

Incidence of Major Pest and Diseases under Natural Field Condition in Pole Type French Bean (*Phaseolus vulgaris* L.) Genotypes

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Abstract— The present investigation was undertaken to identify promising genotypes resistant to major pests and diseases in pole-type French bean. Thirty-two genotypes were evaluated during the Rabi season of 2022–23 at the Regional Agricultural Research Station, Vijayapura, under the University of Agricultural Sciences, Dharwad, Karnataka, India. The experiment was laid out in a Randomized Complete Block Design (RCBD) with two replications under natural field conditions. Significant variation among the genotypes was observed in their response to biotic stresses. Genotypes IC-636224, IC-636225, IC-341797, IC-341922, IC-636240, IC-313309, EC-398555, IC-582514, IIHR-01, and IIHR-02 showed resistance to *Fusarium* wilt with 0–10% mortality. These same genotypes exhibited no symptoms of Bean common mosaic virus and were classified as immune. Similarly, genotypes IC-636224, IC-341797, IC-341807, IC-341922, IC-636240, IC-430379, IC-313309, IC-582514, IC-538073, IC-632961, IC-313320, IC-538077, IC-326977, IIHR-01, and IIHR-02 showed resistance to pod borer with 1–12% pod damage. Furthermore, genotypes IC-538077, IC-582511, IC-632961, IC-326978, IC-328398, IC-313309, IC-430379, and IC-641919 showed no aphid infestation. These lines may be effectively utilized in breeding programmes to develop new varieties with enhanced resistance to insect pests and diseases.

Keywords— *Fusarium wilt*, *Bean common mosaic virus*, *Pod borer*, *Aphids*, *Pole-type French bean*.

I. INTRODUCTION

French bean (*Phaseolus vulgaris* L.) is one of the most common and widely grown vegetable crops in India with a chromosome number of $2n=22$. According to Vavilov (1950), the origin of French bean is Southern Mexico and Central America, while the Peruvian-Ecuadorian-Bolivian area is considered to be a secondary centre of origin. It originated from the wild species *Phaseolus aborigineus* (L.) and was domesticated in Mexico, Peru, and Colombia about 8000 years ago. This crop has extensive geographical distribution in the world.

It is an important legume vegetable belonging to the family Leguminosae or Fabaceae and has worldwide significance as a source of food and feed. The genus *Phaseolus* contains about 70-80 species, among which *Phaseolus vulgaris* (L.) accounts for 90 per cent of cultivated species around the world (Evans, 1979). There are four cultivated species of *Phaseolus* viz., *Phaseolus vulgaris*, *P. coccineus*, *P. lunatus*, and *P. acutifolius* var. *latifolius*, wherein all the species are self-pollinated except *P. coccineus*, which is cross-pollinated.

French bean is known by several names related to its purpose of usage as a vegetable viz., string bean, snap bean, salad bean, haricot bean, and green bean. However, the terms bean, dry bean, kidney bean, and navy bean are designated to pulses (George, 1985). Furthermore, string bean, dwarf bean, and pole bean pertain to distinct growth patterns. In different languages, it has

diverse identities viz., rajmash in Hindi and tingala avare in Kannada. French bean varieties are categorized based on their growth habits i.e., bush type with compact segments, semi-pole type with more extended segment, and pole type with viny growth longer than semi-pole type (Prabhakar et al., 2016).

French bean has a wide range of genetic variations in terms of growth habit (determinate vs. indeterminate), days to maturity, seed size, colour and quality (cooking ability and palatability), vegetative and reproductive growth, pigmentation, leaf size, shape and orientation, and resistance to pests (Leakey, 1970). The choice of promising genotypes from a diverse genetic base and their subsequent utilization for hybridization is one of the strategies for improving the productivity of any crop including beans.

It is cultivated all over the world and has a wide geographical distribution. French bean is mainly used for immature green pods. Rajmash or dried pods are utilized as a pulse and provide a good source of protein for humans (Abate, 2006). Immature pods are eaten fresh and can be easily preserved by freezing, canning, or dehydrating. Dried beans are eaten boiled, baked, fried, or ground into flour. It is highly nutritious as 100 g of green pods contain 1.7 g protein, 4.5 g carbohydrates, 221 IU vitamin A, 11 mg vitamin C, and 50 mg calcium (Gopalakrishnan, 2007). French bean can be used to some extent against diabetes and cardiac problems and is a wonderful natural cure for bladder burn. It has both carminative and reparative qualities in the treatment of constipation and diarrhea (Duke, 1981).

French bean is a short-duration crop; hence, it can be grown in various cropping systems across the hills and plains of India. This vegetable is predominantly cultivated in the states of Himachal Pradesh, Punjab, Haryana, Uttar Pradesh, Bihar, Gujarat, Madhya Pradesh, Maharashtra, Karnataka, Andhra Pradesh, and Tamil Nadu. The total cultivation area for French bean in India is around 2.9 lakh hectares with an annual production of 27.25 lakh tonnes and an average productivity of 9.09 tonnes per hectare. In Karnataka, this crop is grown in an area of 0.17 lakh hectares with 1.94 lakh tonnes of production and productivity of 11.07 tonnes per hectare.

The use of resistant varieties offers a practical and cost-effective approach to managing pests and diseases in green beans. The development and assessment of high-yielding legume varieties with resistance to pests and diseases are crucial for maximizing the crop's production potential (Neritu, 2008). An integrated pest management (IPM) strategy is considered the most effective method for controlling pest problems in beans, as it combines multiple proven techniques to keep pest populations at manageable levels. These methods include cultivating resistant varieties, encouraging natural predators, applying organic and bio-pesticides, practicing crop rotation, and adopting cultural measures such as removing field debris.

This study was undertaken to identify high-yielding bean varieties with strong tolerance to pests and diseases. Accordingly, the present investigation was designed to evaluate insect and disease incidence in pole-type French bean genotypes grown under open conditions.

II. MATERIALS AND METHODS

2.1 Experimental Design and Layout:

The experiment was laid out in a Randomized Complete Block Design (RCBD) with two replications. The genotypes were sown in a plot size of one row each of 3.6 m length. The spacing between rows was 120 cm and the distance between plants was 30 cm.

2.2 Preparation of Experimental Plot and Sowing

The experimental field was ploughed repeatedly and brought to a fine tilth. The recommended dose of farm yard manure (25 tonnes per hectare) and fertilizer dosage of 62.5:100:75 kg NPK per hectare was applied. According to the fertilizer schedule, the full quantity of phosphorous and potassium and half dose of nitrogen were applied as a basal dose, and the remaining half of the recommended nitrogen was top-dressed at 30 and 60 days after sowing. After the layout, the treatments were assigned to different plots in each replication by utilizing a randomization method. The main and sub-water irrigation channels were laid out by considering the slope of the site. The ridges and furrows were opened at 120 cm, and seeds of different genotypes were sown by dibbling on one side of the ridge at 30 cm, and plots were irrigated immediately after the completion of sowing. Wherever seeds did not germinate, gaps were filled by re-sowing seeds within a week. All other activities were carried out as per the recommended package of practices (RPP) given by the University of Horticultural Sciences (UHS), Bagalkot, to grow the crop. The following disease and pest incidences were noticed. The disease and pest incidences under natural epiphytic conditions were calculated by following methodologies.

2.2.1 Fusarium Wilt Incidence (%):

Per cent wilting was calculated by the following formula

$$\text{Per cent wilting} = \frac{\text{Number of plants infected} \times 100}{\text{Total number of plants observed}} \quad (1)$$

ICRISAT established a screening technique for Fusarium wilt incidence (Nene et al., 1981), which was used in this study.

Per cent wilting (mortality)	Disease reaction
0-10% mortality	Resistance
10.1-20% mortality	Moderately resistant
20.1-30% mortality	Moderately susceptible
30.1-50% mortality	Susceptible
Above 50% mortality	Highly susceptible

2.2.2 Bean Common Mosaic Virus (BCMV) Incidence (%):

Per cent damage was calculated by the following formula:

$$\text{Per cent damage} = \frac{\text{Number of plants infected} \times 100}{\text{Total number of plants observed}} \quad (2)$$

Diwakar and Mali (1976) developed the Bean common mosaic virus scale (BCMV), which was used in the present experiment.

Scale	Category	Description
0	Immune	No plants showing BCMV symptoms
1	Resistant	1-5 per cent of plants showing BCMV symptoms
2	Moderately resistant	6-15 per cent of plants showing BCMV symptoms
3	Moderately susceptible	16-25 per cent of plants showing BCMV symptoms
4	Susceptible	26-50 per cent of plants showing BCMV symptoms
5	Highly susceptible	>50 per cent of plants showing BCMV symptoms

2.2.3 Pod Borer Damage (%):

Per cent pod damage was calculated by the following formula:

$$\text{Per cent pod damage} = \frac{\text{Total number of infested pods} \times 100}{\text{Total number of pods observed}} \quad (3)$$

A pod borer incidence scale given by Krishna et al. (2006) was adopted in this study.

Pod damage (%)	Category
01-Dec	Resistant
13-24	Moderately resistant
25-30	Moderately susceptible
>30	Susceptible

2.2.4 Aphid Population:

Five tagged plants were observed in the plot to record the aphid population. The top three leaves were counted, and the average population was calculated.

III. RESULTS AND DISCUSSION

An excellent, cost-effective alternative for pest and disease control is host plant resistance. Pest and disease control in agricultural systems is facilitated by the use of pest and disease-resistant cultivars, which both increase productivity and lower costs. These cultivars also conserve natural resources, cut costs, save time, and are more environmentally friendly than alternative pest and disease management techniques. In general, the growth and yield of pole-type French beans are highly vulnerable to the occurrence of pests and diseases. Among several pests and diseases, Fusarium wilt, Bean common mosaic virus, pod borer, and aphids are particularly important. Hence, considerable importance has been given to finding resistant cultivars since these pests and diseases drastically reduce crop growth, yield, and quality of the pods by adversely affecting the growth of the crop.

3.1 Fusarium Wilt Incidence (%):

Table 1 presents the reaction of pole-type French bean genotypes to Fusarium wilt disease incidence under natural field conditions.

TABLE 1
REACTION OF POLE-TYPE FRENCH BEAN GENOTYPES TO FUSARIUM WILT DISEASE INCIDENCE UNDER NATURAL FIELD CONDITION

Percent wilting (mortality)	Disease reaction	Genotypes
0-10	Resistance	IC-636224, IC-636225, IC-636245, IC-280818, IC-341797, IC-341922, IC-636240, IC-313309, EC-398555, IC-582514, IC-026624, IC-313320, IC-582511, IIHR-01, IIHR-02, Arka Sukomol, Marlida, Super King, US-2
10.1-20	Moderately resistant	IC-636226, IC-636241, IC-641919, IC-341807, IC-430379, IC-538073, IC-538039, IC-326978, IC-326977, IC-538077, Lakshmi, IC-632961
20.1-30	Moderately susceptible	IC-328398
30.1-50	Susceptible	-
>50	Highly susceptible	-

The genotypes viz., IC-636224, IC-636225, IC-636245, IC-280818, IC-341797, IC-341922, IC-636240, IC-313309, EC-398555, IC-582514, IC-026624, IC-313320, IC-582511, IIHR-01, IIHR-02, Arka Sukomol, Marlida, Super King, and US-2 were found to be resistant with per cent mortality of 0-10 per cent. Conversely, it was noted that the genotypes IC-636226, IC-636241, IC-641919, IC-341807, IC-430379, IC-538073, IC-538039, IC-326978, IC-326977, IC-538077, Lakshmi, and IC-632961 were moderately resistant with 10.1-20 per cent incidence. This indicates that the resistant genotypes can be used as donors of resistance to Fusarium wilt disease in further hybridization programmes. These results are in agreement with those reported by Tabasia et al. (2021) and Buruchara and Camacho (2000).

3.2 Bean Common Mosaic Virus Incidence (%):

Table 2 presents the reaction of pole-type French bean genotypes to Bean common mosaic virus (BCMV) disease incidence under natural field conditions.

TABLE 2
REACTION OF POLE-TYPE FRENCH BEAN GENOTYPES TO BEAN COMMON MOSAIC VIRUS (BCMV) DISEASE INCIDENCE UNDER NATURAL FIELD CONDITION

Scale	Disease reaction	Genotypes
0	Immune	IC-636224, IC-636225, IC-641919, IC-341797, IC-341807, IC-341922, IC-636240, IC-430379, IC-313309, EC-398555, IC-582514, IC-328398, IC-326978, IC-632961, IC-538077, IIHR-01, IIHR-02, Marlida, US-2
1	Resistant	IC-538073, IC-313320, Super King
2	Moderately resistant	IC-636241, IC-636245, IC-280818, IC-538039, IC-026624, Lakshmi, IC-636226, Arka Sukomol, IC-326977
3	Moderately susceptible	IC-582511
4	Susceptible	-
5	Highly susceptible	-

The genotypes viz., IC-636224, IC-636225, IC-641919, IC-341797, IC-341807, IC-341922, IC-636240, IC-430379, IC-313309, EC-398555, IC-582514, IC-328398, IC-326978, IC-632961, IC-538077, IIHR-01, IIHR-02, Marlida, and US-2 did not show any symptoms and were classified as immune. Conversely, genotypes with 1-5 per cent incidence (IC-538073, IC-313320, and Super King) belonged to the resistant group, while the moderately resistant group with 6-15 per cent symptoms included IC-636226, IC-636241, IC-636245, IC-280818, IC-538039, IC-326977, IC-026624, Arka Sukomol, and Lakshmi. It is possible to take advantage of resistance breeding for Bean common mosaic virus in French beans with these resistant genotypes. These results are consistent with the findings of Salgar et al. (2021) and Meena et al. (2019).

3.3 Pod Borer Damage (%):

Table 3 presents the reaction of pole-type French bean genotypes to pod damage incidence under natural field conditions.

TABLE 3
REACTION OF POLE-TYPE FRENCH BEAN GENOTYPES TO POD DAMAGE (%) INCIDENCE UNDER NATURAL FIELD CONDITION

Pod damage (%)	Reaction	Genotypes
01-Dec	Resistant	IC-636224, IC-636226, IC-636241, IC-636245, IC-280818, IC-341797, IC-341807, IC-341922, IC-636240, IC-430379, IC-313309, IC-582514, IC-538073, IC-538039, IC-328398, IC-326978, IC-632961, IC-313320, IC-538077, IC-326977, IIHR-01, IIHR-02, Arka Sukomol, Marlida, US-2, Super King, Lakshmi
13-24	Moderately resistant	IC-636225, IC-582511, IC-641919, EC-398555, IC-026624
25-30	Moderately susceptible	-
>30	Susceptible	-

The genotypes like IC-636224, IC-636226, IC-636241, IC-636245, IC-280818, IC-341797, IC-341807, IC-341922, IC-636240, IC-430379, IC-313309, IC-582514, IC-538073, IC-538039, IC-328398, IC-326978, IC-632961, IC-313320, IC-538077, IC-326977, IIHR-01, IIHR-02, Arka Sukomol, Marlida, Super King, Lakshmi, and US-2 were classified into the resistant group with 1-12 per cent pod damage. Meanwhile, the moderately resistant group with 13-24 per cent pod damage included genotypes IC-636225, IC-582511, IC-641919, EC-398555, and IC-026624. This suggests that in a future hybridization programme, the resistant genotypes may be utilized as donors of resistance to the pod borer. Similar findings were also reported by Sahu et al. (2021) and Bharathi et al. (2020).

3.4 Aphid Population:

Table 4 presents the aphid population on the top three leaves of pole-type French bean genotypes under natural field conditions.

TABLE 4
APHID POPULATION ON THE TOP THREE LEAVES UNDER NATURAL FIELD CONDITION

Sl. No.	Genotype	Number of aphids
1	IC-636224	1.68
2	IC-636225	5.35
3	IC-636226	6.3
4	IC-636241	5.7
5	IC-636245	2.05
6	IC-641919	0
7	IC-280818	2.37
8	IC-341797	1.95
9	IC-341807	3.1
10	IC-341922	2.77
11	IC-636240	1.55
12	IC-430379	0
13	IC-313309	0
14	EC-398555	6.1
15	IC-582514	2.9
16	IC-538073	5.02
17	IC-538039	4.15
18	IC-328398	0
19	IC-326978	0
20	IC-326977	4.5
21	IC-026624	3.3
22	IC-632961	0
23	IC-313320	2.07
24	IC-582511	0
25	IC-538077	0
26	IIHR-01	2.15
27	IIHR-02	1.5
28	Arka Sukomol	2.85
29	Lakshmi	3.5
30	Marlida	1.65
31	Super King	2.75
32	US-2	0

The highest number of aphids on the top three leaves was found in genotypes IC-636226 (6.30) followed by EC-398555 (6.10), IC-636241 (5.70), IC-636225 (5.35), IC-538073 (5.02), IC-326977 (4.50), IC-538039 (4.15), Lakshmi (3.50), IC-026624 (3.30), IC-341807 (3.10), IC-582514 (2.90), Arka Sukomol (2.85), IC-341922 (2.77), Super King (2.75), IC-280818 (2.37), IIHR-01 (2.15), IC-313320 (2.07), IC-636245 (2.05), IC-341797 (1.95), IC-636224 (1.68), Marlida (1.65), IC-636240 (1.55), and IIHR-02 (1.50). However, genotypes IC-538077, IC-582511, IC-632961, IC-326978, IC-328398, IC-313309, IC-430379, and IC-641919 did not show any aphid infestation. These genotypes may be utilized in the development of new varieties of pole-type French bean. Similar findings of aphid-less genotypes were also reported by Sahu et al. (2021).

IV. CONCLUSION

The results of the present investigation revealed significant variability among the thirty-two pole-type French bean genotypes with respect to resistance against major pests and diseases. Genotypes such as IC-636224, IC-341797, IC-341922, IC-636240, IC-313309, EC-398555, IC-582514, IIHR-01, IIHR-02, Marlida, and US-2 exhibited promising resistance to Fusarium wilt and Bean common mosaic virus, indicating their potential use as donor parents in future hybridization programmes. Likewise, genotypes IC-538077, IC-632961, IC-328398, IC-326978, IC-430379, and IC-313309 demonstrated resistance to pod borer and aphids and may serve as valuable genetic resources for developing pest-resistant varieties. Overall, these identified genotypes can be effectively utilized in breeding programmes aimed at developing high-yielding pole-type French bean varieties with enhanced resistance to major pests and diseases.

DISCLAIMERS

The authors present only their findings and take full responsibility for the accuracy and quality of the content. The views expressed are solely those of the authors.

INFORMED CONSENT

No animals were used during the research. Plant material used in this study was obtained from the germplasm collection.

CONFLICT OF INTEREST

Neither author has a conflict of interest. No funding or sponsorship was involved in the design or article preparation

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