

Original Research Article

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Incidence of Whiteflies and Viral Diseases of Bittergourd (*Momordica charantia* L.) in Southern Karnataka, India

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ABSTRACT

Surveys conducted on the incidence of whiteflies (*Bemisia tabaci* Gen.) and viral diseases on bitter gourd at Bengaluru, Mandya, Mysuru, Tumkur, Kolar and Chikkaballapur districts of South Karnataka during 2015-16 and 2016-17. In 2015-16 Kharif, Disease Incidence (DI) ranged from 19.25 to 40.67% and Vulnerability Index (VI) 12.83 to 27.11% with a whitefly population of 2.74 to 5.81 per plant in Tumakuru and Mandya districts respectively. In rabi season, disease incidence ranged from 23.85 to 50.56% and vulnerability index 15.90 to 33.70% with a whitefly population of 3.32 to 7.23 per plant in Mysore and Chikkaballapur districts. During 2016-17, in Kharif, disease incidence ranged from 18.18 to 45.44% and vulnerability index 12.12 to 30.30% with a whitefly population of 2.54 to 6.51 per plant in Mysuru and Mandya districts, respectively. In rabi season, disease incidence ranged from 27.00 to 48.85% and vulnerability index was 18.00 to 32.57% with a whitefly population of 3.82 to 6.98 per plant in Mysore and Kolar districts respectively. A positive correlation with disease incidence and whitefly population on bitter gourd was obtained. The activity of whiteflies and the viral disease incidence recorded higher in rabi than in kharif.

Keywords

Bitter gourd, Virus, Whiteflies, Survey, district, Village

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Introduction

Bitter gourd (*Momordica charantia* L.) is an important vegetable crop grown across the Indian subcontinent belongs to the family Cucurbitaceae. In India, this crop is cultivated both commercial scale and in kitchen gardens during the spring-summer and rainy season, particularly in Kerala, Tamil Nadu, Karnataka, Maharashtra and Utter Pradesh. It is of old world origin and is a native of

tropical Asia, particularly in the Indo-Burma region. The crop is widely grown in India, Indonesia, Malaysia, China and tropical Africa. The immature tuberculate fruits have unique bitter taste consumed as vegetables, which are very low in calories but with dense precious nutrients and excellent source of vitamins B1, B2, and B3, C, magnesium, folic acid, zinc, phosphorus, manganese, iron and has high dietary fiber.

Bitter gourd is often used in Chinese cooking for its bitter flavor, typically in stir-fries, soups, and also as tea. The fruit as a juice and leaf as a tea is employed for diabetes, colic, sores, wounds, infections, worms, parasites, measles, hepatitis, treating fever, tumors and purifying blood. Similarly several medicinal properties of the bitter gourd is well documented by various researchers, such as anti-diabetic, anti-ulcerogenic, anti-mutagenic, antioxidant, anti-tumour, anti-lipolytic, analgesic, abortifacient, anti-viral, hypoglycemic and immunomodulatory. An In-vitro studies showed that the bitter gourd proteins (α - and β -monocharin) have inhibitory effect against HIV virus and broad-spectrum anti-microbial activity.

Many In-vivo studies have demonstrated the relatively low toxicity of all parts of the bitter gourd plant when ingested orally (Kandangath *et al.*, 2015). Considering the above its medicinal properties to cure many human health disorders, people have shown interest to include *M. charantia* in their diet and hence the demand of bitter gourd has increased (Raj *et al.*, 2005). Bitter gourd (*M. charantia*) is natural host of many viruses, which affected the cultivation and their production all over the world (Tiwari *et al.*, 2010). The important viruses affecting bitter gourd are Cucumber mosaic virus (CMV) (Nagarajan and Ramakrishnan, 1971), Papaya ring spot virus (PRSV-W), Indian cassava mosaic virus (ICMV), Bitter gourd yellow mosaic virus (Rajinimala *et al.*, 2005), Pepper leaf curl Bangladesh virus (PepLCBV) (Raj *et al.*, 2010) and Tomato leaf curl New Delhi virus (ToL CNDV) (Tiwari *et al.*, 2010). The bitter gourd mosaic is caused by different viruses. Cucumber mosaic virus (CMV) infection of bitter gourd was reported for the first time from Coimbatore India (Nagarajan and Ramakrishnan, 1971). The virus was transmitted by five different species of aphids and was tentatively named as bitter gourd

mosaic virus. The infection of papaya ring spot virus (PRSV) poty virus was described from cucurbitaceous plants with variable symptoms like vein clearing, mottling, malformed leaves and filiformity (CMI, 1984). The association of bitter gourd distortion mosaic virus (BDMV) with bitter gourd was first reported in India from Kerala. The symptoms of BDMV infection in bitter gourd consists of upward curling, shortening of internodes, distortion of leaves, stunting of plants and deformation of fruits (Khan *et al.*, 2002). The simultaneous occurrence of different viruses in bitter gourd plants results in the mosaic complex. Cucumber mosaic, watermelon mosaic and bitter gourd distortion mosaic are the major viral diseases of bitter gourd (Mukhopadhyay, 1985).

Symptom of various mosaics of bitter gourd in Kerala and artificial inoculation of bitter gourd distortion mosaic virus (BDMV) was reported (Zacharia, 2006). The association of Indian cassava mosaic virus (ICMV) with yellow mosaic disease of bitter gourd has been reported from Tamil Nadu, South India (Rajinimala and Rabindran, 2007).

In the background of this, a study was undertaken and surveyed different bitter gourd growing regions of Southern plain regions of Karnataka. The incidence of viral diseases and whitefly population was significant in almost all the farmers fields and symptoms consisted of leaf curl, leaf twisting, complete yellowing and mosaic under different farmers fields.

Materials and Methods

Bitter gourd fields surveyed

Surveys were conducted to study the incidence of whiteflies and viral diseases on bitter gourd during 2015-16 and 2016-17. In this study, the list of cultivated area was

prepared in consultation with officials of Agriculture Department, Government of Karnataka and covered a total of 133 villages of 25 talukas and 6 Districts of Southern plains of Karnataka (Fig. 1).

Sampling and virus disease assessment in bitter gourd

The minimum area (plot) size of 50 cents and randomly at 5 spots 25 plants in each field were selected, examined for whitefly population and symptoms of virus diseases and data recorded on 5 plants at each spot.

Visual severity score

Based on visual symptoms of the plants (showing mosaic, mottling, leaf puckering, yellow mosaic and curling of leaves) percent disease incidence was estimated. Whitefly damage and virus disease severity was estimated using the visual rating scale of 1 – 5 per individual plant; where 1 = 0 – 20% of foliage damaged, 2 = 21 – 40% of foliage damaged, 3 = 41 – 60% of foliage damaged, 4 = 61 – 80% of foliage damaged and 5 = 81 – 100% of foliage damaged.

The bitter gourd plants expressing virus-like symptoms and symptomless leaf samples were collected from each field. The leaf samples were picked by moving diagonally across the field from one individual plant to another as described by Venkataravanappa *et al.*, (2017).

Disease Incidence (DI) and Vulnerability Index (VI) were calculated as given below.

Percent disease incidence was calculated as

$$\text{Disease Incidence (DI)} = \frac{\text{Number of plants infected} \times 100}{\text{Total number of plants}}$$

Based on the rating Vulnerability Index was calculated using the formula,

$$\text{V.I.} = \frac{(0n_0 + 1n_1 + 2n_2 + 3n_3 + 4n_4 + 5n_5) \times 100}{n_t (n_c - 1)}$$

V.I. - Vulnerability index

n_0, n_1, \dots, n_5 - Number of plants in the category of 0,1,2,3,4,5

n_t - Total number of plants

n_c - Total number of categories

Results and Discussion

Viral disease survey and collection of white flies

The survey was conducted in two crop growth periods in a cropping season such as vegetative stage and fruiting stage in both *Kharif* and *rabi* by visual inspection of plants in each field, by following “W” pattern (crossing the rows). The study revealed that, the incidence of whiteflies and viral diseases in bitter gourd was observed in all the surveyed localities with varied level of damage and vulnerability. The most common symptoms observed on the infected plants displaying virus-like disease are mosaic, leaf curl, leaf twisting, mottling, netting and complete yellowing at vegetative stage. Whereas fruiting stage, the plants are expressing severe leaf curl, complete yellowing, twisting of vein, and fruits are small and malformed (Plate 1.). The place of survey, number field’s surveyed, on bitter gourd at different farmer’s fields and location are given the Table 1.

Survey Scenario during 2015-16

During *Kharif*, the incidence of virus disease was recorded on bitter gourd was ranged from 19.25 to 40.67 % and Vulnerability Index (VI) of 12.83 to 27.11 % with average whiteflies population of 2.74 to 5.81 per

plant. Among the districts, Mandya (Fig. 2) recorded highest disease index of 40.67 % and vulnerability index of 27.11 % with whitefly population of 5.81 per plant followed by Chikkaballapur (Fig. 3) recorded 37.64 % (DI), 25.09 % (VI) and 5.37 whiteflies per plant, Bengaluru (Fig. 4) recorded 36.51% (DI), 24.34 % (VI) and 5.20 whiteflies per plant. Whereas, Tumakuru district (Fig. 5) recorded lowest DI (19.25 %), VI (12.83 %) and 2.74 whiteflies per plant.

Similarly in case of *rabi* season, the incidence of viral disease was ranged between 23.85 to 50.56%, VI ranged 15.90 to 34% with 3.32 to 7.23 whiteflies per plant. Chikkaballapura recorded highest DI of 51%, VI of 34 % with 7.23 whiteflies per plant followed by Kolar had a DI of 48.68 %, VI 32.45 % and 6.95 whiteflies per plant and Mandya recorded DI 47%, VI 32 % with 6.82 whiteflies per plant. While the lowest DI was observed in Mysuru (24 %), with VI of 16 % and 3.32 whiteflies per plant (Fig. 6).

Survey Scenario during 2016-17

Similarly survey was made in during 2016-17, the results indicated that during *Kharif*, the incidence of viral disease was recorded in bitter melon is ranged between 18.18 to 45.44 % and Vulnerability Index (VI) 12.12 to 30.30 % with average whiteflies population of 2.54 to 6.51 per plant. Among the districts, Mandya recorded highest disease incidence of 45.44 % and vulnerability index of 30.30 % with whitefly population of 6.51 per plant followed by Bengaluru Rural recorded 43.94 % (DI), 29.29 % (VI) and 6.36 whiteflies per plant, Kolar recorded 42.39 % (DI), 28 % (VI) and 6.06 whiteflies per plant and Chikkaballapur had a DI of 40%, VI of 27 % and 6.02 whiteflies per plant. Whereas in Mysuru recorded lowest DI (18.18 %), VI (12 %) and 2.54 whiteflies per plant respectively. Similarly in *rabi* season, the viral disease

incidence is ranged from 27 to 48%, VI ranged 18 to 32 % with 3.82 to 7.25 whiteflies per plant. Kolar (Fig. 7) recorded highest DI of 49%, VI of 33 % with 6.98 whiteflies per plant followed by Chikkaballapur had a DI of 47.41 %, VI 31.61 % and 7.25 whiteflies per plant and Bengaluru Rural recorded DI of 43.99%, VI 29.33 % with 6.32 whiteflies per plant. While the lowest DI was observed in Mysuru (27%), with VI of 18 % and 3.82 whiteflies per plant.

The activity of whiteflies and the viral disease incidence were recorded higher in *rabi* than in *kharif*. This may be due to many region among them choice of variety grown and prevalence of vector population and environment factors. Normally in *kharif* season most of the farmer grown cereals and other pulse crops due to rains, which may leads the vectors population is very low in Mandya, Tumkur and Mysuru Districts. While in *rabi* most the famers grown different varieties of vegetables which are most prefer host for vectors and also usage of pesticides to manage pests was minimal or nil in Mandya, Tumkur and Mysuru Districts may one of the region to recorded higher incidence of different viruses.

Whereas in Kolar, Chikkaballapur and Bengaluru Districts farmers are cultivated different variety cucurbits and non-cucurbits throughout year and usage of pesticides to manage pests too high is one of the reason, the incidence of viral disease is low on bitter melon as compared other districts.

Symptoms associated with the disease include yellow mottle, mosaic, blistering, leaf curl and reduction in leaf size, yellow mosaic and blistering is also seen in severe infection finally leading to stunting of the plant, reduced flowering and fruiting and hairyness on stem.

Table 1 Incidence of whiteflies and vulnerability of viral disease on bittergourd

Sl. No.	District and Locality	GPS Co-ordinates	2015-16						2016-17					
			Kharif			Rabi			Kharif			Rabi		
			Whiteflies / plant	DI (%)	VI (%)	Whiteflies / plant	DI (%)	VI (%)	Whiteflies / plant	DI (%)	VI (%)	Whiteflies / plant	DI (%)	VI (%)
A	Bengaluru Rural		5.20	36.51b	24.34b	6.28	43.72c	29.14b	6.36	43.94ab	29.29ab	6.32	43.99b	29.33a
1	Devanahalli (7)	13.2417° N, 77.7137° E	5.54	38.93	25.95	6.84	48.00	32.00	6.79	47.00	31.33	7.16	50.21	33.48
2	Hoskote (5)	13.0730° N, 77.7967° E	5.20	36.70	24.47	6.34	44.10	29.40	6.34	43.90	29.27	6.54	45.50	30.33
3	Anekal (5)	12.7105° N, 77.6911° E	5.32	37.40	24.93	6.44	44.80	29.87	6.42	44.40	29.60	6.36	44.20	29.47
4	Nelamangala (5)	13.0874° N, 77.4110° E	4.98	35.10	23.40	5.94	41.10	27.40	6.40	43.80	29.20	5.84	40.30	26.87
5	Doddaballapur (6)	13.2927° N, 77.5389° E	4.93	34.42	22.94	5.83	40.58	27.06	5.87	40.58	27.06	5.72	39.75	26.50
B	Chikkaballapur		5.37	37.64b	25.09b	7.23	50.56a	33.70a	6.02	40.52c	27.01c	7.25	47.41ab	31.61a
1	Chikkaballapur (5)	13.4324° N, 77.7280° E	5.40	37.88	25.25	7.14	50.00	33.33	5.96	37.25	24.83	7.30	41.20	27.47
2	Sidlagatta (4)	13.3937° N, 77.8653° E	5.22	36.70	24.47	7.06	49.10	32.73	5.92	41.30	27.53	7.14	49.90	33.27
3	Chinthamani (7)	13.4020° N, 78.0551° E	5.49	38.34	25.56	7.49	52.57	35.05	6.17	43.00	28.67	7.30	51.14	34.10
C	Kolar		4.79	33.50c	22.34c	6.95	48.68ab	32.45a	6.06	42.39bc	28.26bc	6.98	48.85a	32.57a
1	Malur (5)	13.0035° N, 77.9425° E	4.70	32.90	21.93	7.18	50.26	33.51	6.00	42.00	28.00	7.26	50.82	33.88
2	Bangarpet (4)	12.9915° N, 78.1788° E	4.33	30.28	20.18	6.45	45.15	30.10	5.80	40.60	27.07	6.53	45.68	30.45
3	Kolar (6)	13.1357° N, 78.1326° E	5.33	37.33	24.89	7.23	50.63	33.76	6.37	44.57	29.71	7.15	50.05	33.37
	Mandya		5.81	40.67a	27.11a	6.82	47.55b	31.70a	6.51	45.44a	30.30a	6.28	43.88b	29.25a
1	Nagamangala (7)	12.8271° N, 76.7596° E	5.84	40.71	27.14	6.90	48.07	32.05	6.71	46.81	31.21	6.44	44.86	29.90
2	K.R.Pet (4)	12.6558° N, 76.4881° E	5.50	38.63	25.75	6.63	46.13	30.75	6.55	45.70	30.47	6.33	44.13	29.42

3	Srirangapatna (5)	12.4216° N, 76.6931° E	5.58	39.00	26.00	6.88	47.80	31.87	6.56	45.82	30.55	6.20	43.30	28.87
4	Malavalli (6)	12.3853° N, 77.0536° E	5.53	38.92	25.94	6.67	46.42	30.94	6.30	43.92	29.28	5.92	41.17	27.44
5	Mandya (7 Villages)	12.5222° N, 76.9009° E	5.91	41.57	27.71	6.96	48.86	32.57	6.46	45.26	30.17	7.00	49.14	32.76
6	Maddur (5 Villages)	12.5839° N, 77.0435° E	6.48	45.20	30.13	6.90	48.00	32.00	6.46	45.16	30.11	5.78	40.70	27.13
	Mysuru		2.82	20.73d	13.82d	3.32	23.85e	15.90d	2.54	18.18e	12.12e	3.82	27.00c	18.00c
1	Nanjanagud (5)	12.1200° N, 76.6801° E	2.58	20.90	13.93	3.56	25.20	16.80	2.26	16.20	10.80	3.98	28.00	18.67
2	Tirumakudalu Narasipur (5)	12.2110° N, 76.9038° E	2.84	20.00	13.33	3.26	23.40	15.60	2.48	17.90	11.93	3.84	27.00	18.00
3	Heggadadevana Kote (5)	12.0880° N, 76.3319° E	2.94	21.00	14.00	3.12	22.60	15.07	2.64	18.80	12.53	3.70	26.30	17.53
4	Hunasur (5)	12.3009° N, 76.2885° E	2.92	21.00	14.00	3.34	24.20	16.13	2.76	19.80	13.20	3.74	26.70	17.80
	Tumkur		2.74	19.25d	12.83d	4.32	30.25d	20.17c	2.54	23.45d	15.63d	4.78	33.15d	22.10b
1	Koratagere (5)	13.5240° N, 77.2376° E	2.82	20.00	13.33	4.34	30.50	20.33	3.28	23.00	15.33	4.78	33.30	22.20
2	Gubbi (5)	13.3118° N, 76.9398° E	2.82	19.70	13.13	4.44	31.20	20.80	3.40	24.00	16.00	4.84	33.70	22.47
3	Tumkur (5)	13.3392° N, 77.1140° E	2.56	17.90	11.93	4.28	29.90	19.93	3.42	24.30	16.20	4.70	32.50	21.67
4	Madhugiri (5)	13.6643° N, 77.2089° E	2.76	19.40	12.93	4.20	29.40	19.60	3.26	22.50	15.00	4.78	33.10	22.07

Note: Means with the different letters are significant ($p>0.05$) as analyzed by Duncan Multiple Range Test (DMRT)

*Figures in brackets are No of villages surveyed in each Talukas.

DI = Disease Index

VI = Vulnerability Index

Fig.1 Map of Karnataka showing surveyed regions

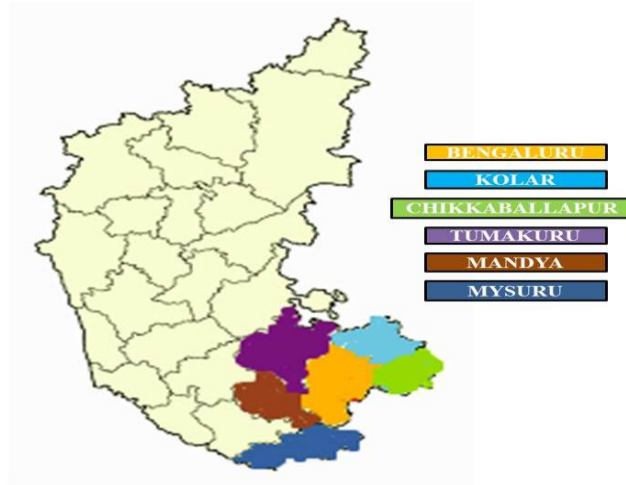


Fig.2 Incidence of whiteflies and vulnerability of viral disease on bitter gourd at Mandya

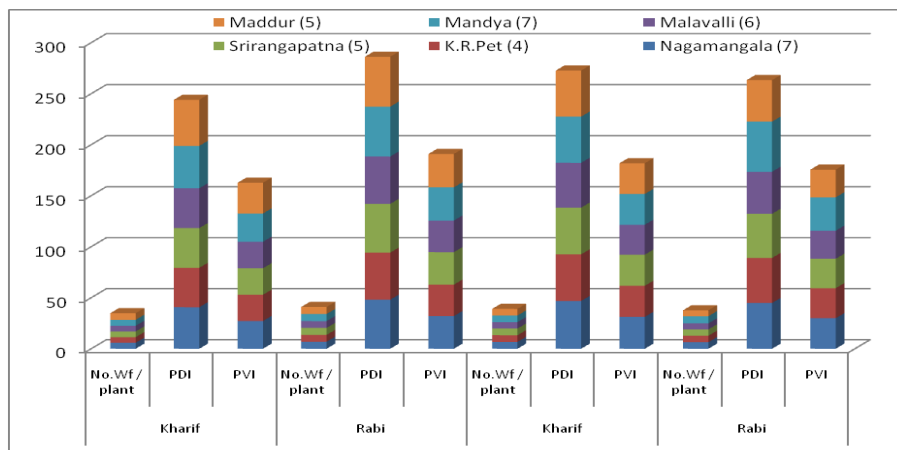


Fig.3 Incidence of whiteflies and vulnerability of viral disease on bitter gourd at Chikkaballapur

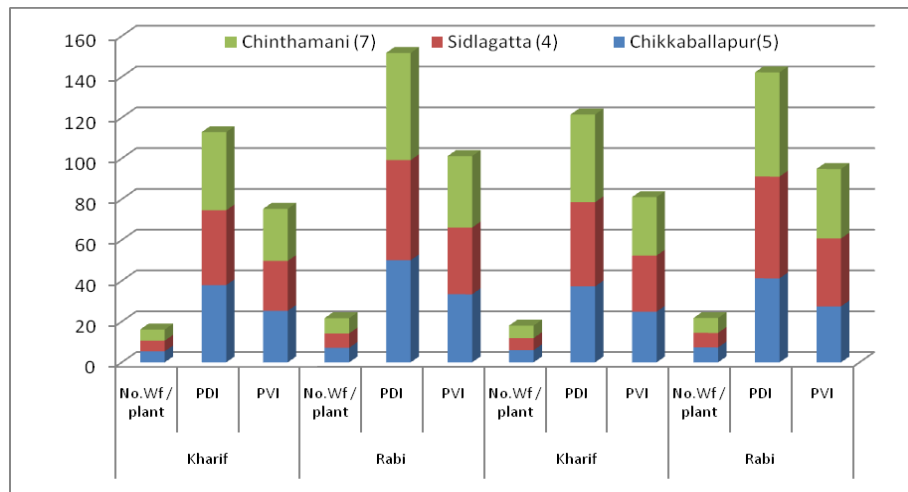


Fig.4 Incidence of whiteflies and vulnerability of viral disease on bitter gourd at Bengaluru

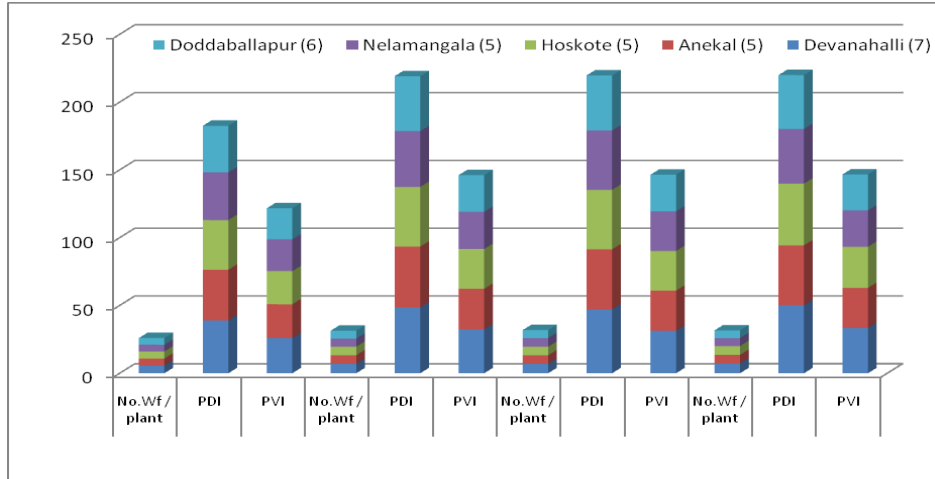


Fig.5 Incidence of whiteflies and vulnerability of viral disease on bitter gourd at Tumkur

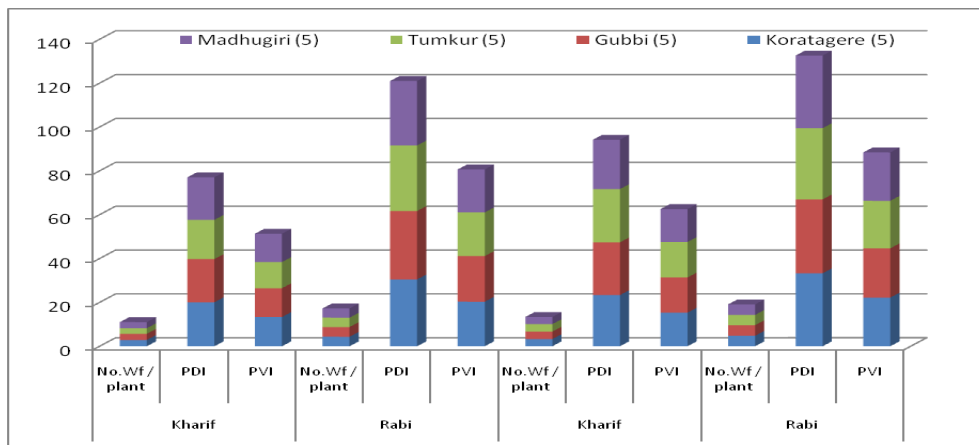


Fig.6 Incidence of whiteflies and vulnerability of viral disease on bitter gourd at Mysuru

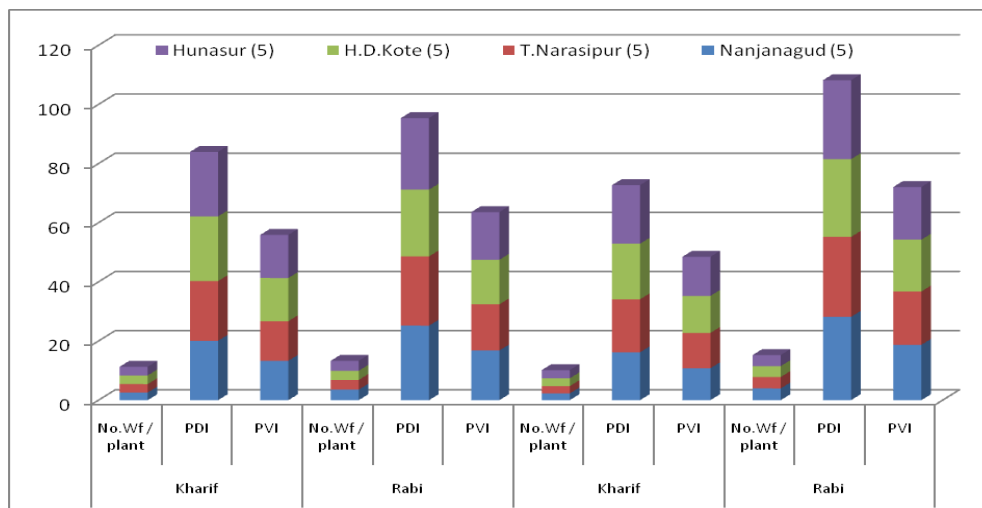


Fig.7 Incidence of whiteflies and vulnerability of viral disease on bitter gourd at Kolar

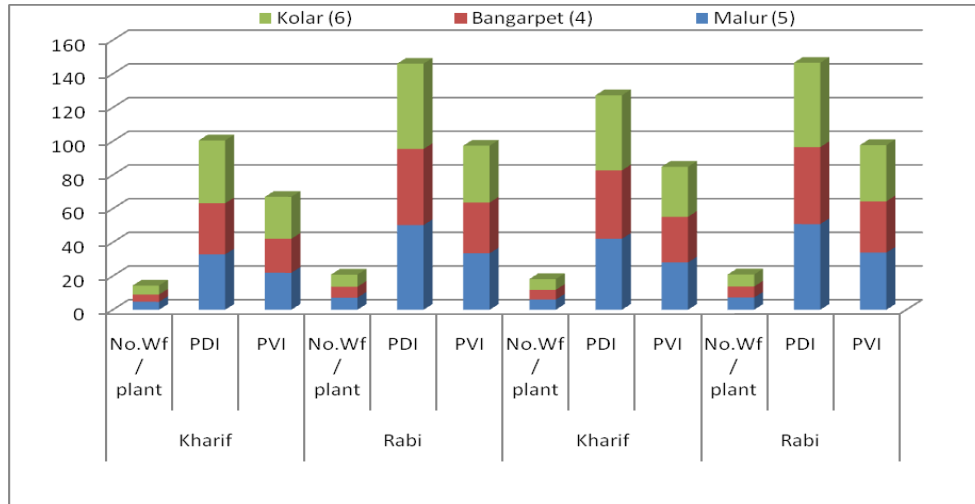


Plate.1 Incidence of whiteflies and viral disease on bittergourd



Enzyme Linked Immunosorbent Assay (ELISA) revealed the presence of three viruses belonging to PRSV Papaya ringspot Potyvirus, Begomo, Cucumber mosaic virus (CMV), Indian cassava mosaic virus (ICMV) and POTY group causing a mixed infection in bitter gourd. This was found in Bengaluru Chikkaballapur and Kolar districts as the absorbance values of samples in all the districts show an increase of 2.15 times more than the healthy. Whereas, in Mandya, Mysuru, Tumkur the reaction of sample showed POTY antiserum which indicates the presence of Begomo and CMV infection only. The major variety that was grown in Bengaluru, Kolar and Chikkaballapur was Var. Arka Harit, Preethi and Priya while the Mandya and Mysuru farmers from Var. Preethi and Tumkur Var. Green long and white long were following open precision system and the hybrid Palee (F1), Sanjini (F1), Soumya (F1) was popular among them.

In India, a whitefly transmitted bitter gourd distortion mosaic virus (BDMV) producing mosaic, reduced leaf size, curling, deformed fruits, thick and hairy stem was reported (Giri and Mishra 1986). Radhika and Umamaheswaran conducted a survey at five locations in Thiruvananthapuram district, Pappanchani area recorded highest incidence of viral disease (60%) while highest Vulnerability Index (V.I) was recorded from Vellayani (56.00). In Idukki district, six major bitter gourd cultivating areas were surveyed among which Rajakumary area recorded the highest disease incidence (100%) and V.I (82.00). In Palakkad district, five locations were surveyed, among which Panackatri and Thekkepotta recorded highest disease incidence of 88% and highest V.I (69.00). Symptoms associated with the disease include yellow mottling, mosaic, blistering, leaf curl and reduction in leaf size. Yellow mosaic and blistering is also seen in case of severe infection finally leading to stunting of the

plant, reduced flowering and fruiting and hairyness on the stem. Enzyme Linked

Immunosorbent Assay (ELISA) and Dot Immunobinding Assay (DIBA) revealed the presence of three viruses belonging to Begomo, CMV and POTY group causing a mixed infection in bitter gourd. Abou-Jawdahl *et. al.*, (2000) reported major economic loss due to cucurbit viral diseases in Lebanon. A survey conducted revealed the presence of Zucchini yellow mosaic Potyvirus (ZYMV) and Cucurbit aphid-borne yellows Polerovirus (CABYV) are the most common viruses followed by Watermelon mosaic Potyvirus (WMV), Papaya ringspot Potyvirus-watermelon strain (PRSV-W) and to a lesser extent Cucumber mosaic Cucumovirus (CMV). The occurrence of yellow mosaic disease of bitter gourd in Tamil Nadu caused by (ICMV) has been reported (Rajinimala and Rabindran, 2007) as mosaic and mottling on young leaves. The mottling usually started at the edges of the leaf and advanced inwards subsequently, chlorotic patches appeared on leaves and in advanced stages of infection, the entire leaf becomes chlorotic with few, small patches of green tissue remaining over the leaf area. The occurrence of seven viruses in cucumber from major cultivated area of Oklahoma, USA was reported (Ali, 2012).

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