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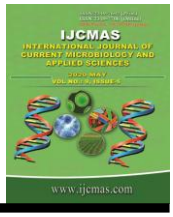

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Assessment on Management of Yellow Mosaic Virus in Pole beans through Integrated Approach

B. Manjunath[1*], B. S. Rajendra Prasad[2], S. Pavithra[3], R. Manjunath[4], A. P. Mallikarjuna Gowda[1], Savita S. Manganavar[2], B. Gayathri[4] and Y. D. Chithra[1]

[1]ICAR-Krishi Vigyan Kendra, Bengaluru Rural District, Karnataka, India
[2]ICAR - Krishi Vigyan Kendra, Ramanagaram District, Karnataka, India
[3]ICAR- Krishi Vigyan Kendra, Mandya District, Karnataka, India
[4]ICAR- Krishi Vigyan Kendra, Chikkaballapura District, Karnataka, India

**Corresponding author*

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A B S T R A C T

Pole bean, an important vegetable crop is becoming susceptible for yellow mosaic virus disease transmitted by whiteflies throughout the year. The present investigation was carried out to evaluate the efficacy of different integrated approaches for the management of the disease. Intercropping with two rows of border crops of maize 30 days before sowing of pole bean, mulching with black silver mulch, seed treatment with Thiomethaxam 25 WG – 5g/kg seeds during sowing, soil application of *Pseudomonas fluorescens* along with neem cake (1kg/100kg), installation of yellow sticky trap @ 10 no/acre and spraying of seaweed extract (1.5ml/L) 20 days after sowing, spraying of Thiamethoxam 25% WG (0.5 g/L) and Imidacloprid 17.8 SL (0.5ml/L) 30 and 45 days after sowing respectively recorded less disease incidence and higher yield compared to recommended practice.

Introduction

Pole bean (*Phaseolus vulgaris* L) is a native of South America, where it has been cultivated as a staple food for centuries. The cultivars of French bean were bred to grow as vines which cling to poles or trellises, hence it is called pole bean. It is consumed as immature tender fruits, green grains as vegetables and dry grain (Rajmah). The nutritive value of 100 g of green pod contains 1.7 g protein, 0.1 g fat, 4.5 g carbohydrate, 1.8 g fibre and is also rich in minerals and vitamins. It has some medicinal properties in control of diabetes, cardiac problems and natural cure for bladder burn (Duke, 1981).

Pole bean suffers from fungal, bacterial and viral diseases. Among them ascochyta blight, anthracnose, rust, root rot, angular leaf spot, bacterial blight, common bean mosaic virus, yellow mosaic virus and bean leaf roll virus. Among viral diseases yellow mosaic has been considered as an important limiting factor in pole bean productivity (Maramorosch and Muniyappa, 1981).

Yellow mosaic disease in pole bean is widely distributed in the tropical and sub-tropical regions. The symptom appears as brilliant yellow or golden yellow colour on leaves which may be partially or completely yellow. Cultivars express rugosity and rolling of leaves, while tolerant cultivars develop mild yellowing and often the plans show stunting. Pods exhibits blotching, discoloration with reduced size and number (Jyothi *et al.*, 2013). The estimation of crop loss ranged from 40 to 100 per cent depending on the cultivar and time of infection (Pierre, 1975 and Galvez and Cardenas, 1980, Sharma *et al.*, 2015).

Bemisia tabaci (Gennadius) (Aleyrodidae: Homoptera) is one of the important sucking pest which inflicts heavy damage to the crop, not only through direct loss of plant vitality by feeding cell sap but also by transmitting the yellow mosaic virus disease (Muniyappa, 1980).

Since pole bean is grown extensively throughout the year in and around Bengaluru rural district, Ramanagaram district, Mandya district and Chikkaballapura district as important vegetable crop, the crop succumb for many diseases. Moreover, the crop is becoming susceptible for yellow mosaic virus disease transmitted by whiteflies throughout the year.

The average yield of pole bean in the above mentioned districts is 25 t/ha as against potential yield of 35 t/ha which accounts for 25% lesser yield. This is mainly due to the damage caused by yellow mosaic virus to the extent of 39% crop loss. In view of above facts, the on farm technology on management of yellow mosaic virus in pole bean through integrated approach was conducted in all the 4 districts in order to achieve higher yield, quality and profit.

Materials and Methods

The Krishnarajapura village, Doddaballapur, Bengaluru Rural district, Kalya village, Ramanagaram district, Nelamakanahalli village, Mandya district and Gadidasanahalli, Chikkaballapura district were selected for the case study, where in farmers were growing pole bean as main crop by following their own practices with indiscriminate use of pesticides with more cost of cultivation. The field experiment was carried out with four treatments with five replications. The treatment details are mentioned in Table 1.

The disease incidence observations were recorded from 20 days after sowing up to 60 days after sowing at an interval of 10 days and the data were analysed statistically. Yield data was recorded at different intervals of harvesting and the data was pooled at the final stage of the harvesting. Net returns from each treatment were calculated by considering the yield obtained and cost of treatment on hectare basis. Benefit: Cost (B: C) ratio was calculated to compare the economic feasibility of various treatments.

Results and Discussion

The management of yellow mosaic virus in pole bean through integrated approach revealed that the per cent disease incidence of yellow mosaic virus across the districts was less at different days after sowing when compared to the recommended practice. The average disease incidence was less in

alternate practice 2 compared to recommended practice in all the 4 districts (Table 1a, 2a, 3a and 4a) .The yield was recorded high in alternate practice 2 compared to recommended practice across all the 4 districts (Table 1b, 2b, 3b and 4b).

The combination of treatments in alternate practice 2 was found effective in managing the yellow mosaic disease in pole bean compared to recommended practice. The African tall maize sown 3 weeks before main crop acts as a barrier crop and restrict the movement of viruliferous whiteflies to get into the field and settle on the pole bean crop. These findings are in conformity with the findings as reported by Jyothi *et al.,* (2013) and Jeevan (2013). Seed treatment with Thiomethaxam 25 WG – 5g/kg seeds can protect the young plants upto 30 to 40 days after sowing. Similar results were obtained by Jyothi *et al.,* 2013 and Jeevan (2013). These results are in conformity with the findings as reported by Shankarappa (2002) in managing tomato leaf curl virus. Use of reflective mulches in between the rows will help in interfering on settlement of whiteflies on the host plant. The control of whiteflies is due to the fact that mulches reflects UV wavelength, which interfere with the orientation of whitefly and location on host (Charles Summer *et al.,* 2005).

Soil application of *Pseudomonas fluorescens* along with neem cake (1kg/100kg), installation of yellow sticky trap @ 10 no/acre and spraying of seaweed extract (1.5ml/L) 20 days after sowing, spraying of Thiamethoxam 25% WG (0.5 g/L) and Imidacloprid 17.8 SL (0.5ml/L) 30 and 45 days after sowing respectively recorded less disease incidence and higher yield compared to recommended practice (Table 5). Similar findings were reported by Panduranga *et al.,* (2011) in managing mung bean yellow mosaic disease in green gram. The benefit cost ratio was found to be high in alternate practice 2 compared to recommended practice (Table 6).

Table.1a Percent disease incidence and yield of Pole beans in On Farm testing conducted on integrated management of yellow mosaic virus in pole beans during 2019-20 at Krishnarajapura, Nelamangala Taluk, Bengaluru Rural District

Treatment details	Yellow mosaic virus incidence (%)					Average per cent disease incidence	Yield (t/ha)
	20 DAS	30 DAS	40 DAS	50 DAS	60 DAS		
Farmer's Practice	16.45	33.95	30.22	24.68	19.62	24.98	30.06
Recommended practice	15.75	25.10	21.20	15.13	12.62	17.96	29.07
Alternate Practice 1	17.10	30.66	26.79	21.30	16.50	22.47	28.10
Alternate Practice 2	4.17	7.12	5.81	4.26	3.19	4.91	33.46
SEm ±	0.34	0.73	0.59	0.46	0.32	0.49	1.00
CD (0.05)	1.12	2.39	1.92	1.51	1.03	1.59	3.25
CV	7.27	7.45	7.33	7.36	7.53	7.39	7.14

DAS – Days After Sowing

Table.1b Economics of treatments evaluated for the management of yellow mosaic virus in pole beans during 2019-20

Treatments	Yield (t/ha)	No. of sprays	Cost of sprays (Rs./ha)	Cost of cultivation/ ha	Gross returns	Net returns	B:C ratio
T1 (FP)	29.78	05	18921	149133	573866	424733	3.85
T2(RP)	28.62	02	7900	139781	583733	443951	4.17
T3(AP1)	27.86	02	6150	142150	564866	422716	3.97
T4(AP2)	**33.11**	**03**	**11795**	**145270**	**708546**	**563276**	**4.88**

FP - Farmers practice, RP - Recommended practice, AP1 -Alternate practice 1,
AP2 - Alternate practice 2

Table.2a Percent disease incidence and yield of Pole beans in On Farm testing conducted on integrated management of yellow mosaic virus in pole beans during 2019-20 at Kalya, Magadi Taluk, Ramanagaram District

Treatment details	Yellow mosaic virus incidence (%)					Average per cent disease incidence	Yield (t/ha)
	20 DAS	30 DAS	40 DAS	50 DAS	60 DAS		
Farmer's Practice	17.10	30.66	26.79	21.30	16.50	22.47	29.25
Recommended practice	10.95	25.10	20.07	16.62	10.15	16.58	28.27
Alternate Practice 1	17.24	27.93	24.50	17.60	13.40	20.13	27.50
Alternate Practice 2	6.72	9.41	7.28	5.88	3.44	6.55	32.76
SEm ±	0.39	0.74	0.53	0.40	0.36	0.48	1.12
CD (0.05)	1.26	2.43	1.72	1.31	1.16	1.58	3.65
CV	6.54	7.99	6.70	6.98	8.11	7.26	8.22

DAS – Days After Sowing

Table.2b Economics of treatments evaluated for the management of yellow mosaic virus in pole beans during 2019-20

Treatments	Yield (t/ha)	No. of sprays	Cost of sprays (Rs./ha)	Cost of cultivation/ ha	Gross returns	Net returns	B:C ratio
T1 (FP)	29.78	05	18600	143219	585000	441781	4.08
T2(RP)	28.62	02	7600	139246	565400	426154	4.06
T3(AP1)	27.86	02	5900	142700	550000	407300	3.85
T4(AP2)	**33.11**	**03**	**11045**	**144690**	**687960**	**543270**	**4.75**

FP - Farmers practice, RP - Recommended practice, AP1 -Alternate practice 1,
AP2 - Alternate practice 2

Table.3a Percent disease incidence and yield of Pole beans in On Farm testing conducted on integrated management of yellow mosaic virus in pole beans during 2019-20 at Nelamakanahalli, Malavalli Taluk, Mandya District

Treatment details	Yellow mosaic virus incidence (%)					Average per cent disease incidence	Yield (t/ha)
	20 DAS	30 DAS	40 DAS	50 DAS	60 DAS		
Farmer's Practice	16.45	33.95	30.22	24.68	19.62	24.98	29.64
Recommended practice	14.95	21.10	24.07	16.62	10.15	17.38	28.65
Alternate Practice 1	15.17	28.31	24.50	19.60	14.12	20.34	27.97
Alternate Practice 2	5.47	8.47	6.20	4.86	3.91	5.78	33.06
SEm ±	0.34	0.73	0.59	0.46	0.32	0.49	0.95
CD (0.05)	1.12	2.39	1.92	1.51	1.03	1.59	3.09
CV	7.27	7.45	7.33	7.36	7.53	7.39	6.86

DAS – Days After Sowing

Table.3b Economics of treatments evaluated for the management of yellow mosaic virus in pole beans during 2019-20

Treatments	Yield (t/ha)	No. of sprays	Cost of sprays (Rs./ha)	Cost of cultivation/ ha	Gross returns	Net returns	B:C ratio
T1 (FP)	29.78	05	18150	144600	563160	418560	3.89
T2(RP)	28.62	02	7450	142750	544350	401600	3.81
T3(AP1)	27.86	02	6000	143500	531430	387930	3.70
T4(AP2)	**33.11**	**03**	**11200**	**145200**	**694260**	**549060**	**4.78**

FP - Farmers practice, RP - Recommended practice, AP1 -Alternate practice 1,
AP2 - Alternate practice 2

Table.4a Percent disease incidence and yield of Pole beans in On Farm testing conducted on integrated management of yellow mosaic virus in pole beans during 2019-20 at Gadidasanahalli, Chintamani Taluk, Chikkaballapura District

Treatment details	Yellow mosaic virus incidence (%)					Average per cent disease incidence	Yield (t/ha)
	20 DAS	30 DAS	40 DAS	50 DAS	60 DAS		
Farmer's Practice	14.30	30.20	26.10	21.22	17.82 (24.97)	21.93 (27.73)	30.15
Recommended practice	10.95	25.10	20.07	16.62	10.15 (18.57)	16.58 (23.72)	28.47
Alternate Practice 1	16.25	28.02	22.62	15.29	11.46	18.73	27.85
Alternate Practice 2	6.17	8.67	7.81	5.26	4.19	6.42	33.16
SEm ±	0.34	0.73	0.59	0.46	0.32	0.49	0.95
CD (0.05)	1.12	2.39	1.92	1.51	1.03	1.59	3.33
CV	7.27	7.45	7.33	7.36	7.53	7.39	7.37

DAS – Days after Sowing

Table.4b Economics of treatments evaluated for the management of yellow mosaic virus in pole beans during 2019-20

Treatments	Yield (t/ha)	No. of sprays	Cost of sprays (Rs./ha)	Cost of cultivation/ ha	Gross returns	Net returns	B:C ratio
T1 (FP)	29.78	05	18650	146520	603000	456480	4.11
T2(RP)	28.62	02	7700	140290	569400	429110	4.05
T3(AP1)	27.86	02	5950	142150	557000	414850	3.92
T4(AP2)	**33.11**	**03**	**11500**	**146100**	**696360**	**550260**	**4.77**

FP - Farmers practice, RP - Recommended practice, AP1 -Alternate practice 1,
AP2 - Alternate practice 2

Table.5 Pooled data of percent disease incidence and yield of Pole beans in On Farm Testing conducted on integrated management of yellow mosaic virus in pole beans at different regions

Treatment details	Average Per cent Disease Incidence								Pooled PDI	Pooled yield
	2019-20		2019-20		2019-20		2019-20			
	Krishnarajapura, Nelamangala Taluk, Bengaluru Rural District		Kalya, Magadi Taluk, Ramanagaram District		Nelamakanahalli, Malavalli Taluk, Mandya District		Gadidasanahalli, Chintamani Taluk, Chikkaballapura District			
	PDI	Yield (t/ha)	PDI	Yield (t/ha)	PDI	Yield (t/ha)	PDI	Yield (t/ha)		
Farmer's Practice	24.98	30.06	22.47	29.25	24.98	29.64	21.93	30.15	23.59	29.78
Recommended practice	17.96	29.07	16.58	28.27	17.38	28.65	16.58	28.47	17.13	28.62
Alternate Practice 1	22.47	28.10	20.13	27.50	20.34	27.97	18.73	27.85	20.42	27.86
Alternate Practice 2	4.91	33.46	6.55	32.76	5.78	33.06	6.42	33.16	5.92	33.11
SEm ±	0.49	1.00	0.48	1.12	0.49	0.95	0.49	0.95	0.49	1.00
CD at 5%	1.59	3.25	1.58	3.65	1.59	3.09	1.59	3.33	1.59	3.33
CV	7.39	7.14	7.26	8.22	7.39	6.86	7.39	7.37	7.36	7.40

Table.6 Economics of treatments evaluated for the management of yellow mosaic virus in pole beans

Treatments	Yield (t/ha)	No. of sprays	Cost of sprays (Rs./ha)	Cost of cultivation/ ha	Gross returns	Net returns	B:C ratio
T1 (FP)	29.78	05	18580	145868	581256	435388	3.98
T2(RP)	28.62	02	7663	140516	565720	425203	4.02
T3(AP1)	27.86	02	6000	142625	550824	408199	3.86
T4(AP2)	**33.11**	**03**	**11385**	**145315**	**696781**	**551466**	**4.80**

Table.7 Schedule of technology application for the management of yellow mosaic virus in pole beans

Time of application	Chemical/Product	Quantity/dosage
Before sowing	Intercropping with two rows of border crops of maize days before sowing Soil application of *Pseudomonas fluorescens* along with neem cake	1 kg (1 kg *Pseudomonas fluorescens* in 100 kg neem cake)
Sowing time	Seed treatment with Thiomethaxam 25 WG – 5g/kg seeds, Mulching with black silver mulch	5g/Kg seeds
20 Days After Sowing	Spraying of seaweed extract Installation of yellow sticky trap	1.5 ml/1itre of water 10 no/acre
30 Days After Sowing	Thiamethoxam 25% WG	0.5 g/litre of water
45 Days After Sowing	Imidacloprid 17.8 SL	0.5ml/litre of water

Based on the present work, schedule of technology application for effective and efficient management of yellow mosaic virus in pole beans has been developed and also residue free produce can be obtained (Table 7). This schedule found to be more eco-friendly, environmentally compatible and safe for human health as well as agro-ecosystem.

Majority of the pole bean growing farmers are using pesticides indiscriminately would increase the cost of production and resurgence in the vector. The integrated approaches like growing border crop, use of reflective mulches and recommended dose of chemicals for management of the vector would not only reduces the cost of production but also reduces the disease by increasing the yield.

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