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Varietal Screening of French Bean (*Phaseolus vulgaris* L.) Varieties against Spider Mite, *Tetranychus urticae* Koch under Field Condition

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A B S T R A C T

An experiment was carried out to screen twelve French bean varieties against two spotted spider mite, *T. urticae* under open field condition. Among the twelve cultivars screened for their reaction to spider mite *T. urticae*, the descending order of these French bean varieties were as Gujarat Rajmah>Arka Komal> HUR-137 > IPR-98-5 >Suvidha>Arka Bold >ArkaAroop> IVFB-1 > HUR-203 > PDR-14 > HUR-15 > IPR-98-31.

Introduction

French bean is one of the very profitable cool season legume vegetable grown for its tender pods, shelled green beans and dry beans. The dry seed type varieties are called as "Rajmah" in India. It is valued for its protein rich (23%) seeds. They are also rich in calcium, phosphorus and iron. Globally French bean is cultivated on about 28 m ha with a production of 19 million tonnes. In India, it is grown on an area of about 1 lakh ha mainly in the states of Maharashtra (60,000 ha), Jammu and Kashmir (10,000 ha), Himachal Pradesh and Uttar Pradesh Hills, Nilgiri (Tamil Nadu) and Palni (Kerala) hills, Chickmagalur (Karnataka) and Darjeeling hills (West Bengal). In Gujarat, it is grown near the metro cities like Surat, Baroda, Ahmedabad, and Rajkot under poly houses as well as in open field for continuous supply of its fresh tender pods for vegetable purpose. Indiscriminate use of pesticides has not only caused the resistance in phytophagous mites but also has polluted the environment. Integrated pest management is the solution to the problems of the resistance and environmental pollution. Use of resistant varieties is a component of Integrated Pest Management. Heavy incidence of insect and mite pests has been observed under protected as well as in open field on French bean due to congenial environmental conditions. Spider mite belongs to the family Tetranychidae are among the destructive pests of many agri-horticultural crops in many parts of the world. *Tetranychus urticae* Koch, commonly known as two spotted red spider mite, is

acosmopolitan mite pest reported as serious pest on many economically important plants like French bean, cucurbits, cotton, alfalfa, flowers *etc*. (Meyer and Rodriguez, 1966; Manjulata *et al*., 2002).Two spotted spider mite infests the underside of leaves, where profuse webbing may be present. The rapid developmental rate, short generation time and high net reproductive rate of *T. urticae* allows them to achieve damaging population levels very quickly when growth conditions are good, resulting in an equally rapid decline of host plant quality (Najafabadi, 2012). Host plant resistance is one of the important component of IPM, the search for resistant varieties starts with screening of available plant materials of diverse origin. The present study undertaken to evaluate the French bean varieties for identifying the possible resistant varieties against infestation of *T. urticae*.

Materials and Methods

Twelve French bean varieties were evaluated for their reaction to *T. urticae* in open field condition. The seeds of all twelve varieties were sown in separate bed on 22nd December 2015. All standard agronomic practices were followed for the sowing. Sowing of varieties was done in open field and utilized for screening against spider mite, *T. urticae.* Weekly observation on the population of spider mite, *T. urticae* was taken commencing from a fortnight after germination and continued throughout entire crop period. For the purpose of investigation five plants were randomly selected each time and each variety replication wise. Population densities of spider mite was assessed by taking three random leaves representing top, middle and bottom canopy of the plant from respective variety. Thus, in all 15 leaves/replication were observed at one time for each variety. The plucked leaves were held in separate polythene bags which were properly labelled and brought to Acarology laboratory for examination under stereo binocular microscope. On each leaf, the spider mite, *T. urticae* was counted (mobile stages) under stereo binocular microscope on 2 cm^2 leaf area. The data on numerical count were averaged and converted to per unit area (per leaf bit or per leaf) and analysed statistically using Completely Randomized Design (CRD). On the basis of the average number of mites present on each leaf of French bean, the reactions of plant were worked out to spider mite. To enumerate host plant resistance based on morphophysical characters of leaves of all the twelve cultivars of French bean, the observations for morphological characters of leaves *viz*., length of leaf hair (mm), plant height (cm), number of leaves per plant, thickness of leaf lamina (mm) and density of leaf hairs were recorded in the same way as done in the sampling of spider mites described during crop period. The numbers of hairs was converted in 2 cm^2 area from upper and lower surface of leaf was recorded from the middle area of the leaf. The thickness of leaf lamina was recorded with digital Vernier Callipers instrument by placing two equal width acrylic sheets, and places the French bean leaves in between them. The measurement was taken with constant temperature and pressure during observation, from middle area of the leaf. The number of leaves was measured by selecting leaves randomly from upper, middle and bottom portion of the plants. The plant height was measured with the help of meter rod in cm^2. The length of leaf hair, and leaf hair density was recorded with Scope Software.

Results and Discussion

Population of spider mite, *T. urticae* on various French bean varieties

During the period of present investigations, twelve French bean varieties were screened for their reaction to spider mite, *T. urticae*

under open field condition, the observations on the population of *T. urticae* were recorded at weekly interval from January 2015 to June 2015. It is seen from the population data presented in Table 2 that in 1st SMW the population of spider mite ranged from 0.93 mites per 2 cm^2leaf to 5.53 mites per 2 cm^2 leaf. The lowest population was recorded on IPR-98-31 and the highest population was recorded on HUR-137. In 2nd SMW the lowest spider mite population were recorded on PDR-14 (1.53 mites/2 cm^2 leaf), whereas the highest spider mite population were recorded on Gujarat Rajmah (6.93 mites/2 cm^2 leaf) followed by 6.27 and 5.13 mites per 2 cm^2 leaf on various cultivar viz., ArkaKomal and Hur-137. During the 3rd SMW the intensity of spider mite population was increased gradually and ranging between 1.37 to 6.03 mites per 2 cm^2 leaf whereas in 4th SMW the spider mite population were ranging between from 1.23 to 6.46 mites per 2 cm^2 leaf, whereas, in the 5th SMW the spider mite population were fluctuate on some of the French bean cultivar, the population of spider mite was increased whereas in some of the cultivar the population of spider mite were decreased. In French bean cultivars IPR-98-5, IPR-98-31, Arka Aroop, Arka Bold, HUR-137, PDR-14 the spider mite population was decreased and on HUR-15, ArkaKomal, Gujarat Rajmah, Suvidha, HUR-203 it increased. During the 6th SMW the intensity of infestation ranged between 1.13 to 4.47 mites per 2 cm^2 leaf whereas in the 7th SMW the population of spider mite were ranged between 1.47 to 7.33 mites per 2 cm^2 leaf, whereas in 8th SMW the population were ranged between 0.80 to 4.73 mites per 2 cm^2 leaves. During 9th to 11th SMW the spider mite population was gradually increased. In 12th SMW the population of spider mite fluctuates, on some of the French bean varieties, the spider mite population was increased, while in some of the varieties like IVFB -1, IPR-98-31, Suvidha *etc*. were decreased. The highest population of spider mite was recorded during 11th, 15th, 17th, 18th, 21st, and 23rd SMW. On the basis of overall mean of spider mite population on different French bean varieties the descending order were: Gujarat Rajmah>ArkaKomal> HUR-137 > IPR-98-5 >Suvidha>Arka Bold >ArkaAroop> IVFB-1 > HUR-203 > PDR-14 > HUR-15 > IPR-98-31. In past, Ramireddy *et al.,* (2004) recorded least incidence of *T. urticae* on Angel Bell and highest on Collection No-10 of chrysanthemum germplasm. According to Hole and Salunkhe (2005) the rose cultivars Rajhans was found to be the most promising recording the lowest population of mites, while cultivar Arjun recorded the maximum number of mites. Bhusal (2011) reported Jaya and IIHR-6 varieties of chrysanthemum less susceptible to *T. urticae* whereas, Toke (2010) reported rose variety Shakira as tolerant to *T. urticae* under poly house conditions. Further in recently, Shukla and Radadia (2015) also reported that among the carnation varieties the variety Domingo was highly tolerant to spider mite, while variety Rubisco was highly susceptible to spider mite attack. Thus, more or less support the present findings.

Morphological character of French bean varieties

During the experiment period, the various morphological characters of all the twelve French bean varieties were recorded. The various characters were presented in the Table 3. They were just discussed in the light of incidence of mean number of spider mite population. The data recorded were plant height, number of leaves per plant, thickness of leaves, length of leaf hair and density of hair on leaf surface. Out of various parameters contributing towards final yield of the crop, the number of leaves per plant and plant height is of prime importance.

Table.1 Population of spider mite, *T. urticae* French bean varieties under open field condition (year 2015)

SMW	Varieties of French bean											
	IVFB-1	**IPR-98-5**	**ArkaAroop**	**Arka Bold**	**PDR-14**	**HUR-15**	**IPR-98-31**	**ArkaKomal**	**Gujarat Rajmah**	**HUR-137**	**Suvidha**	**HUR-203**
1.	2.33	3.67	3.07	2.73	2.00	1.20	0.93	3.80	5.13	5.53	2.93	1.67
2.	4.00	3.67	3.00	4.27	1.53	2.20	1.80	6.27	6.93	5.13	4.20	3.33
3.	3.17	3.67	3.03	3.50	1.77	1.70	1.37	5.03	6.03	5.33	3.57	2.50
4.	2.84	3.70	4.31	4.97	1.80	1.23	1.48	5.39	6.46	4.28	2.42	2.61
5.	4.33	3.07	3.07	3.20	1.53	1.40	1.20	5.60	7.20	3.53	2.93	3.33
6.	2.87	2.87	2.93	4.27	1.67	1.13	1.40	4.00	4.47	3.20	3.60	4.00
7.	4.53	4.93	4.20	3.73	2.20	1.53	1.47	5.40	7.33	4.60	4.40	3.07
8.	2.60	3.07	3.00	4.27	1.80	1.27	0.80	4.00	4.73	3.13	3.60	4.20
9.	4.27	5.07	4.07	3.47	2.07	1.40	1.47	5.33	7.33	4.53	4.53	3.20
10.	3.80	4.93	4.20	3.73	2.20	1.53	1.27	4.80	7.20	4.53	4.27	2.80
11.	4.53	5.07	4.20	3.80	1.80	1.47	1.60	4.93	8.13	4.53	440	3.07
12.	3.80	4.93	4.20	3.73	2.20	1.53	1.27	4.80	7.20	4.53	4.27	2.80
13.	3.80	4.93	4.20	3.73	2.20	1.53	1.27	4.80	7.20	4.53	4.27	2.80
14.	2.60	3.07	3.00	4.27	1.80	1.27	0.80	4.00	4.73	3.13	3.60	4.20
15.	4.53	5.07	4.20	3.80	1.80	1.47	1.60	4.93	8.13	4.53	4.40	3.07
16.	3.80	4.93	4.20	3.73	2.20	1.53	1.27	4.80	7.20	4.53	4.27	2.80
17.	4.53	5.07	4.20	3.80	1.80	1.47	1.60	4.93	8.13	4.53	4.40	3.07
18.	4.53	5.07	4.20	3.80	1.80	1.47	1.60	4.93	8.13	4.53	4.40	3.07
19.	3.80	4.93	4.20	3.73	2.20	1.53	1.27	4.80	7.20	4.53	427	3.07
20.	3.80	4.93	4.20	3.73	2.20	1.53	1.27	4.80	7.20	4.53	4.27	3.07
21.	4.53	5.07	4.20	3.80	1.80	1.47	1.60	4.93	8.13	4.53	4.40	3.07
22.	2.60	3.07	3.00	4.27	1.80	1.27	0.80	4.00	4.73	3.13	3.60	4.220
23.	4.53	5.07	4.20	3.80	1.80	1.47	1.60	4.93	8.13	4.53	4.40	3.07
Seasonal Mean	**3.75±0.77**	**4.34±0.87**	**3.79±0.58**	**3.83±0.43**	**1.91±0.22**	**1.46±0.21**	**1.34±0.28**	**4.84±0.58**	**6.83±1.24**	**4.35±0.67**	**3.97±3.11**	**3.11±0.59**

Table.2 Reaction of French bean cultivars against *T. urticae* in open field condition

S. No.	Cultivars	Min.	Max.	Mean ± S. D.	Reaction to spider mite
1	IVFB-1	2.33	4.53	3.75 ± 0.77	Less Susceptible
2	IPR-98-5	2.87	5.07	4.34 ± 0.87	Medium Susceptible
3	ArkaAroop	2.93	4.31	3.79 ± 0.58	Less Susceptible
4	Arka Bold	2.73	4.97	3.83 ± 0.43	Less Susceptible
5	PDR-14	1.53	2.20	1.91 ± 0.22	Tolerant
6	HUR-15	1.13	2.20	1.46 ± 0.21	Tolerant
7	IPR-98-31	0.80	1.80	1.34 ± 0.28	Tolerant
8	ArkaKomal	3.80	6.27	4.84 ± 0.58	Medium Susceptible
9	Gujarat Rajmah	4.47	8.13	6.83 ± 1.24	Highly Susceptible
10	HUR-137	3.13	5.53	4.35 ± 0.67	Medium Susceptible
11	Suvidha	2.42	4.53	3.97 ± 3.11	Less Susceptible
12	HUR-203	1.67	4.20	3.11 ± 0.59	Less Susceptible

Table.3 Biomorphological character of French bean cultivars in field condition

S. No.	Name of Cultivars	Mite population Mean±S. D.	No. of leaves per plant Mean±S.D.	Plant height (cm) Mean±S.D.	Thickness of leaf lamina (mm) Mean± S.D.	Length of leaf hair (mm) (Mean)	Leaf hair density (cm^2) Mean±S.D.
1	IVFB-1	3.75 ±0.77	157.00±0.00	51.00±2.00	0.47±0.01	0.04	41.33±1.15
2	IPR-98-5	4.34 ±0.87	151.67±2.89	40.33±2.52	0.43±0.01	0.03	36.33 ±0.58
3	ArkaAroop	3.79 ±0.58	159.33±0.58	53.67±2.08	0.51±0.02	0.03	42.67 ±0.58
4	Arka Bold	3.83 ±0.43	159.00±6.08	52.33±1.53	0.52±0.01	0.03	43.00 ±1.00
5	PDR-14	1.91 ±0.22	165.67±4.04	61.33±4.16	0.62±0.01	0.05	47.33 ±2.52
6	HUR-15	1.46 ±0.21	171.67±10.41	63.00±1.00	0.58±0.02	0.04	43.00 ±1.00
7	IPR-98-31	1.34 ±0.28	171.67±7.64	61.33±2.08	0.62±0.01	0.05	42.33 ±0.58
8	ArkaKomal	4.884±0.58	158.33±7.64	43.00±3.61	0.46±0.01	0.03	37.00 ±1.00
9	Gujarat Rajmah	6.83±0.1.2	140.00±5.00	33.33±1.53	0.35±0.01	0.03	31.67 ±2.89
10	HUR-137	4.35 ±0.67	151.67±2.89	42.67±3.21	0.44±0.02	0.03	37.33 ±1.15
11	Suvidha	3.97 ±0.58	158.33±3.21	51.67±3.51	0.51±0.01	0.03	38.33 ±0.58
12	HUR-203	3.11 ±0.59	153.33±0.58	53.00±2.65	0.51±0.01	0.04	39.33 ±2.31

The spider mite population and the number of leaves per plant of different cultivars were recorded and it is evident from the Table 3 that the mean spider mite population was highest on Gujarat Rajmah (6.83 mites/2 cm^2 leaf) in open field condition, that's why the spider mite infestation is considerably more, so the plant height, and number of leaves per plant, were recorded less so it is consider as highly susceptible cultivar in field condition. In comparison to the tolerant variety, the spider mite infestation is less and the plant grow healthy, so the plants having maximum numbers of leaves as well as the plant height was also high in comparison to other varieties of French bean grown in open field condition. So, the maximum number of leaves per plant and highest height were recorded in the cultivar PDR-14, HUR-15, and also in IPR-98-31 in open field condition, while the minimum number of leaves and plant height were recorded on Gujarat Rajmah in open field condition. Thickness of leaf is a character that contributes towards resistance and hence effects the spider mite population. The data revealed that the highest thickness of leaf lamina was recorded in tolerance cultivar *i. e.* PDR-14, HUR-15, and also in IPR-98-31, while minimum thickness of leaf lamina were recorded on highly susceptible variety Gujarat Rajmah in open field condition, than from all other cultivar of French bean.

Length of leaf hair on French bean leaves has immense importance in resistance process and impairing spider mite population as they become unable to take their mouth parts at feeding sites. The data are regarding length of leaf hair in millimetre on leaf. The maximum length of leaf hair was recorded on highly tolerant plant *i.e.* PDR-14, HUR-15, and IPR-98-31 in open field condition. Minimum lengths of leaf hair were recorded in cultivar Gujarat Rajmah. In open field condition the highest leaf hair length were recorded (0.05 mm) in less susceptible cultivar PDR-14 and IPR-98-31. Leaf hair density plays an important role on spider mite population as it hinders their feeding. The cultivar PDR-14 (47.00 mites/2 cm^2 leaf), HUR-15 (48.00 mites/2 cm^2 leaf) and (43.00 mites/2 cm^2 leaf), IPR-98-31 were recorded highest leaf hair density under poly house condition. The minimum leaf hair density were recorded on the cultivar Gujarat Rajmah (36.67 mites/2 cm^2 leaf) followed by ArkaKomal (35.33 mites/2 cm^2 leaf). Whereas the maximum leaf hair density were recorded in tolerant variety PDR-14 (47.33 mites/2 cm^2 leaf) followed by in HUR-15 (43.00 mites/2 cm^2 leaf) under open field condition, the minimum leaf hair length (31.67 mites/2 cm^2 leaf) was recorded on Gujarat Rajmah, followed by (36.33 mites/2 cm^2 leaf) on IPR-98-5 variety of French bean. Misra *et al*., (1990) found a significant negative correlation between density of brinjal leaf and mite population. Further, Shah and Shukla (2013) also reported that on various gerbera cultivars, bio-morphological character of plants play important role on spider mite population build-up. Thus, more or less closely support the present findings.

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