TGX 849-D-13-4 (25.69%) and VP-1147 (19.89%). Genotypes EC 18594 (1218 kg/ha) and JS 20-37 (1416 kg/ha) gave reasonable good yield despite showing low infestation of major insects and maturity duration have less than 95 days.

Keywords: Different soybean genotypes/varieties, girdle beetle, stem fly and defoliators

Introduction
Soybean [*Glycine max* (L.) Merrill, Leguminosae] is a major oil-seed legume crop also known as Golden Bean. The productivity potential of soybean is higher than other legumes. It is also a richest and cheapest source of quality protein which can also be used for alleviating protein calorie malnutrition. It contains around 40% protein with all the essential amino acids and 18-20% oil besides minerals and vitamins. Soybean crop world production during 2015-16, 323.7 million metric ton, it contributes more than 90 per cent of the world's acreage. In India during the year 2015-16, soybean cultivation reached to 116.28 lakh ha with production of 90 lakh tones and productivity of 781 kg / ha. Soybean is the main rainy season crop of Madhya Pradesh which occupied an area of 59.06 lakh ha with production of 44 lakh tones and productivity of 784 kg / ha (www.sopa.org)

In soybean crop approx 380 species of insects have been reported from different parts of the world [11]. When soybean introduced in India only about a dozen minor insect pests were recorded, while in 1997 this number increased to an alarming figure 270, besides 1 mite, 2 millipedes, 10 vertebrates and 1 snail [5]. In Madhya Pradesh about 130 insect pests have been reported causing damage to various parts of soybean crop (www.sopa.org).

The Girdle beetle (*Obereopsis brevis*), stem fly (*Melanagromyza sojae*), semilooper *(Chrysodeixis acuta, Gesonia gemma and Diachrysia orichalcea)* and Tobacco caterpillar (*Spodoptera litura*) were found infesting soybean genotypes under field condition during the crop season (*kharif* 2016 and *kharif* 2017). Integrated pest management comprises of biological, cultural and bio-rational approaches as major components. Among these, use of resistant/ tolerant varieties is the most promising means of insect pests management and also beneficial to protect the environment from toxic chemical residues.

The aim of the study is screening of soybean genotypes/varieties for resistance and/or tolerance against major insect-pests (*kharif* 2016 and *kharif* 2017)

Materials and Methods

Details of experiment *Kharif* 2016 and 2017

1. No. of genotypes: 51(50 genotypes/variety, 1 susceptible check)
2. Plot size: 1 row of 5 m length
3. Spacing (R x R): 45 cm

Table 1: Treatment details- *Kharif* 2016-2017 (genotypes/variety of soybean)

Kharif – 2016				Kharif – 2017			
S. No.	**Genotypes/Variety**	**S. No.**	**Genotypes/Variety**	**S. No.**	**Genotypes/Variety**	**S. No.**	**Genotypes/Variety**
1	AGS 166	26	EC 291448	1	P501	26	EC 241 768
2	AGS 2	27	EC 308287	2	PR 15-126-3-8	27	EC 241 771
3	AGS 95	28	EC 309509	3	PR 35	28	EC 241 777
4	B 254	29	EC 309537	4	SPC 174	29	EC 241 778
5	BR 4	30	EC 309538	5	TGX 849-D-13-4	30	EC 241 778
6	BS 2	31	EC 30968	6	TGX 854-42D	31	EC 241 807
7	EC 100027	32	EC 313976	7	TGX 855-32E	32	EC 242104
8	EC 103332	33	EC325103	8	TK 5	33	EC 245986
9	EC 103336	34	EC 325111	9	V 1	34	EC 250583
10	EC 107407	35	EC 333875	10	EC-333860	35	EC 250591
11	EC 107416	36	EC 333879	11	EC-358002	36	EC 251886
12	EC 14458	37	EC 34057	12	EC-377883	37	EC 309518
13	EC 14476	38	EC 383165	13	PPI-72-2-5-6	38	DSB 1
14	EC 175317	39	EC39177	14	VP-1143	39	JS 20-37
15	EC 241309	40	EC 457286	15	VP-1147	40	JS 20-42
16	EC241656	41	EC 467282(A)	16	VP-1162	41	KB 17
17	EC 241696	42	EC 615160	17	VP-1164	42	MAUS 176
18	EC 242072	43	EC 7048	18	EC-390981	43	NRC 67
19	EC 242086	44	M 204	19	DB 1588	44	NRC 71
20	EC 245988	45	MACS 58	20	DN290	45	NRC 78
21	EC 251396	46	PI 210178	21	EC 109540	46	NRC 84
22	EC 251431	47	PI 259539	22	EC 114573	47	PS 1347
23	EC 280149	48	EC 457387	23	EC 18594	48	SQL 89
24	EC 287454	49	EC 2581	24	EC 241 650	49	VP 1165
25	EC 291398	50	EC 251358	25	EC 241 756	50	EC 1619
		51	JS 335(Check)*				

*Variety JS 335 (as susceptible check)

Method of observation

- **Defoliators:** Number of larvae (Spp. wise) per meter were observed at three places and mean was reported in numbers per meter. Dominant defoliators were reported separately.
- Larval population of soybean insect pests were recorded at weekly interval and continued till maturity from 3 randomly selected spot of 1-meter row length/plot by beat and seat method.
- **Stem fly:** Stem tunnelling was recorded in 5 plants at physiological maturity. Express stem tunnelling in per cent.
- **Girdle beetle:** Marked 1-meter area at **3** places of soybean experimental field and recorded number of total plants and girdled plants infestation. Labeled all the infested plants with date, in earmarked area and record number of plants showing typical 'cut-off' symptoms. Calculated percent damage out of total plants per meter (in earmarked area).
- Grain yield from each plot were recorded.

Results

2. Screening of soybean genotypes/varieties for resistance and/or tolerance against major insect-pests (*kharif* 2016)

Fifty-one genotypes along with susceptible check (JS 335) were tested for resistance/tolerance against insect pests as per the methodologies explained in "Material and Methods".

2.1 Larval population of insect pests on different soybean genotypes/variety

Girdle beetle (*Obereopsis brevis*), stem fly (*Melanagromyza sojae*), semilooper *(Chrysodeixis acuta, Gesonia gemma and Diachrysia orichalcea)* and Tobacco caterpillar (*Spodoptera litura*) were found infesting soybean genotypes under field condition during the crop season (*kharif* 2016). Among the 50 genotypes, 7 genotypes had not germinated.

2.2 *Obereopsis brevis* (Infestation percentage)

Mean infestation percentage of *Obereopsis brevis* varied significantly among the genotypes (Table 2).

Genotype EC 241309(35.94%) took more infestation whereas the genotype EC 175317 (2.94%) took less infestation percentage. Genotypes JS 335 (susceptible check) had 11.50 infestation percent. The genotypes were grouped in to three categories as less infestation (<10%), medium infestation (10 – 20%) and more infestation (>20%).

Among the genotypes, 8 genotypes had less infestation percentage *Viz.* PI 259539 (3.70%), EC 333879 (4.76%), PI 210178 (4.26%), AGS 95 (5.71%), B 254 (8.33%), EC 14476 (8.64%), EC 467282(A) (9.09%) and EC 107416 (9.30%), 12 had medium infestation percentage and 20 had more infestation percentage.

2.3 *Obereopsis brevis* (Damage percentage)

Mean damage percentage of *Obereopsis brevis* varied significantly among the genotypes (Table 2).

Genotype EC 175317 (2.94%) found minimum damage percentage whereas the genotype MACS 58 (19.23%) found maximum damage percentage. Genotypes JS 335 (susceptible check) had 5.45 damage percent. All genotypes were grouped in to three categories as minimum damage percent (<5%), medium damage percent (5 – 10%) and maximum damage percent (>10%).

Among the 50 genotypes, 7 genotypes AGS 95, B 254, EC 325111, EC 333879, EC 467282(A), PI 210178 and EC 251358 had not found damage. 7 had minimum damage percentage. 11 had medium damage percentage. 18 had maximum damage percentage.

2.4 *Melanagromyza sojae* (Stem tunneling percentage)

Stem tunneling percentage due to stem fly maggot (*Melanagromyza sojae*) varied significantly among the genotypes (Table 2).

Genotype B 254 (74.17%) noticed maximum stem tunneling whereas the genotype EC 241309 (3.02%) noticed minimum percent of stem tunneling. Genotypes JS 335 (susceptible check) had found 27.62 percent of stem tunneling. All genotypes were grouped in to three categories as minimum stem tunneling percent (<25%), medium stem tunneling percent (25 – 35%) and maximum stem tunneling percent (>35%).

Among the 50 genotypes, 8 genotypes exhibited minimum stem tunneling EC 309538 (13.29%), EC 242072 (14.75%), EC 100027 (15.63%), EC 309509 (17.01%), EC 241696 (23.21%), EC 291448 (23.53%), EC 34057 (24.31%) and EC 309537 (24.39%). 14 had medium stem tunneling percentage. 21 had maximum stem tunneling percentage.

4.2.1.5 Semilooper Complex (*Chrysodeixis acuta, Gesonia gemma and Diachrysia orichalcea*)

Semilooper complex (*Chrysodeixis acuta, Gesonia gemma and Diachrysia orichalcea*) varied significantly among the genotypes (Table 2).

Overall mean larval population of semilooper recorded at 51 different genotypes of the soybean crop indicated that larval population varied from 4.00 l/m (B 254) to 36.00 l/m (EC 291398 and EC 308287). Genotypes JS 335 (susceptible check) had found 28.00 larvae per meter. Genotypes were grouped in to three categories as minimum population (<10 larvae per meter), medium population (10-20 larvae per meter) and maximum population (>20 larvae per meter).

Among the 50 genotypes, minimum larval population was recorded in 5 genotypes B 254 (4.00 per mrl), AGS 166 (6.00 per mrl), EC 615160 (6.00 per mrl), EC 251358 (9.00 per mrl) and EC 333879 (9.00 per mrl). Medium larval population was recorded in 24 genotypes. Maximum larval population was recorded in 21 genotypes.

2.6 Tobacco caterpillar (*Spodoptera litura*)

Population of *Spodoptera litura* larvae varied significantly among the genotypes (Table 2). Mean larval population of *Spodoptera litura* recorded at 51 different soybean genotypes crop indicated that larval population varied from 1.00 l/m (EC 14476, EC 251396, EC 309509, EC 309537, EC 30968, EC 34057, EC 615160 and PI 259539) to 5.00 l/m (AGS 2 and EC 291448,). Genotypes JS 335 (susceptible check) had found 2.00 larvae per meter. In 23 genotypes noticed 0.00 l/m. Rest of the 10 genotypes in between 2.00 per mrl to 4.00per mrl.

2.7 Days to flowering

Flowering is the indicator of end of vegetative phase of the plant. The days to flowering varied significantly among the genotypes (Table 2).

The genotype AGS 166 and EC 615160 noticed early flowering (30 days) while the genotype EC 251396 and EC 308287 noticed late flowering days (46.00 days). Genotypes JS 335 (susceptible check) had noticed 47.00 days. Based on the days to flowering, the genotypes were grouped into three categories as early (< 35.00 days), medium (35.00-40.00 days) and late (>40.00 days).

Among the genotypes, 3 had early *Viz*. EC 107416 (31 days), AGS 2 (34 days) and EC 457286 (34 days). and 14 had late *Viz*. EC 291448 (41 days), EC 14476 (41 days), EC 280149 (41 days), EC 103336 (42 days), EC 242072 (42 days), MACS 58 (42 days), EC 291398 (43 days), EC 309509 (43 days), EC 309537 (43 days), EC 325111 (43 days), EC 107407 (45 days), EC 245988 (45 days), EC 291448 (45 days) and EC39177 (45 days) while rest of the 27 genotypes had medium flowering times.

2.8 Days to maturity

The days to maturity varied significantly among the genotypes (Table 2). The genotype (EC 308287) took more days for maturity (105.00 days) while the genotype (AGS 166) took less days for maturity (84 days). Genotypes JS 335 (susceptible check) had noticed 100.00 days. Based on the days to maturity, the genotypes were grouped into three categories as early (< 90.00 days), medium (90.00-100.00 days) and late (>100.00 days).

Among the genotypes, 8 had early *Viz*. AGS 2 (85.00 days), EC 615160 (85.00 days), EC 457387 (85.00 days), EC 251358 (85.00 days), EC 467282(A) (86.00 days), EC 100027 (88.00 days), EC 313976 (88.00 days), and EC 325103 (89.00 days). and 10 had late *Viz*. EC 245988 (100.00 days), EC 251396 (101.00 days), EC 175317 (102.00 days), AGS 95 (103.00 days), BR 4 (103.00 days), EC 14458 (103.00 days), EC 309538 (103.00 days), EC39177 (104.00 days), EC 457286 (104.00 days), MACS 58 (104.00 days), and rest of the 26 genotypes had medium maturity times.

2.9 Yield (kg/ha)

The seed yield varied significantly among different soybean genotypes (Table 2). The highest seed yield was observed in EC 14476 (1462.00 kg) and lowest was in EC 280149 (118.00 kg). Soybean variety used as a susceptible check JS 335 yielded 1502.00 kg. Based on the seed yield per ha, the genotypes were grouped into three categories as low seed yielder (<600.00 kg), medium seed yielder (600.00-900.00 kg) and high seed yielder (>900.00 kg).

Among 50 genotypes, 12 genotypes were low *Viz*. EC 175317 (196.00 kg), EC 103336 (280.00 kg), EC 333879 (231.00 kg), EC 467282(A) (302.00 kg), B 254 (404.00 kg), EC 107416 (418.00 kg), AGS 95 (476.00 kg), EC 308287 (484.00 kg), EC39177 (529.00 kg), EC 615160 (538.00 kg), EC 309509 (574.00 kg) and EC 291448 (596.00 kg). 13 genotypes were medium *Viz.* EC 251358 (622.00 kg), EC 14458 (644.00 kg), EC 309537 (667.00 kg), EC 313976 (680.00 kg), BR 4 (689.00 kg), EC 251396 (751.00 kg), EC 309538 (751.00 kg), EC 103332 (760.00 kg), EC 241696 (769.00 kg), PI 210178 (831.00 kg), MACS 58 (836.00 kg), EC 325103 (876.00 kg), EC 30968 (893.00 kg), whereas 15 left genotypes were high in seed yielder per hectare.

Table 2: Screening of germplasm line for resistance against major insect-pests (*kharif*-2016)

S. No.	Genotypes	Girdle beetle (% Infestation)	Girdle beetle (% damage)	Stem fly (% stem tunneling)	Semilooper (l/m) *	*S. litura* (l/m)	DTF	DTM	Yield (kg/ha)
1.	AGS 166	12.50	7.14	63.83	6	3	30	84	929
2.	AGS 2	17.86	8.93	27.21	12	5	34	85	920
3.	AGS 95	5.71	0.00	40.51	10	0	36	103	476
4.	B 254	8.33	0.00	74.17	4	4	36	96	404
5.	BR 4	17.46	7.94	41.67	17	3	35	103	689
6.	BS 2	-	-	-	-	-	-	-	-
7.	EC 100027	27.45	17.65	15.63	21	0	36	88	947
8.	EC 103332	26.67	13.33	35.05	18	0	41	97	760
9.	EC 103336	13.64	4.55	29.73	21	0	42	97	280
10.	EC 107407	14.92	7.46	35.71	10	2	45	94	956
11.	EC 107416	9.30	4.65	30.60	15	0	31	97	418
12.	EC 14458	14.63	7.32	39.24	30	0	35	103	644
13.	EC 14476	8.64	3.70	30.39	17	1	41	97	1462
14.	EC 175317	2.94	2.94	69.92	20	0	36	102	169
15.	EC 241309	35.94	15.63	13.02	20	0	38	92	1169
16.	EC241656	16.88	7.79	46.99	15	0	35	96	916
17.	EC 241696	15.09	3.77	23.21	18	0	40	96	769
18.	EC 242072	21.05	10.53	14.75	12	0	42	96	1040
19.	EC 242086	-	-	-	-	-	-	-	-
20.	EC 245988	12.86	4.29	35.62	22	3	45	100	1258
21.	EC 251396	34.21	13.16	35.71	19	1	46	101	751
22.	EC 251431	-	-	-	-	-	-	-	-
23.	EC 280149	20.41	11.22	57.99	22	0	41	99	118
24.	EC 287454	-	-	-	-	-	-	-	-
25.	EC 291398	10.14	7.25	26.53	36	2	43	99	1116
26.	EC 291448	25.93	11.11	23.53	23	5	45	99	596
27.	EC 308287	21.74	8.70	27.55	36	2	46	105	484
28.	EC 309509	14.75	11.48	17.01	24	1	43	97	578
29.	EC 309537	21.05	10.53	24.39	13	1	43	97	667
30.	EC 309538	13.85	6.15	13.29	13	0	36	103	751
31.	EC 30968	22.22	13.33	36.65	21	1	39	94	893
32.	EC 313976	25.00	15.63	28.67	17	0	36	88	680
33.	EC325103	25.00	15.00	27.22	16	0	39	89	876
34.	EC 325111	15.00	0.00	28.78	10	2	43	96	160
35.	EC 333875	-	-	-	-	-	-	-	-
36.	EC 333879	4.76	0.00	50.00	9	0	36	95	231
37.	EC 34057	11.49	8.05	24.31	14	1	35	93	1191
38.	EC 383165	20.25	5.06	54.64	21	0	37	97	1422
39.	EC39177	32.45	10.81	27.93	12	0	45	104	529
40.	EC 457286	17.24	8.62	53.38	9	0	34	104	1009
41.	EC 467282(A)	9.09	0.00	40.12	11	0	38	86	302
42.	EC 615160	27.27	13.64	44.44	6	1	30	85	538
43.	EC 7048	-	-	-	-	-	-	-	-
44.	M 204	12.50	4.69	32.66	16	0	40	96	1307
45.	MACS 58	40.38	19.23	29.07	22	3	42	104	836
46.	PI 210178	4.26	0.00	41.43	20	3	37	96	831
47.	PI 259539	3.70	3.70	35.66	22	1	35	93	978
48.	EC 457387	20.93	11.63	41.14	22	0	38	85	907
49.	EC 2581	-	-	-	-	-	-	-	-
50.	EC 251358	22.22	0.00	47.62	9	0	38	85	622
51.	JS 335(Check)	11.50	5.45	27.62	28	2	47	100	1502

* Combined population of *Gesonia gemma, Chrysodeixis acuta* and *Diachrysia orichalcea.*

2.2 Screening of soybean genotypes/varieties for resistance and/or tolerance against major insect-pests (*kharif* 2017)

2.2.1 Larval population of insect pests on different soybean genotypes/variety

Girdle beetle (*Obereopsis brevis*), stem fly (*Melanagromyza sojae*), semilooper *(Chrysodeixis acuta, Gesonia gemma and Diachrysia orichalcea)* and Tobacco caterpillar (*Spodoptera litura*) were found infesting soybean genotypes under field condition during the crop season (*kharif* 2017).

4.2.2.2 *Obereopsis brevis* (Infestation percentage)

Mean infestation percentage of *Obereopsis brevis* varied significantly among the genotypes (Table 3). Genotype TGX 849-D-13-4 (11.20%) took more infestation whereas the genotype SPC 174, EC-333860, VP-1143, VP-1147, EC 114573, DSB 1, NRC 78, SQL 89 and EC 1619 (0.00%) took no infestation percentage. The genotypes were grouped in to two categories as less infestation (<5%) and more infestation (>5%).

Among the 50 genotypes, 31 genotypes had less infestation percentage *Viz*. EC 18594 (0.47%), TGX 855-32E (0.49%), PPI-72-2-5-6 (0.66%), V 1 (0.85%), VP 1165 (0.89%), JS 20-42 (0.91%), EC-377883 (0.95%), VP-1164 (0.99%), NRC 67 (1.33%), PS 1347 (1.37%), EC 241 650 (1.41%), PR 35 (1.44%), EC 241 756 (1.52%), EC 242104 (0.53%), JS 20-37 (1.53%), NRC 71 (1.59%), MAUS 176 (1.63%), PR 15-126-3-8 (1.75%), JS 20-42 (1.88%), DN290 (2.04%), EC 241 768 (2.14), VP-1162 (2.50%), NRC 84 (2.50%), EC 241 777 (2.63%), P501 (2.96%), TGX 854-42D (3.51%), EC 250583 (3.64%), EC 241 807 (3.70%), EC-358002 (3.88%), DB 1588 (4.00%) and TK 5 (4.08%), and 19 had more infestation percentage.

2.2.3 *Obereopsis brevis* (Damage percentage)

Mean damage percentage of *Obereopsis brevis* varied significantly among the genotypes (Table 3). Genotype PR 35, SPC 174, TGX 855-32E, EC-333860, VP-1143, VP-1147, EC-390981, EC 114573, EC 18594, EC 241 768, DSB 1, KB 17, MAUS 176, NRC 67, NRC 71, NRC 78, NRC 84, SQL 89 and EC 1619 (0.00%) found no damage percentage whereas the genotype EC 241 778 (3.17%) found maximum damage percentage. All genotypes were grouped in to three categories as minimum damage percent (<1%), medium damage percent (1 – 2%) and maximum damage percent (>2%).

Among the 50 genotypes, 12 had minimum damage percentage *Viz*. PPI-72-2-5-6 (0.66%), EC 245986 (0.68%), EC 242104 (0.76%), JS 20-37 (0.76%), V 1 (0.85%), EC 109540 (0.88%), EC 241 777 (0.88%), EC 250583 (0.91%), EC 241 807 (0.93%), EC-377883 (0.95%), EC-358002 (0.97%) and VP-1164 (0.99%), 20 had medium damage percentage and 12 had maximum damage percentage.

2.2.4 *Melanagromyza sojae* (Stem tunneling percentage)

Stem tunneling percentage due to stem fly maggot (*Melanagromyza sojae*) varied significantly among the genotypes (Table 3). Genotype EC 250583 (83.90%) noticed maximum stem tunneling whereas the genotype VP-1147 (19.89%) noticed minimum percent of stem tunneling. All genotypes were grouped in to three categories as minimum stem tunneling percent (<35%), medium stem tunneling percent (35–55%) and maximum stem tunneling percent (>55%).

Among the 50 genotypes, 5 genotypes exhibited minimum stem tunneling *Viz*. TGX 849-D-13-4 (25.69%), EC-390981 (28.50%), VP-1143 (28.97), EC 241 771 (32.24%) and SQL 89 (34.74%), 23 had medium stem tunneling percentage and 16 had maximum stem tunneling percentage.

2.2.5 Semilooper (*Chrysodeixis acuta, Gesonia gemma* and *Diachrysia orichalcea*)

Semilooper (*Chrysodeixis acuta, Gesonia gemma* and *Diachrysia orichalcea*) varied significantly among the genotypes (Table 3). Mean larval population of semilooper recorded at 50 different genotypes of the soybean crop indicated that larval population varied from 0.00 l/m (PR 35) to 19.00 l/m (DN290). Genotypes were grouped in to three categories as minimum population (<5 larvae per meter), medium population (5-10 larvae per meter) and maximum population (>10 larvae per meter).

Among the 50 genotypes, minimum larval population was recorded in 4 genotypes *Viz*. SPC 174 (3.00 per mrl), PS 1347 (3.00 per mrl), TGX 854-42D (4.00 per mrl) and EC 309518 (4.00 per mrl), and medium larval population was recorded in 31 genotypes and maximum larval population was recorded in 12 genotypes.

2.2.6 Spodoptera litura

Spodoptera litura varied significantly among the genotypes (Table 3). Mean larval population of *Spodoptera litura* recorded at 50 different genotypes indicated that larval population varied from 1.00 l/m (DN290 and DSB 1) to 15.00 l/m (VP-1162).

Among the 50 genotypes in 15 genotypes noticed 0.00 l/m (P501, PR 35, SPC 174, TGX 849-D-13-4, TGX 854-42D, TK 5, V 1, EC-333860, EC-377883, EC 241 650, EC 241 778, EC 241 807, EC 242104, EC 250591 and EC 309518). Rest of the genotypes comes in between 2.00 per mrl to 13.00 per mrl.

2.2.7 Days to flowering

The days to flowering varied significantly among the genotypes (Table 3). The genotype SPC 174 noticed early flowering (29.00 days) while the genotype TGX 849-D-13-4 noticed late flowering days (55.00 days). Based on the days to flowering, the genotypes were grouped into three categories as early (< 40.00 days), medium (40.00-45.00 days) and late (>45.00 days).

Among the genotypes, 15 had early *Viz*. DN290 (34.00 days), EC 241 650 (34.00 days) and EC 241 756 (34.00 days), PPI-72-2-5-6 (34.00 days), DSB 1 (35.00 days), MAUS 176 (35.00 days), VP 1165 (35.00 days), EC 241 807 (36.00 days), NRC 67 (36.00 days), NRC 71 (36.00 days), NRC 84 (36.00 days), TK 5 (37.00 days), EC 241 777 (38.00 days), JS 20-42 (38.00 days) and NRC 84 (38.00 days), and 10 had late *Viz*. EC 114573 (45.00 days), EC 241 778 (45.00 days), EC 309518 (45.00 days), EC 1619 (45.00 days), EC 245986 (46.00 days), EC 241 778 (47.00 days), EC 251886 (47.00 days), EC 18594 (48.00 days), PR 35 (49.00 days), EC-390981 (49.00 days), and rest of the 19 genotypes had medium flowering times.

2.2.8 Days to maturity

The days to maturity varied significantly among the genotypes (Table 3). The genotype (EC 241 778) took more days for maturity (106.00 days) while the genotype (TGX 854-42D, DN290 and EC 241 650) took less days for maturity (80.00 days). Based on the days to maturity, the genotypes were grouped into three categories as early (< 90.00 days), medium (90.00-100.00 days) and late (>100.00 days).

Among the genotypes, 11 had early *Viz*. TK 5 (82.00 days), EC 241 777 (82.00 days), EC 241 807 (82.00 days), PPI-72-2-5-6 (84.00 days), EC 242104 (85.00 days), NRC 71 (86.00 days), EC 241 771 (87.00 days), NRC 67 (87.00 days), DSB 1 (88.00 days), NRC 84 (88.00 days) and EC 241 756 (89.00 days), and 13 had late *Viz*. PR 15-126-3-8 (100.00 days), VP-1147 (100.00 days), EC-390981 (100.00 days), EC 241 778 (100.00 days), KB 17 (100.00 days), SQL 89 (100.00 days), DB 1588 (102.00 days), EC 1619 (102.00 days), EC 245986 (104.00 days), EC 114573 (104.00 days), PR 35 (105.00 days), EC 18594 (105.00 days) and PS 1347 (105.00 days), while 21 had medium maturity times.

2.2.9 Yield (kg/ha)

The seed yield varied significantly among different soybean genotypes (Table 3). The highest seed yield was observed in JS 20-37 (1416.00 kg) and lowest was in EC 1619 (4.00 kg).

Based on the seed yield per ha, the genotypes were grouped into three categories as low seed yielder (<300.00 kg), medium seed yielder (300.00-600.00 kg) and high seed yielder (>600.00 kg).

Among 50 genotypes, 4 genotypes were high *Viz*. EC 245986 (630.00 kg), EC 241 807 (649.00 kg), TGX 849-D-13-4 (790.00 kg) and EC 250591 (819.00 kg), and 3 genotypes were medium *Viz*. TK 5 (333.00 kg), EC-390981 (344.00 kg) and EC 241 771 (458.00 kg), whereas 26 genotypes were low seed yielder per hectare.

Table 3: Screening of germplasm line for resistance against major insect-pests (*kharif*-2017)

S. No.	Genotypes	Girdle beetle (% Infestation)	Girdle beetle (% damage)	Stem fly (% stem tunnel-ing)	Semilooper (larvae/m)	*S. litura* (larvae/m)	DTF	DTM	Yield (kg/ha)
1.	P501	2.96	1.48	54.60	9	0	43	97	290
2.	PR 15-126-3-8	1.75	1.75	38.85	5	2	44	100	12
3.	PR 35	1.44	0.00	43.48	0	0	49	105	26
4.	SPC 174	0.00	0.00	76.47	3	0	29	91	143
5.	TGX 849-D-13-4	11.20	1.60	25.69	6	0	55	99	790
6.	TGX 854-42D	3.57	1.79	71.93	4	0	35	80	148
7.	TGX 855-32E	0.49	0.00	42.68	10	3	41	97	101
8.	TK 5	4.08	2.04	66.04	9	0	37	82	333
9.	V 1	0.85	0.85	49.40	8	0	41	96	29
10.	EC-333860	0.00	0.00	45.10	15	0	43	98	84
11.	EC-358002	3.88	0.97	40.24	7	2	42	95	269
12.	EC-377883	0.95	0.95	44.44	8	0	43	99	221
13.	PPI-72-2-5-6	0.66	0.66	46.95	7	8	34	84	149
14.	VP-1143	0.00	0.00	28.97	9	5	41	97	140
15.	VP-1147	0.00	0.00	19.89	10	5	43	100	299
16.	VP-1162	2.50	1.25	42.42	5	15	34	99	218
17.	VP-1164	0.99	0.99	44.97	8	2	43	98	182
18.	EC-390981	0.00	0.00	28.50	9	10	49	100	344
19.	DB 1588	4.00	1.33	51.33	9	3	44	102	22
20.	DN290	2.04	1.02	60.98	9	1	34	80	97
21.	EC 109540	1.75	0.88	38.79	10	2	42	98	240
22.	EC 114573	0.00	0.00	52.68	9	2	45	104	27
23.	EC 18594	0.47	0.00	40.91	9	6	48	105	1218
24.	EC 241 650	1.41	1.41	67.52	9	0	34	80	43
25.	EC 241 756	1.52	1.52	74.63	8	5	34	89	14
26.	EC 241 768	2.14	0.00	48.48	12	2	43	92	19
27.	EC 241 771	6.92	2.31	32.24	13	3	41	87	458
28.	EC 241 777	2.63	0.88	44.21	5	5	38	82	96
29.	EC 241 778	7.14	3.17	39.68	11	0	45	100	25
30.	EC 241 778	8.97	1.28	44.51	9	3	47	106	10
31.	EC 241 807	3.70	0.93	63.57	9	0	36	82	649
32.	EC 242104	1.53	0.76	59.06	12	0	41	85	39
33.	EC 245986	6.76	0.68	53.46	7	7	46	104	630
34.	EC 250583	3.64	0.91	83.90	8	2	43	99	39
35.	EC 250591	6.50	1.63	47.45	13	0	42	97	819
36.	EC 251886	5.31	1.77	47.19	5	2	47	96	10
37.	EC 309518	5.36	1.79	59.04	4	0	45	92	9
38.	DSB 1	0.00	0.00	71.54	6	1	35	88	10
39.	JS 20-37	1.53	0.76	52.91	13	3	42	99	1416
40.	JS 20-42	1.88	1.25	59.33	9	4	38	92	80
41.	KB 17	0.91	0.00	39.15	9	15	42	100	49
42.	MAUS 176	1.69	0.00	61.54	9	13	35	93	34
43.	NRC 67	1.33	0.00	73.00	9	12	36	87	229
44.	NRC 71	1.59	0.00	46.77	7	7	36	86	198
45.	NRC 78	0.00	0.00	61.76	7	7	38	94	37
46.	NRC 84	2.50	0.00	52.94	12	7	36	88	61
47.	PS 1347	1.37	1.37	62.82	3	5	41	105	8
48.	SQL 89	0.00	0.00	34.74	10	3	41	100	181
49.	VP 1165	0.89	0.00	48.82	6	6	35	91	31
50.	EC 1619	0.00	0.00	65.00	9	3	45	102	4

* Combined population of *Gesonia gemma, Chrysodeixis acuta* and *Diachrysia orichalcea.*

Discussion

During kharif-2016, based on above criteria we have found below 10% girdle beetle (*Obereopsis brevis*) infestation, genotypes AGS 95 (5.71%), B 254 (8.33%), EC 107416 (9.30%), EC 14476 (8.54%), EC 175317 (2.94%), EC 333879 (4.76%), EC 467282(A) (9.09%), PI 210178 (4.26%) and PI 259539 (3.70%) but no exhibited plant damage despite showing infestation symptoms of girdle beetle. Stem tunneling due to stem fly (*Melanagromyza sojae)* infestation was below ETL (≤ 26%) in EC 100027 (15.63%), EC 241309 (13.02%), EC 242072 (23.21%), EC 309509 (17.01%), EC 309537 (24.39%), EC 309538 (13.26%) and EC 34057

(24.31%) but less genotypes found *Spodoptera litura* larvae per meter. These genotypes need to be further screened to confirm the resistance. Semilooper complex (*Chrysodeixis acuta, Gesonia gemma and Diachrysia orichalcea)* minimum larval population was recorded in 5 genotypes B 254 (4.00 per mrl), AGS 166 (6.00 per mrl), EC 615160 (6.00 per mrl), EC 251358 (9.00 per mrl) and EC 333879 (9.00 per mrl). 14 soybean varieties showed resistant/tolerance to one of the other major insect-pests (Joshi and Sharma, 2003) [5], Antibiotic effect of insect resistant soybean on common cutworm (*Spodoptera litura*) and its inheritance (Kamatsu *et. al*. 2004) [6], Relative stability of resistance in soybean to leaf-feeding insects in the field (Wu-YeChun *et. al*. 2004) [14], Field screening of soybean genotypes for resistance to major insect pests of soybean (Singh *et. al*. 2007) [12], Identification of resistant sources to major defoliator pests of soybean (Harish *et. al* 2009) [4], Evaluation of soybean genotypes for resistance against major insect-pests (Garewal *et. al*. 2003) [2] and Screening of soybean genotypes for resistance against three major insect-pests. (Awasthi *et. al*. 2005) [1]. Compared to other line, some genotypes i.e., EC 14476 (1462 kg/ha) and EC 383165 (1422 kg/ha) gave reasonably good yield despite showing high infestation of major insects and maturity duration have less than 95 days. Screening of elite soybean lines for resistance against stem fly Melanagromyza sojae Zehntner (Taware *et. al*. (2004) [13] and Effect of grading screen size on physical properties and quality of soybean seed (Rathod *et. al*. 2007) [10] Hence, these lines could be considered as tolerant lines table 2.

During *kharif* – 2017, because of unfavorable weather conditions the yield levels in all the genotypes were very less, which did not reflect yield potential. Hence the yield per *se* is not discussed in this section. Based on above criteria we have found girdle beetle infestation, genotypes SPC 174, EC-333860, VP-1143, VP-1147, EC-390981, EC 114573, DSB 1, NRC 78, SQL 89 and EC 1619 exhibited no plant damage despite showing infestation symptoms of girdle beetle. Work on identification of resistant lines & varieties has also been conducted by scientists like Patil *et. al*. (2006) [8] reported field screening of soybean genotypes for resistance to girdle beetle and Screening of soybean cultivars against girdle beetle (Kumawat *et. al* 2010) [7]. Stem tunnelling due to stem fly infestation was below ETL (≤ 26%) in TGX 849-D-13-4 (25.69%) and VP-1147 (19.89%). Field evaluation of soybean cultivars for their major pests (Salunke *et. al*. 2002) [11], Field evaluation of soybean cultivars for their major pests (Pierson *et. al*. 2010) [9] and field resistance of soybean genotypes against incidence of major insect pests (Gupta *et. al*. 2004) [3]. Semilooper complex *(Chrysodeixis acuta, Gesonia gemma* and *Diachrysia orichalcea)* minimum larval population was recorded in 4 genotypes *Viz*. SPC 174(3.00 per mrl), PS 1347 (3.00 per mrl), TGX 854-42D (4.00 per mrl) and EC 309518 (4.00 per mrl). Genotypes EC 18594 (1218 kg/ha) and JS 20-37 (1416 kg/ha) gave reasonable good yield despite showing low infestation of major insects and maturity duration have less than 95 days. Hence, these genotypes need to be further screened to confirm the resistance. Compared to other lines could be considered as tolerant lines table 3.

Conclusion

During kharif-2016, below 10% girdle beetle (*Obereopsis brevis*) infestation, genotypes AGS 95 (5.71%), B 254 (8.33%), EC 107416 (9.30%), EC 14476 (8.54%), EC 175317 (2.94%), EC 333879 (4.76%), EC 467282(A) (9.09%), PI 210178 (4.26%) and PI 259539 (3.70%). Stem tunnelling due to stem fly (*Melanagromyza sojae)* infestation was below ETL (≤ 26%) in EC 100027 (15.63%), EC 241309 (13.02%), EC 242072 (23.21%), EC 309509 (17.01%), EC 309537 (24.39%), EC 309538 (13.26%) and EC 34057 (24.31%). Semilooper complex (*Chrysodeixis acuta*, *Gesonia gemma* and *Diachrysia orichalcea)* minimum larval population was recorded in 5 genotypes B 254 (4.00 per mrl), AGS 166 (6.00 per mrl), EC 615160 (6.00 per mrl), EC 251358 (9.00 per mrl) and EC 333879 (9.00 per mrl). EC 14476 (1462 kg/ha) and EC 383165 (1422 kg/ha) gave reasonably good yield.

During *kharif* – 2017, girdle beetle infestation, genotypes SPC 174, EC-333860, VP-1143, VP-1147, EC-390981, EC 114573, DSB 1, NRC 78, SQL 89 and EC 1619. Stem tunnelling due to stem fly infestation was below ETL (≤ 26%) in TGX 849-D-13-4 (25.69%) and VP-1147 (19.89%). Semilooper complex (*Chrysodeixis acuta*, *Gesonia gemma* and *Diachrysia orichalcea*) minimum larval population was recorded in 4 genotypes *Viz*. SPC 174(3.00 per mrl), PS 1347 (3.00 per mrl), TGX 854-42D (4.00 per mrl) and EC 309518 (4.00 per mrl). Genotypes EC 18594 (1218 kg/ha) and JS 20-37 (1416 kg/ha) gave reasonable good yield.

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