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Development of integrated disease management (IDM) module for major diseases in bitter gourd

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Abstract

A field experiment was conducted for three consecutive years from 2016 to 2019 to devise and evaluate the six different integrated disease management (IDM) modules against major diseases in bitter gourd and its economics at Indian Institute of Vegetable Research (IIVR), Varanasi. The IDM module (T6) comprised of growing two rows of bajra as border crops, use of black silver polythene mulching followed by seed treatment with coordinated compound of carbendazim 12%+ mancozeb 63%@ 3 g/kg, drenching with captan 70 % +hexaconazole 5% WP @0.1% at 15 days after germination followed by sequential spray of imidacloprid 17.8 SL@ 7.5 ml/ 15 l + Neem oil 0.2%, captan 70 % +hexaconazole 5% WP @0.1%, imidacloprid 17.8 SL @7.5 ml/ 15 l + Neem oil 0.2% and fosetyl-Al @0.1% at 10 days interval from 30 days after sowing is validated as effective for bitter gourd disease management. Module was efficacious in reducing the incidence of mosaic and downy mildew diseases in bitter gourd with higher fruit yield. Though all IDM modules have lowered the severity of downy mildew and mosaic disease significantly over control, T6 have reduced severity of downy mildew by 27% and mosaic disease by 40% over the control. In addition, T6 has increased the yield by 2.46 times than control. Furthermore, highest cost benefit ratio of 1:2.1 has obtained in T6 IDM module against control (1:1.20). Also, module T6 has reduced the severity of powdery mildew and cercospora leaf spot disease in bitter gourd.

Key words: mosaic, downy mildew, IDM module, disease incidence, bitter gourd, yield

Introduction

Bitter gourd (*Momordica charantia* L.) is one among the nutritious vegetable crop, belonging to family cucurbitaceae, grown extensively in India and throughout south-east Asian countries. In India, bitter gourd occupies an area of 97,000 ha with a total production of 1.13mt (NHB 2018). It is consumed as food for its. In addition to its excellent source of minerals, vitamins, dietary fibers and antioxidant properties, it possesses antiviral, antimalarial and immune booster properties. It is highly beneficial in treating blood disorders, liver disorders, eye problems, alcohol detoxification, piles, psoriasis and respiratory disorders (Anonymous 2014). Naturally, bitter gourd has been reported to be infected by many biotic and abiotic factors. Among biotic factors, fungal diseases like downy mildew (*Pseudoperonospora cubensis*), powdery mildew (*Erysiphe cichoracearum, Podosphaera xanthii* and *Sphaerotheca fuliginea*), leaf spot (*Cercospora citrullina*) and mosaic disease caused by begomovirus (Tomato leaf curl New Delhi virus Bitter gourd yellow mosaic virus; and Pepper leaf curl Bangladesh virus) are major obstruction to bitter gourd cultivation in India (Raj and Yadav 2005; Rajinimala, et al. 2005; Watson and Napier 2009; Tiwari et al. 2010; Raj et al. 2010). Manivannan et al. (2018) described seed-transmissible nature of begomovirus (BGYMV) in cucurbits in India. Diseases caused by viruses are major problem causing significant yield loss. Rajinimala et al. (2009) reported severe yield loss in bitter gourd due to association of yellow mosaic virus (BGYMV). The yield loss due to leaf distortion and yellow vein mosaic viruses in cucurbits is estimated to be around 69% (Malathi et al. 2017). This implies that the development of effective IDM modules needs to formulate with the inclusion of different components such as cultural, biological and chemical methods to minimize the yield losses. Mohan (1995) described that application of 5% Neem Seed Kernel Extract (NSKE) was very effective in reducing the incidence of urd bean yellow mosaic virus. Rai et al. (2008) reported that five sprays of Dithane M-45, Dithane Z-78 or Aliette (all 0.3%), mancozeb or chlorothalonil @ 2 g/l twice at 10 intervals in cucumber was effective in reducing the incidence of downy mildew disease. Additionally, cultural practices, such as adjustment in sowing date, use of barrier crops,

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plastic mulch, roughing and need-based application of insecticide may considerably reduce the disease incidence as well as yield loss caused by viral diseases (Mathew and Alice 2002; Kaur and Kang 2005; Watson 2009).

Materials and methods

A field experiment was conducted at research farm of Indian Institute of Vegetable Research (IIVR), Varanasi for three consecutive years during 2016 to 2019. The experiment was conducted in randomized block design with seven treatments and three replications on bitter gourd cv. Kalyanpur Barahmasi. The details of different integrated disease management (IDM) modules devised for bitter gourd disease management were described in Table 1. The efficacy of different modules evaluated based on its effect on percent disease index (PDI) of different diseases (downy mildew, cercospora leaf spot, powdery mildew and mosaic disease). Totally 50 leaves were selected randomly from each plot and grading has been done based on 0-5 scale. Disease score chart used for estimating PDI for different diseases are as follows:

Downy mildew and powdery mildew: (Jamadar and Desai 1997)

0 - no symptom;

1 - 0 –10% leaf area covered with mildew growth;

2 - 10.1 – 15% leaf area covered with mildew growth;

3 - 15.1 – 25% leaf area covered with mildew growth;

4 - 25.1 – 50% leaf area covered with mildew growth;

5- > 50% leaf area covered with mildew growth.

Cercospora leaf spot disease (McGrath et al. 1993)

0- no infection visible;

1- >0% and ≤ 20% leaf area necrotic;

2- >20% and ≤ 40% leaf area necrotic;

3- >40% and ≤ 60% leaf area necrotic;

4- >60% and ≤ 80% leaf area necrotic

5- >80% leaf area necrotic

Mosaic disease

0- no symptoms

1- Mild mosaic pattern in young leaves covering <10% area

2- Mosaic pattern in young leaves covering <25% area

3- Mosaic pattern in young leaves covering <50%area, blistering and puckering of leaves

4- Widespread mosaic pattern in young leaves covering <75% area, distortion of leaves

5- Widespread mosaic pattern in young leaves covering >75% area, distortion of leaves and stunting of the plants. PDI was calculated individually for different diseases using the formula,

$$\text{Per cent Disease Index (PDI)} = \frac{\text{Sum of all scores}}{\text{Total number of leaves observed}} \times \frac{100}{\text{Maximum disease grade}}$$

In addition, effect of IDM modules on fruit yield was recorded and their corresponding cost benefit ratios were also computed.

Results and Discussion

Bitter gourd crop is exposed to sequential infection of various diseases caused by fungal, bacterial and viral pathogens. According to the prevailing weather parameters, diseases appear at the different crop growth stage. There are several newer molecules of fungicides are identified for the control and management of fungal diseases in crop plants (Morton and Staub 2008). Indiscriminate and repeated use of single fungicide may lead to the development of resistance by the fungal population. To overcome this shortfall, it is very essential to use the newer fungicides in disease management program. Use of cultural component such as border cropping with bajra and black silver polythene mulching were reduced viral disease incidence and vector population in watermelon crop (Priyanka et al. 2018). Use of seed coating bioconsortia (Seed Pro) containing *Bacillus subtilis* (OTPB1) and *Trichoderma harzianum* (OTPB3) have enhanced seed germination, seedling vigour and resistance to seed-borne fungal pathogens in vegetable crops (Kumar et al. 2015). Pandey et al. (2010) found imidacloprid as most effective insecticides in the management of whitefly transmitted leaf curl disease in chili speculating possible reasons by its systemic action. In order to reduce the use of chemical pesticides and to provide the need-based management option, IDM modules were devised comprising of cultural, biological and chemical components for the management of bitter gourd diseases.

Upon field experimentation of different IDM module on bitter gourd diseases for three consecutive years from 2016-17 to 2018-19, highly variable incidence of diseases was observed. During 2016-17, occurrence of downy mildew, powdery mildew and cercospora leaf

spot were recorded. Incidence of mosaic disease and downy mildew were observed in the second year (2017-18). Whereas mosaic disease, downy mildew and cercospora leaf spot were infected during third year (2018-19).

Of the different IDM modules tested, lowest disease severity for downy mildew and mosaic disease were recorded in T6 followed by T5 (Table 2). Module T6 comprising of border cropping with bajra; use of black silver mulching sheet; seed treatment with coordinated compound of carbendazim 12%+ mancozeb 63%; soil drenching with captan 70% +hexaconazole 5% WP and sequential application of imidacloprid 17.8 SL + Neem oil, captan 70 % +hexaconazole 5% WP, imidacloprid 17.8 SL + Neem oil and fosetyl-Al as foliar spray has reduced severity of mosaic disease and downy mildew by 39 – 40% in comparison to control. Though less percent disease index of powdery mildew was recorded in module T1 (33), T6 has reduced 25.58% severity compared to control. Additionally, all the modules evaluated were reduced the disease severity of leaf spot by 24 - 50% compared to control. But the data does not show statistically significant. Similarly, upon integration of neem, pheromone traps and green labeled insecticides in bell pepper in IPM module, significantly low incidence of collar/stem rot and mosaic virus complex were observed in IPM field than the non-IPM module consisting only chemical insecticides (Sardana et al. 2012).

The level of disease control and crop yield is often better in IDM programme than conventional method (Hewson *et al.* 1998). In the present study, all the IDM modules have increased the yield by 1.7 - 2.5 times higher than the control plot. Module T6 recorded significantly higher mean yield of 2787 kg/ha which is increased by 146% over control (1131kg/ha). Economics of different IDM modules showed enhanced cost benefit ratio than the control. Among all the modules, T6 has recorded highest cost benefit ratio of 1:2.1 whereas control recorded 1:1.2. This is in corroboration with the findings of Halder *et al.* (2018) showing that adoption of IPM technology leads to low disease incidence and higher profit in IPM fields than non-IPM fields of bitter gourd. Further Mondal and Mondal (2012) concluded that average yield was better in the IDM villages as compared to control in non-IDM villages and the average pesticide expenditure of IDM trained farmers was significantly lower than non-IDM farmers. Since efficacy of modules are time, crop and region specific, devising and evaluating innovative modules with newer components suitable to local condition are highly essential for the crop disease management. It was discernible that application of IDM

Table 1: Details of treatment schedules used in Bitter gourd

Treatment No	Treatment details
T1	T0 + seed treatment with Seed Pro @ 25 g/kg and soil drenching of Seed Pro @ 5% at 1st true leaf stage after germination followed by 5 sprays of Seed Pro (1%) at 10 days interval in rotation with neem oil (0.2%) alternatively after 15 days after drenching
T2	T0 + seed treatment with carbendazim 12% + mancozeb 63% @3 g/kg and drenching of captan 70% + hexaconazole 5% WP @0.1% at 1st true leaf stage after germination followed by 5 spraying of Seed Pro (1%) at 10 days interval in rotation with Neem oil (0.2%) alternatively after 15 days after drenching
T3	T0 + seed treatment with Seed Pro @25 g/kg and soil drenching of Seed Pro @ 5% 1st true leaf stage after germination followed by spraying of captan 70% + hexaconazole 5% WP @ 0.1% followed by spraying of (imidacloprid 17.8 SL @ 7.5 ml/ 15 l + Neem oil 0.2%) followed by fosetyl-Al @ 0.1% followed by captan 70 % + hexaconazole 5% WP @ 0.1% followed by spraying of (imidacloprid 17.8 SL @ 7.5 ml/ 15 l + Neem oil 0.2%) followed by fosetyl-Al @ 0.1% at 10 days interval.
T4	T0 + seed treatment with Seed Pro @ 25 g/kg and soil drenching of Seed Pro @ 5% at1st true leaf stage after germination followed by spray of (imidacloprid 17.8 SL @ 7.5 ml/ 15 l + Neem oil 0.2%) followed by spray of tebuconazole 50%+ trifloxystrobin 25% @1g/l followed by fosetyl-Al @ 0.1%, followed by spray of tebuconazole 50%+ trifloxystrobin 25% @1g/l followed by spray of (imidacloprid 17.8 SL @7.5 ml/ 15 l + Neem oil 0.2%) followed by Fosetyl-Al @0.1% at 10 days interval
T5	T0 + Seed treatment with carbendazim 12%+ mancozeb 63% @ 3 g/kg and drenching of captan 70 % + hexaconazole 5% WP @ 0.1% 15 days after germination followed by spraying of tebuconazole 50% + trifloxystrobin 25% @1g/l + spray with (imidacloprid 17.8 SL @ 7.5 ml/ 15 l + Neem oil 0.2%) followed by fosetyl-Al @ 0.1% followed by spraying of tebuconazole 50% + trifloxystrobin 25% @1g/l + spray with (imidacloprid 17.8 SL @ 7.5 ml/ 15 l + Neem oil 0.2%) followed by fosetyl-Al @ 0.1% at 10 days interval
T6	T0 + Seed treatment with carbendazim 12%+ mancozeb 63% @ 3 g/kg and drenching of captan 70 % +hexaconazole 5% WP @ 0.1% 15 days after germination followed by spray with (imidacloprid 17.8 SL @ 7.5 ml/ 15 l + Neem oil 0.2%) %) followed by spraying of captan 70 % +hexaconazole 5% WP @ 0.1% followed by fosetyl-Al @ 0.1% followed by spraying of captan 70 % +hexaconazole 5% WP @ 0.1% + spray with (imidacloprid 17.8 SL @ 7.5 ml/ 15 l + Neem oil 0.2%) %) followed by fosetyl-Al @ 0.1% at 30 days after drenching
T7	Untreated Control

Table 2: Pooled analysis of percent diseases index and yield analysis of different IDM modules at IIVR (Varanasi)

T. No	Mosaic disease		Downy mildew		Leaf spot		Powdery mildew		Yield		CB ratio
	PDI	% reduction over control	PDI	% reduction over control	PDI	% reduction over control	PDI	% reduction over control	Yield (kg/acre)	% increase over control	
T1	66.19	26.67	51.02	23.29	59.67	24.19	33	61.63	2143	89.48	1:1.5
T2	80.53	10.78	47.47	28.63	50.92	35.31	55	36.05	2544	124.93	1:1.8
T3	86.29	4.40	53	20.31	57.97	26.35	57	33.72	2334	106.37	1:1.7
T4	67.04	25.73	50.01	24.81	39.28	50.10	70	18.61	1959	73.21	1:1.4
T5	64.73	28.29	53.61	19.40	55.39	29.63	54	37.21	1983	75.33	1:1.5
T6	**54.15**	**40.01**	**40.38**	**39.29**	**48.17**	**38.81**	**64**	**25.58**	**2787**	**146.42**	**1:2.1**
T7 (Control)	90.26		66.51		78.71		86		1131		1:1.2
C.D.	20.95		12.75		N/A		10.34		669.06		
SE(m)	5.94		4.1		6.04		3.36		214.76		
SE(d)	8.4		5.79		8.54		4.75		303.71		
C.V.	11.55		13.71		15.33		12.4		17.5		

module T6 effectively reduced the disease incidence with increased yield in bitter gourd in Varanasi region.

Conclusion

In conclusion, the need-based application of plant protection measures in IDM module may reduce the indiscriminate use of pesticides to attain safer and economic vegetable cultivation. In future, the devised module may undergo refinement according to the disease changing scenario and feasibility of IDM components availability for bitter gourd cultivation.

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सारांश

करेले के प्रमुख रोगों के प्रबंधन के लिए वर्ष 2016 से 2019 तक लगातार तीन वर्षों तक छः अलग–अलग एकीकृत रोग प्रबंधन मॉड्यूल्स का मूल्यांकन भा.कृ.अनु.प.–भारतीय सब्जी अनुसंधान संस्थान, वाराणसी में किया गया। सभी मॉड्यूलों के तुलना में टी$_6$ मोड्यूल्स, जिसके विभिन्न घटकों जैसे– सीमा फसलों के रूप में बाजरे की दो पत्तियों को लगाना, काला– सिल्वर पालीथीन पलवार का प्रयोग के साथ बीजों का उपचार, समन्वित यौगिक (कार्बेन्डाजिम 12 प्रतिशत + मैंकोजेब 63 प्रतिशत 3 ग्राम/किग्रा. बीज की दर से) के द्वारा पौधशाला की मिट्टी को कैप्टान 70 प्रतिशत + हेक्साकोनाजोल समन्वित यौगिक के घोल का जमाव के 15 दिनों के उपरान्त प्रयोग किया गया और इसके बाद इमिडाक्लोप्रिड 17.8 एस.एल. की 7.5 मिली. प्रति 15 लीटर + नीम तेल 0.2 प्रतिशत, कैप्टान 70 प्रतिशत+ हेक्साकोनाजोल 5 प्रतिशत घुलनशील पाउडर की 0.1 प्रतिशत नीम तेल 0.2 प्रतिशत व फोसेटीन–ए1 बी 0.1 प्रतिशत का बीज बुआई के 30 दिनों बाद, 10 दिन के अंतराल पर मूल्यांकन से करेले की फसल के रोग प्रबंधन में प्रभावी पाया गया। अधिक उपज के साथ करेला में मोजैक व मृदुरोमिल आसिता रोग के प्रबंधन में प्रभावी पाया गया। हाँलाकि सभी एकीकृत मॉड्यूलों में रोगों का प्रकोप अनुपचारित नियंत्रण की तुलना में कम पाया गया। जबकि सभी मॉड्यूलों में टी$_6$ मृदुरोमिल आसित में 27 प्रतिशत एवं मोजैक रोग 40 प्रतिशत नियंत्रक की तुलना में कमी आयी। इसमें अधिकतम लागत लाभ अनुपात 1:2:1 समन्वित रोग प्रबंधन माड्यूल टी$_6$ में नियंत्रक की तुलना (1:1.20) पाया गया। इसके अलावा टी$_6$ माड्यूल में करेले के मृदुरोमिल आसिता व सर्कोस्पोरा पत्ती धब्बा रोगों में कमी स्पष्ट रूप से पायी गयी।

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