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Screening of soybean germplasm against whitefly, *Bemisia tabaci* (Genn.)

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Abstract
The field screening of soybean germplasm lines against whitefly was conducted with 24 soybean germplasm lines during *Kharif* 2015 and 2016. The pooled mean of whitefly incidence among different germplasm lines was in the range of 2.54 to 4.30 whiteflies per plant. The highest number of whiteflies per plant was observed on JS 20-71 followed by DS 3101 and DS 3202. The whitefly incidence was minimum on VLS 89, PS 1550 and SL 955. Based on the response of germplasm lines to whiteflies, the germplasm lines were categorized as moderately resistant (UPSM 534, VLS 89, SL 955, PS 1550, MACS 1410, JS 20-34 and Bragg), susceptible (JS 335, SL 983, SL 688, SL 1028, PS 1556, PS 1347, PS 1092, MACS 1370, KDS 753, JS 93-05, DSb 28-3, Dsb 25 and DSb 2302) and highly susceptible (JS 20-71, DS 3102 and DS 3101).

Keywords: Whitefly, resistance, soybean, incidence, germplasm

Introduction
Soybean [*Glycine max* (L.) Merrill] is popularly known as "Golden bean" or "Miracle crop" of 20th century because of its oil and protein, and its use in food, feed and other industrial purposes. Its seed contains about 40 per cent protein and 20 per cent oil (Singh and Hymowitz, 1999) [10]. Its oil is used in the manufacturing of paints, varnishes, lubricants, antibiotics etc. It is a rich source of minerals like calcium, iron and phosphorus along with vitamins (A, B, D and E) and essential amino acids (Mundewadikar and Deshmukh, 2014) [7].
The major soybean growing countries in the world are United States of America, Brazil, Argentina, China and India; they contribute 90% of the global soybean output. In India, it is cultivated in 11.50 m ha area with total production of 14.12 m t and productivity of 1239 kg/ha. The major soybean cultivating states in India are Madhya Pradesh, Maharashtra, Rajasthan, Karnataka, Andhra Pradesh and Uttarakhand (ICAR- IISR, 2017) [4].
The productivity of soybean in India is low (1239 kg/ha) compare to the world productivity (2809 kg/ha) due to various biotic and abiotic factors. Insect pests and diseases are causing 32 per cent yield loss and became important biotic constraints to soybean production in India (Sharma and Shukla, 1997) [9]. The major insect pests of soybean in Uttarakhand are stem fly, girdle beetle, tobacco caterpillar, Bihar hairy caterpillar, green semilooper and whitefly (Ram, 1995) [8]. The whitefly is one of the important sucking pests of soybean which besides causing direct damage to the crop by feeding on cell sap of leaves, it transmits a Gemini virus which causing Yellow mosaic virus disease (YMD). The management of whitefly as insect pest and vector become more complicated at present, due to the high selection pressure of insecticides and development of biotypes. In view of existing situation and importance of soybean in Indian economy, the necessary prerequisite for successful management of whitefly through IPM includes the cultural methods like cultivation of resistant varieties to whitefly that avoid the incidence of whitefly population. Hence, the present investigation was carried out to find out the germplasm lines resistant to whitefly.

Material and Methods
The field screening of 24 soybean germplasm lines against whitefly was conducted in randomized block design at Norman E. Borlaug Crop Research Centre, G. B. Pant University of Agriculture and Technology, Pantnagar during *kharif*, 2015 and 2016. The germplasm lines were sown in two rows with 3m length of each row and replicated twice with the spacing of 45

cm X 5 cm. The experiment was conducted under unprotected condition and all standard agronomic practices were followed for growing of crop. The population of whiteflies was taken on upper, middle and bottom canopy of five randomly selected plants in all the plots at seven days interval from three weeks after sowing to crop maturity. According to population of whiteflies, the germplasm lines were categorized as, 1 is highly resistant (0.1 to 1 whitefly), 2 is resistant (1.1 to 2 whitefly), 3 is moderately resistant (2.1 to 3 whitefly), 4 is susceptible (3.1 to 4 whitefly) and 5 is highly susceptible (4.1 to 5 whitefly) **(**Gulluoglu *et al*., 2010) [3].

Results and Discussion

The population dynamics of whitefly on 24 germplasm lines was recorded from 30 DAS to 103 DAS during 2015 and 2016 (Table 1). The mean pest population was ranged from 2.05 to 3.84 whiteflies per plant and it was significantly varied among different germplasm lines during 2015. The highest population of 3.84 whiteflies per plant was observed on JS 93-05 whereas, the lowest population of 2.05 whiteflies per plant was recorded on UPSM 534.

The mean pest incidence was significantly varied from 3.03 to 4.76 whiteflies per plant during 2016. The highest mean pest population of 4.76 whiteflies per plant was observed on JS 20-71 and the lowest mean pest population of 3.03 whiteflies per plant was observed on UPSM 534.

The pooled mean of whitefly incidence among different germplasm lines was in the range of 2.54 to 4.30 whiteflies per plant. The highest pest incidence was observed on JS 20-71 (4.30 whiteflies per plant) followed by DS 3101 (4.16 whiteflies per plant), DS 3202 (4.07 whiteflies per plant), JS 335 (3.99 whiteflies per plant) and PS 1347 (3.43 whiteflies per plant). The lowest population was recorded on UPSM 534 (2.54 whiteflies per plant) followed by VLS 89 (2.66 whiteflies per plant), PS 1550 (2.74 whiteflies per plant) and SL 955 (2.90 whiteflies per plant).

Based on the response of germplasm lines to whiteflies, the germplasm lines were categorized as moderately resistant, susceptible and highly susceptible. Among 24 germplasm lines, 7 germplasm lines (UPSM 534, VLS 89, SL 955, PS 1550, MACS 1410, JS 20-34 and Bragg) were found under moderately resistant category. 14 germplasm lines (JS 335, SL 983, SL 688, SL 1028, PS 1556, PS 1347, PS 1092, MACS 1370, KDS 753, JS 93-05, DSb 28-3, Dsb 25 and DSb 2302) were found under susceptible category and 3 germplasm lines (JS 20-71, DS 3102 and DS 3101) were found under moderately highly susceptible category.

The development, screening and identification of resistant cultivars against a insect pest was a continuous process. The similar findings related to these results were reported by Trimohan *et al.* (2003) [11] who found six promising whitefly resistant genotypes *viz*., SL 525, DS 97-12, SL 517, PS 1283, SL 528 and PS 1251 by the field screening of 70 soybean genotypes similarly Khanzada *et al*. (2013) [6] studied the relative resistance of soybean cultivars against sucking insect pests. They observed that four cultivars *viz*., AGS 20, Bragg, Wales and PR 142 were resistant to whitefly. Vijay (2013) [12] noticed that three soybean germplasm lines namely JS-95-60, JS-20-38 and JS-97-52 were exhibited resistant reaction to whiteflies, whereas a single germplasm line *i.e.* JS-93-05 had shown susceptible reaction against whitefly similarly Chejara and Khanpara (2014) [2], reported that the soybean genotypes PK 746, GS 3 and J 645 were found as resistant source for whitefly whereas, the highest whitefly population was recorded on three soybean genotypes *viz*., AGS 107, GS 2 and AGS 112**.**

Bisht *et al.* (2015) [1] screened 41 soybean germplasm lines to find out the resistant source against whiteflies under field conditions. They noticed that the maximum whitefly incidence was recorded on two germplasm lines namely KDS 699 and DS 2706, whereas the minimum whitefly incidence was observed on KDS 8. Kalyan and Ameta (2017) [5] studied the effect of different soybean varieties *viz*., RKS-24, JS-93-05, Pratap Soya-1, JS-335, Pratap Soya-2 and JS-95-60 on whitefly incidence. They observed that the incidence of whitefly was low on the five soybean cultivars namely RKS 24, JS 95-60, JS 93-05, JS 335 and Pratap Soya-1; however the highest whitefly incidence was recorded on the cultivar Pratap Soya-2.

Table 1: Screening of soybean germplasm against whitefly

S. No.	Germplasm line	Number of whiteflies per plant			Scale	Germplasm response
		2015	2016	Pooled mean		
1	Bragg	3.52 (2.01)	2.50 (1.73)	3.01 (1.87)	3	Moderately resistant
2	DS 3101	4.59 (2.26)	3.73 (2.06)	4.16 (2.16)	5	Highly susceptible
3	DS 3102	4.52 (2.24)	3.61 (2.03)	4.07 (2.14)	5	Highly susceptible
4	DSb 2302	4.26 (2.18)	3.25 (1.94)	3.76 (2.06)	4	Susceptible
5	DSb 25	4.19 (2.17)	3.20 (1.92)	3.70 (2.05)	4	Susceptible
6	DSb 28-3	3.65 (2.04)	2.62 (1.77)	3.13 (1.91)	4	Susceptible
7	JS 20-34	3.42 (1.98)	2.38 (1.70)	2.90 (1.84)	3	Moderately resistant
8	JS 20-71	4.76 (2.29)	3.84 (2.08)	4.30 (2.19)	5	Highly susceptible
9	JS 93-05	4.13 (2.15)	3.10 (1.90)	3.61 (2.03)	4	Susceptible
10	KDS 753	3.59 (2.02)	2.56 (1.75)	3.08 (1.89)	4	Susceptible
11	MACS 1370	3.73 (2.06)	2.68 (1.78)	3.20 (1.92)	4	Susceptible
12	MACS 1410	3.45 (1.99)	2.43 (1.71)	2.94 (1.86)	3	Moderately resistant
13	MACS 1460	4.33 (2.20)	3.35 (1.96)	3.84 (2.08)	4	Susceptible
14	PS 1092	3.79 (2.07)	2.76 (1.81)	3.27 (1.94)	4	Susceptible
15	PS 1347	4.40 (2.21)	3.43 (1.98)	3.91 (2.10)	4	Susceptible
16	PS 1550	3.26 (1.94)	2.23 (1.65)	2.74 (1.80)	3	Moderately resistant
17	PS 1556	3.86 (2.09)	2.83 (1.82)	3.34 (1.96)	4	Susceptible
18	SL 1028	3.93 (2.10)	2.89 (1.84)	3.41 (1.98)	4	Susceptible
19	SL 688	4.01 (2.12)	2.96 (1.86)	3.48 (2.00)	4	Susceptible
20	SL 955	3.33 (1.96)	2.30 (1.67)	2.81 (1.82)	3	Moderately resistant
21	SL 983	4.05 (2.13)	3.03 (1.88)	3.54 (2.01)	4	Susceptible

22	VLS 89	3.18 (1.92)	2.14 (1.62)	2.66 (1.78)	3	Moderately resistant
23	JS 335	4.46 (2.23)	3.51 (2.00)	3.99 (2.12)	4	Susceptible
24	UPSM 534	3.03 (1.88)	2.05 (1.60)	2.54 (1.74)	3	Moderately resistant
	SEm	0.03	0.04	0.03		
	CD (P = 0.05)	0.08	0.12	0.08		

Figures in parentheses are √x+0.5 values

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