The Pharma Innovation Journal 2021; SP-10(12): 1569-1573

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; SP-10(12): 1569-1573
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www.thepharmajournal.com
Received: 04-10-2021
Accepted: 06-11-2021

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Screening of okra (*Abelmoschus esculentus*) genotypes/varieties against whitefly (*Bemisia tabaci*) under field conditions in Varanasi region

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Abstract
Okra is an important vegetable crop for Indian agriculture and is grown extensively throughout the year in all parts in India. Sucking complex like whitefly *Bemisia tabaci*, jassid *Amrasca biguttula biguttula* and aphid *Aphis gossypii* are more deleterious insect pests pose a major threat, affecting the okra production. While screening for whitefly resistance, it was noted that Arka Anamika and Pusa A-4 were found to be resistant against whitefly population and on the other site Pusa Sawani and EC-169417 were found to be susceptible with highest average whitefly population during both the year of experimentation (2018-19 & 2019-20).

Keywords: okra, screening, whitefly, genotype, varieties, resistance

Introduction

Okra (*Abelmoschus esculentus* L. Moench.) is a vegetable crop of great social and economic importance in the tropics, subtropics and hot regions of temperate zones. Okra is considered as an important constituent for balanced food due to its dietary fibers and amino-acid composition which is rich in lysine and tryptophan (Hughes, 2009). Bhendi or lady's finger in India is a major contributor to the total global vegetable production. Okra is an important vegetable crop for Indian agriculture and is grown extensively throughout the year in all parts of the country and India is ranked first in production. The crop is attacked by a variety of pests throughout its growth stages (Rai *et al*. 1993, Rao *et al*. 2002). One of the main reasons for low productivity is growing of local unimproved cultivars/OP varieties by the farmers and very high incidence of Yellow Vein Mosaic Virus (YVMV) disease which is transmitted through whitefly (*Bemisia tabaci*Genn.) (Arora *et. al*., 2008). The loss in yield, due to YVMV in okra is ranging from 30% to 100% depending on the age of the plant at the time of infection. Whiteflies are the milky white minute flies; nymphs and adults suck the cell sap from the leaves. The affected leaves are curled and dried. The affected plants show a stunted growth. Whiteflies are also responsible for transmitting yellow vein mosaic virus (Singh *et al*., 2008).

These insect pests of okra are generally managed by using different synthetic insecticides and the continuous use of these pesticides at large scale created problems like pest resistance, resurgence pesticides residues, destruction of beneficial fauna and environmental pollution (Adilakshmi, 2008). It also increases the cost of production but also poses serious hazards to the operators and consumers. As fruits are picked at short intervals, hence, the insecticidal application not only increases insecticidal load on crop but becomes hazardous too (Sardana and Dutta 1989). Various methods of insect pest management have been used to protect crops from insect pest damage, to increase crop production and to enhance food security. Resistant and tolerant varieties form the basic components of Integrated Pest Management over which other components are to be built up. Therefore, an alternative method by introducing or determining the use of resistant varieties that may contain different chemical substances to detoxify these insect's attack will be one of main component to be added in IPM as an environmental friendly pest management approaches.

Materials and Methods

The seeds of twenty okra varieties/genotypes were collected from Indian Institute Vegetable Research, Varanasi and a field experiment was carried out to find out the resistant/tolerant and susceptible okra varieties/genotypes to sucking pests, shoot and fruit borer (*E. vittella*) and subsequent yellow vein mosaic virus disease appearance under field condition at vegetable research farm institute of agricultural sciences, Banaras Hindu University. Population dynamics of whiteflies, *Bemisia tabaci* (Gennadius) both nymphs and adults were recorded during the vegetative stage, flowering and fruiting stage on three leaves (1 top+ 1 middle + 1 bottom) of five randomly selected plants with an interval of seven days.

Statistical analysis after appropriate transformation of data will be undertaken as per Gomez and Gomez (1976). Data from field experiments were analyzed by Randomized Block Design (RBD).

Results and Discussion

Screening of twenty okra genotypes were conducted during both year of experimentation at vegetable research farm, Banaras Hindu University, with all suitable agronomic practices as per recommended. During 2018-19 (Table-1& Fig 1), among those varieties, mean highest average number of whitefly per three leaves was found in Pusa Sawani(8.48) which was consider to be most susceptible among the rest. Highest average number of whitefly per three leaves was found during 40th and 41st standard meteorological week having value 15.22 and 14.78. Whitefly population in Pusa Sawani variety generally started appearing from 36th standard meteorological week and it gradually increases up to 40th and 41st standard meteorological week, after which it further decreased till last. Above results were found to be at par with genotype EC-169417. In genotype EC -169417 mean average whitefly population per three leaves was found to be 7.18. Highest average whitefly population was found in 41st standard meteorological week i.e. 14.69 in genotype EC-169417. A higher mean whitefly population was also reported in genotype/variety Parbhani kranti, Kashi Satdhari, SB-6 and EC-112231 with 5.47, 5.71 5.08 and 4.70 number of whitefly per three leaves respectively. Genotype like IC-117333, IC-117245, EC-169408, EC-112231 and IC-341190-C were found to be moderate susceptible to whitefly with mean average whitefly population value per three leaves of 4.01, 3.98, 3.74, 4.70 and 4.32 respectively. Arka Anamika and Pusa A-4 variety were found to be least population of whitefly during 1st year of experimentation and considered to be most resistant. In Arka Anamika mean average number of whitefly (2.04) was found to be lowest. Highest average number whiteflies were found during 40th Standard meteorological week i.e. 4.11. Pusa A-4 variety was found to be at par with Arka Anamika with mean average value 2.62 whitefly per three leaves. Highest average number whiteflies were found during 41st Standard meteorological week i.e. 4.57, after which it generally decrease till last observation. Varsha Uphar, Punjab Padmini, Hisar Unnat and P-7 variety were found to moderate resistance to whitefly with mean average whitefly population per three value 2.81,2.86,3.06 and 3.15.Highest average population were recorded during 40th and 41st standard meteorological week.

During 2nd year of experimentation (2019-20) (Table 2 & Fig 1) a near similar trend were observed in many variety/ genotype. Arka Anamika and Pusa A-4 were found to be most resistant to whitefly with least mean average population. Arka Anamika variety was found to be least whitefly population 1.81 per three leaves and was found to be most resistant among the rest variety. Initial population was started during 36th standard meteorological week (0.85) and it attends its peak during 41st standard meteorological week (4.16). Pusa A-4 was found to be at par with Arka Anamika. Mean average population of Pusa A-4 was recorded to be 1.98 per three leaves. Punjab Padmini(1.96), Varsha Uphar(2.32), Hisar Unnat(2.72) and P-7(3.25) were found to be moderate resistant to whitefly. Highest average population was found to be during 41st standard meteorological week. Among twenty selected variety/genotype Pusa Sawani and EC-169417 were recorded to be most susceptible, with highest average whitefly population per three leaves during 2nd year of experimentation. In Pusa Sawani mean average population were recorded to be 8.17, which was highest among the rest. Starting from its initial phase, average whitefly population reached its peak during 41st standard meteorological week and it further decrease. Similarly EC-169417 was found to be at par with Pusa Sawani with mean average whitefly population 8.15 per three leaves. Highest average number of whitefly was recorded during 41st standard meteorological week (18.18) during experimentation. Parbhani kranti (7.50), SB-6 (7.23), Kashi Satdhari (6.16) and EC-169459(5.85) were found to be moderately susceptible to whitefly. Highest average population was recorded during 41st standard meteorological week.

The whitefly population on all okra genotypes observed during 36 S.W and attained a peak population in 41 S.W. Thereafter, whitefly population decreased gradually and sustained up to 46 S.W. during both the years of study. The present results are almost similar with the findings of Singh (2013) who reported that whitefly population reported on okra 3 weeks after sowing and peak population was observed during fortnight of October. Earlier Singh (2013) reported that whitefly population gradually declined after peak population and persisted up to 3rd week of November and these findings are similar with present findings. Similarly, Gonde *et al.* (2013) [4] and Nagar *et al*. (2017) [7] also found a near similar result about whitefly population.

Table 1: Screening of okra genotypes against *B. tabaci* under field conditions during 2018-19

Tr. No.	Genotype/ Variety	Average* number of whiteflies per 3 leaves at different standard weeks											
		36SW	37 SW	38 SW	39 SW	40 SW	41 SW	42 SW	43 SW	44 SW	45 SW	46SW	Mean
1.	Arka Anamika(R)	0.62 (1.25)	1.93 (1.70)	1.90 (1.69)	2.42 (1.84)	4.11 (2.25)	3.49 (2.11)	3.05 (2.00)	2.66 (1.90)	1.35 (1.52)	0.68 (1.28)	0.25 (1.10)	2.04
2.	Varsha Uphar	1.26 (1.49)	1.76 (1.65)	2.25 (1.79)	3.17 (2.17)	4.11 (2.25)	5.42 (2.52)	3.61 (2.14)	2.51 (1.86)	4.89 (2.42)	1.51 (1.57)	0.42 (1.17)	2.81
3.	Punjab Padmini	1.15 (1.45)	1.49 (1.56)	2.24 (1.79)	2.85 (1.95)	5.08 (2.46)	6.97 (2.81)	5.21 (2.48)	3.10 (2.01)	2.09 (1.74)	1.12 (1.44)	0.21 (1.08)	2.86
4.	Hisar Unnat	1.39 (1.53)	2.04 (1.73)	3.16 (2.03)	3.46 (2.10)	6.02 (2.64)	6.30 (2.69)	4.71 (2.38)	3.49 (2.11)	1.88 (1.65)	0.79 (1.32)	0.43 (1.17)	3.06
5.	Parbhani Kranti	2.17 (1.77)	3.52 (1.87)	4.54 (1.86)	5.46 (2.53)	11.85 (3.58)	10.52 (3.39)	6.92 (2.81)	5.59 (2.56)	5.30 (2.50)	3.21 (2.04)	1.08 (1.42)	5.47
6.	Kashi Satdhari	2.78	3.67	5.25	5.65	12.67	10.13	7.12	5.46	5.45	3.45	1.18	5.71

		(1.93)	(2.15)	(2.49)	(2.57)	(3.69)	(3.33)	(2.84)	(2.53)	(1.84)	(2.10)	(1.46)	
7.	PusaSawani(S)	3.58 (2.13)	7.87 (2.97)	9.36 (3.21)	10.20 (3.34)	15.22 (4.02)	14.78 (3.97)	12.50 (3.67)	7.47 (2.90)	6.50 (2.73)	3.64 (2.14)	2.33 (1.18)	8.49
8.	P-7	1.17 (1.46)	2.27 (1.79)	3.10 (2.01)	3.51 (2.11)	6.06 (2.65)	6.37 (2.71)	4.75 (2.39)	3.40 (2.09)	2.21 (1.78)	0.77 (1.31)	0.49 (1.20)	3.15
9.	Pusa A-4	0.85 (1.34)	1.90 (1.69)	2.73 (1.92)	3.31 (2.06)	4.67 (2.37)	4.57 (2.35)	3.64 (2.14)	2.80 (1.94)	2.29 (1.80)	1.25 (1.48)	0.82 (1.33)	2.62
10.	EC-169419	1.55 (1.58)	2.93 (1.97)	3.78 (2.17)	4.35 (2.30)	8.00 (2.99)	6.51 (2.73)	4.79 (2.40)	2.83 (1.95)	3.31 (2.06)	2.43 (1.84)	0.92 (1.37)	3.76
11.	IC-117245	1.63 (1.61)	4.05 (2.24)	4.67 (2.37)	5.47 (2.53)	7.28 (2.87)	6.34 (2.70)	4.45 (2.32)	3.60 (2.13)	3.47 (2.10)	1.76 (1.65)	1.11 (1.44)	3.98
12.	EC-169408	1.22 (1.47)	2.86 (1.95)	3.50 (2.11)	4.17 (2.26)	6.28 (2.69)	8.11 (3.01)	5.14 (2.47)	3.54 (2.12)	2.62 (1.89)	2.25 (1.79)	1.45 (1.55)	3.74
13.	EC-112241	2.26 (1.79)	2.74 (1.92)	3.64 (2.14)	4.73 (2.38)	6.60 (2.75)	8.18 (3.02)	4.84 (2.41)	3.26 (2.05)	2.35 (1.82)	2.22 (1.78)	1.26 (1.49)	3.82
14.	IC-117333	2.43 (1.84)	3.47 (2.10)	4.51 (2.34)	4.84 (2.41)	7.29 (2.87)	8.68 (3.10)	4.84 (2.41)	3.30 (2.06)	3.33 (2.07)	1.33 (1.51)	1.09 (1.43)	4.01
15.	EC-169459	2.40 (1.83)	1.90 (1.69)	3.42 (2.09)	4.35 (2.30)	5.78 (2.59)	6.53 (2.73)	4.38 (2.31)	3.45 (2.10)	2.52 (1.86)	1.17 (1.46)	0.85 (1.34)	3.34
16.	IC-341190-C	2.37 (1.82)	3.57 (2.13)	3.40 (2.09)	4.05 (2.24)	7.70 (2.94)	9.26 (3.20)	6.26 (2.69)	4.37 (2.31)	3.24 (2.05)	2.33 (1.81)	0.93 (1.37)	4.32
17.	EC-112231	2.51 (1.86)	4.58 (2.35)	5.20 (2.48)	6.20 (2.67)	7.12 (2.84)	7.99 (2.99)	6.27 (2.69)	4.65 (2.37)	3.16 (2.03)	2.38 (1.82)	1.66 (1.62)	4.70
18.	IC-033206	1.47 (1.56)	2.66 (1.90)	3.44 (2.10)	4.07 (2.24)	6.20 (2.67)	7.61 (2.93)	4.55 (2.35)	3.61 (2.14)	2.75 (1.92)	2.09 (1.74)	1.60 (1.60)	3.64
19.	EC-169417	3.08 (2.01)	5.31 (2.50)	7.18 (2.85)	8.46 (3.07)	12.74 (3.70)	14.69 (3.95)	9.76 (3.27)	7.58 (2.92)	5.06 (2.45)	3.39 (2.08)	1.75 (1.64)	7.18
20.	SB-6	1.92 (1.69)	2.46 (1.85)	4.80 (2.40)	5.85 (2.61)	10.40 (3.37)	8.64 (3.10)	8.03 (3.00)	6.62 (2.75)	3.30 (2.06)	2.71 (1.91)	1.16 (1.45)	5.08
SE(m)		0.26	0.17	0.15	0.20	0.21	0.20	0.20	0.18	0.82	0.23	0.20	--
C.D.		0.75	0.49	0.45	0.60	0.62	0.59	0.59	0.53	2.36	0.67	0.59	--

Average* of three replication SW=Standard Week Figure in parenthesis are √x+0.5 transformed value (where x=Actual number)

Table 2: Screening of okra genotypes against *B. tabaci* under field conditions during 2019-20

Tr. No.	Genotype/Variety	Average* number of whiteflies per 3 leaves at different standard weeks											
		36SW	37 SW	38 SW	39 SW	40 SW	41 SW	42 SW	43 SW	44 SW	45 SW	46SW	Mean
1.	Arka Anamika(R)	0.85 (1.34)	1.43 (1.54)	1.63 (1.61)	2.27 (1.79)	3.10 (2.01)	4.16 (2.26)	2.13 (1.75)	1.81 (1.46)	1.45 (1.55)	0.61 (1.25)	0.44 (1.18)	1.81
2.	Varsha Uphar	0.97 (1.39)	1.86 (1.68)	1.93 (1.70)	2.77 (1.93)	3.47 (2.10)	4.55 (2.35)	3.32 (2.07)	2.83 (1.94)	2.06 (1.73)	1.16 (1.45)	0.59 (1.24)	2.32
3.	Punjab Padmini	0.86 (1.35)	1.24 (1.48)	2.01 (1.72)	2.29 (1.80)	3.76 (2.17)	4.11 (2.25)	2.29 (1.80)	2.13 (1.75)	1.51 (1.57)	0.62 (1.25)	0.69 (1.28)	1.96
4.	Hisar Unnat	0.83 (1.33)	1.91 (1.69)	2.30 (1.80)	3.20 (2.04)	4.57 (2.35)	6.18 (2.67)	3.47 (2.10)	3.09 (2.01)	2.56 (1.87)	1.26 (1.49)	0.55 (1.22)	2.72
5.	Parbhani Kranti	2.72 (1.92)	4.59 (2.35)	5.41 (2.52)	7.82 (2.96)	15.40 (4.04)	18.71 (4.43)	10.13 (3.33)	6.51 (2.73)	5.49 (2.54)	3.43 (2.09)	2.30 (1.80)	7.50
6.	Kashi Satdhari	2.53 (1.87)	4.24 (2.28)	5.15 (2.47)	6.51 (2.73)	10.19 (3.34)	13.09 (3.75)	8.79 (3.12)	6.27 (2.69)	5.29 (2.50)	3.86 (2.19)	1.89 (1.69)	6.16
7.	PusaSawani(S)	2.76 (1.93)	5.17 (2.47)	6.83 (2.79)	8.91 (3.14)	13.23 (3.77)	18.79 (4.44)	11.17 (3.48)	9.19 (3.18)	6.66 (2.76)	4.68 (2.41)	2.46 (1.85)	8.17
8.	P-7	1.90 (1.69)	2.19 (1.77)	2.68 (1.91)	3.13 (2.02)	6.32 (2.70)	6.72 (2.77)	4.58 (2.35)	3.42 (2.09)	2.67 (1.90)	0.97 (1.39)	1.16 (1.45)	3.25
9.	Pusa A-4	0.69 (1.28)	1.34 (1.51)	2.14 (1.78)	2.37 (1.82)	3.87 (2.20)	4.23 (2.28)	2.56 (1.87)	2.12 (1.75)	1.45 (1.55)	0.67 (1.28)	0.39 (1.16)	1.98
10.	EC-169419	1.69 (1.62)	2.41 (1.83)	2.92 (1.97)	4.12 (2.25)	5.92 (2.62)	8.25 (3.03)	5.22 (2.48)	4.43 (2.32)	2.76 (1.93)	2.50 (1.86)	1.40 (1.53)	3.78
11.	IC-117245	1.96 (1.71)	3.58 (2.13)	5.66 (2.57)	8.55 (3.08)	8.90 (3.14)	12.65 (3.69)	6.24 (2.68)	4.27 (2.28)	2.60 (1.88)	1.76 (1.65)	0.99 (1.39)	5.20
12.	EC-169408	2.05 (1.73)	2.83 (1.94)	3.05 (2.00)	4.64 (2.36)	6.15 (2.66)	8.18 (3.02)	5.59 (2.56)	3.46 (2.10)	2.46 (1.85)	2.88 (1.96)	1.20 (1.47)	3.95
13.	EC-112241	2.06 (1.73)	4.15 (2.26)	4.58 (2.35)	8.36 (3.05)	6.72 (2.77)	12.23 (3.63)	6.33 (2.70)	4.59 (2.35)	3.55 (2.12)	2.69 (1.91)	1.90 (1.69)	5.20
14.	IC-117333	2.43 (1.84)	4.04 (2.23)	4.08 (2.24)	6.58 (2.74)	10.42 (3.37)	8.25 (3.03)	8.00 (2.99)	6.34 (2.70)	3.18 (2.03)	1.83 (1.67)	1.05 (1.41)	5.11
15.	EC-169459	2.22 (1.78)	4.63 (2.36)	5.39 (2.52)	7.70 (2.94)	9.48 (3.23)	13.58 (3.81)	7.89 (2.97)	5.49 (2.54)	3.72 (2.16)	2.72 (1.92)	1.55 (1.58)	5.85
16.	IC-341190-C	2.09 (1.74)	4.06 (2.24)	4.81 (2.40)	7.95 (2.98)	9.08 (3.17)	12.07 (3.61)	6.59 (2.75)	4.23 (2.28)	3.36 (2.08)	2.34 (1.81)	1.15 (1.45)	5.25
17.	EC-112231	1.55	3.24	5.16	7.95	8.66	6.31	4.93	3.46	2.33	1.66	1.40	4.24

		(1.58)	(2.05)	(2.47)	(2.98)	(3.10)	(2.69)	(2.42)	(2.10)	(1.88)	(1.62)	(1.53)	
18.	IC-033206	1.98 (1.71)	3.31 (2.06)	3.90 (2.20)	4.98 (2.44)	5.79 (2.60)	7.86 (2.97)	5.75 (2.59)	4.08 (2.24)	3.09 (2.01)	2.49 (1.85)	1.27 (1.49)	4.05
19.	EC-169417	2.85 (1.95)	4.44 (2.32)	6.86 (2.79)	9.68 (3.26)	14.02 (3.87)	18.18 (4.37)	12.53 (3.67)	10.27 (3.35)	5.64 (2.57)	3.59 (2.13)	1.61 (1.60)	8.15
20.	SB-6	2.56 (1.87)	4.19 (2.27)	5.49 (2.54)	8.28 (3.03)	12.61 (3.68)	15.60 (4.07)	10.62 (3.40)	8.25 (3.03)	6.02 (2.64)	3.26 (2.05)	2.65 (1.90)	7.23
SE(m)		0.18	0.22	0.22	0.22	0.78	0.35	0.23	0.21	0.23	0.25	0.21	--
C.D.		0.52	0.64	0.64	0.65	2.25	1.02	0.67	0.61	0.67	0.72	0.61	--

Average* of three replication SW=Standard Week Figure in parenthesis are √x+0.5 transformed value (where x=Actual number)

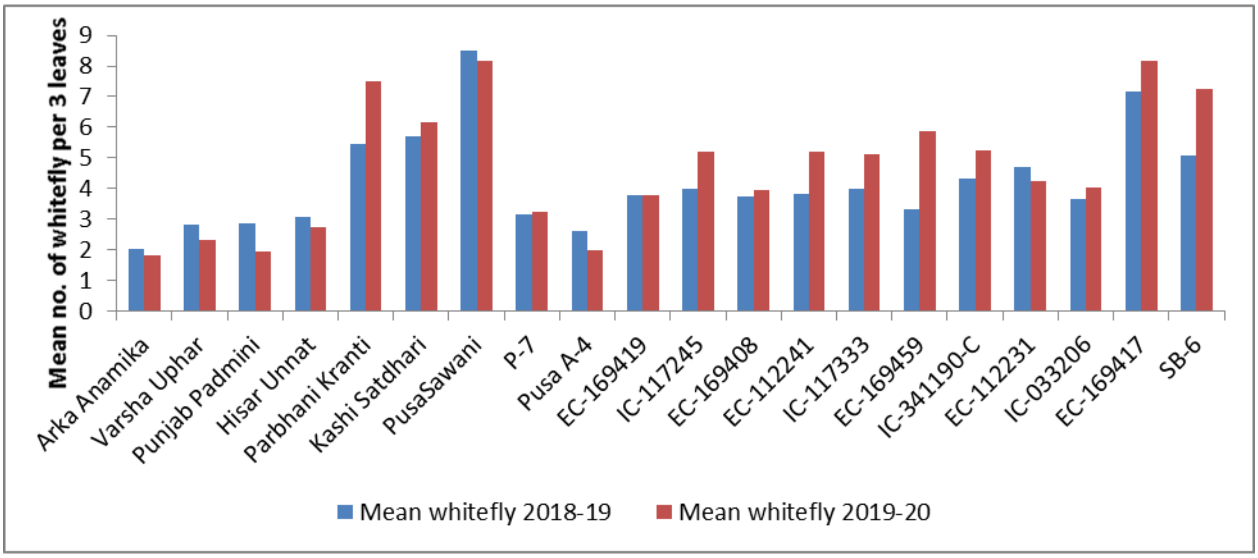

Fig 1: Screening of okra genotypes against *B. tabaci* under field conditions during 2018-19 & 2019-20

Conclusion

While screening twenty selected variety/genotype it was clear that variety Arka Anamika and Pusa A-4 were found to be resistant for whitefly population and on the other site PusaSawani and EC-169417 were recorded to be susceptible with highest average whitefly population during both the year of experimentation.

Acknowledgements

The authors acknowledge Prof. Anand Kumar Singh (Ex. Head, Department of Horticulture) for their assistance, encouragement and cooperation during the research. The authors also acknowledge Institute of Agricultural sciences, Banaras Hindu University, for their kind support during experimentation.

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