Indian Journal of Entomology Online published Ref. No. e22216 DoI. No.: 10.55446/IJE.2022.666

ON FARM IMPLEMENTATION OF SUSTAINABLE IPM TECHNOLOGY AND ITS ECONOMIC ANALYSIS FOR BITTER GOURD INVOLVING FARMERS' CENTRED APPROACH IN HARYANA

H R Sardana*, M Narayan Bhat, Niranjan Singh and Halder Jaydeep[1]

ICAR-National Research Centre for Integrated Pest Management, New Delhi 110012, India
[1]ICAR-Indian Institute of Vegetable Research, Varanasi 221305, Uttar Pradesh, India
*Email: hrsardana@rediffmail.com (corresponding author)

ABSTRACT

Area-wide field experiments were conducted in bitter gourd during 2014-2016 at Karnal, Haryana to study validation and economic viability and feasibility of adaptable and rational IPM technology involving farmers' driven holistic approach. The adoption of IPM technology, apart from lowering the incidence of major pests, reduced the number of chemical sprays to 5-9 from 15-17 in non-IPM fields with higher yields of 31.3, 22.3 and 18.75 mt/ ha in IPM compared to 29.5, 20.8 and 17.45 mt/ ha in non-IPM fields with marginally higher CBR of 1:1.80, 1:1.54 and 1:1.91 in IPM than 1:1.60, 1:1.30 and 1:1.68, respectively, in FP fields. There was a net income increase of Rs 23718.1, 35079 and 32403/ ha in IPM fields over FP fields. On an average, IPM farmers harnessed higher net return of Rs. 1.27 lakh/ ha with B:C ratio of 1:1.75 compared to the non-IPM farmers with net return of Rs. 0.97 lakh/ ha with a B:C ratio of 1:1.52.

Key words: Bitter gourd, IPM technology, thrips, whitefly, fruit fly, *Diaphania indica*, lady bird beetle, Cercospora leaf spot, begomovirus, natural enemies, spider, pesticides, prophylactic spray, net return, B: C ratio

Bitter gourd (*Momordica charantia* L.: Cucurbitaceae) is extensively cultivated throughout India, occupies an area of 0.09 m ha with a production of 1.05 mt (Anonymous, 2016)). India is still far behind many countries in terms of productivity owing to attack by several pests, of which fruit fly *Bactrocera cucurbitae*; thrips *Thrips palmi* and cucumber moth *Diaphania indica* and leaf curl (begomovirus) are important and cause substantial yield losses in Haryana. Quicker control strategy using indiscriminate and excessive reliance on chemical pesticides and quest of getting higher yields, has led to environmental destruction (Halder et al., 2010, 2013). It is not unusual for the bitter gourd growers to give upto 15 chemical sprays in a season, which most of the times are unnecessary without any appreciable increase in the yield. Information on development of IPM modules for the holistic management of pests in bitter gourd in a wider area approach is very scanty. Numerous management strategies for the pests of bitter gourd have been developed but these have mostly been dealt in isolation and have met with little desired success. The integration of all the pest management strategies in a farmers led approach/ mode could reduce application of harmful chemical pesticides to a great extent. Keeping this in view, validation of multifaceted adaptable IPM technology in bitter gourd was carried out in a participatory manner at farmers' fields to reduce the over dependence and reliance on chemical pesticides and protecting the ecosystem as a whole (Sardana et al., 2017).

MATERIALS AND METHODS

Three year trials on validation of IPM technology in bitter gourd crop were carried out during 2014-16 at Padhana, Karnal, Haryana. Before initiation of validation of IPM technology, adaptable IPM module for bitter gourd was synthesized based on the base line information, pest and natural enemies status in District Karnal from farmers; recommendations made by relevant research institutes and literature. The IPM module thus synthesized was validated during 2014 initially in an area of 10 ha acres comprising 25 farming families with the following interventions: seed treatment with *Trichoderma asperellum* @ 10 g/ kg seed, installation of cue lure traps (MAT) for fruit flies @ 25/ ha, raking of soil for exposing fruit fly pupae to sunlight and predatory fauna and dormant weeds, spray of fipronil 5SC against thrips, need based pray of *Bacillus thuringiesnsis* @ 2 g/ l against cucumber moth *Diaphania indica,* need based spraying of imidacloprid 17.8SL @ 40 g a.i.ha^{-1} for whitefly, hoppers, other sucking insects and prophylactic spray with thiophenate methyl 70WP @ 0.2% against *Cercospora* leaf spot (*Cercospora citrulina*). The results on the pest incidence/natural enemies population and the economic viability of IPM were compared with non-IPM (farmers' own way of managing the pests) which consisted of only chemical pesticides which included mainly: imidacloprid 17.8SL @ 0.5 ml/ l, thiamethoxam 70 WG @ 0.5 g/ l, acetamiprid 20SP @ 0.33 g/ l, spinosad 45SC @ 0.5 ml/ l, cypermethrin 25EC @ 1 ml/ l, profenophos 40EC + cypermethrin 4EC @ 1 ml/ l, quinalphos 25 EC @ 2 ml/ l; dimethoate 30EC @ 2 ml/ l, mancozeb 75WP @ 2 g/ l, metalaxyl 8WP + mancozeb 64 WP @ 2.5 g/ l and streptocycline @ 0.02%. Local farmers often gave higher than recommended doses of pesticides and frequently applied unknown herbal tonic/micronutrient mixtures with different pesticides with apprehension to rejuvenate their crops. During 2015, the adaptable IPM technology was refined and revalidated on 20 ha comprising 50 farming families in the same location. Due to frequent fungal contamination, the installation of food bait traps and individual bagging of fruits was stopped due to difficulty in implementing. Use of *Bt* against cucumber moth was also discontinued as *Diaphania* did not appear to cause economic damage. During 2016, validated IPM technology was further refined and revalidated in 150 acres in Padhana which involved 75 farming families. Use of insecticides against fruit fly was discontinued as these were found ineffective.

Periodical observations were made on the major biotic fauna in bitter gourd at selected farmers' field, fruit flies trapped in cue lure traps, fruits damage due to melon fruit fly were recorded and percent fruit damage was woked out. For cucumber moth (larvae) population on square meter area (due to thick entangaled canopy) at five locations from each acre area was counted while thrips population were counted on one inflrescence from each plant and white fly on 10 leaves from each plant. For *Cercospora* leaf spot, 0-5 scale was used and based on this percent disease index (PDI) was calculated. For leaf curl, 5 spots were randomly selected from each field of one acre, and in each spot, 15 randomly selected growing tips of one feet length were inspected and % incidence was calculated. Leaf curl caused by begomovirus was confirmed using specific primers. For economic analysis, numbers of chemical sprays, cost of cultivation (per ha), yield (ton/ha), net returns (per ha) and cost :benefit ratio (CBR) were computed and results were presented in Table 2. To estimate the pesticide residue contamination, bitter gourd fruits (up to 50 g each) from both IPM and non-IPM fields were collected and analysed in pesticide residue lab of ICAR-IARI, New Delhi, India.

RESULTS AND DISCUSSION

The adoption of IPM technology resulted in reduction in incidence of all major pests in IPM plots compared to non-IPM plots; *D. indica,* which appeared from June onwards in early reproductive stage was effectively managed by a single spray of *Bt* @ 2 g/ l. In contrast, non-IPM farmers applied a series of chemicals which resulted in increasing the cost of production. Thrips incidence remained higher in non-IPM plots during 2014, 2015 and 2016 being 7.20, 6.90 and 4.3, respectively with an average of 6.10 whereas in the IPM plots these were only 4.8, 3.8, 1.9/ plant, respectively with an average of 3.5. Installation of cue lure traps @ 25/ ha for fruit fly management from flowering onwards and raking of soil resulted in significantly lower fruit damage i.e. 6.7, 4.5 and 2.3% during 2014, 2015 and 2016, respectively, as against higher fruit fly damage registred in FP fields i.e. 9.4, 9.5 and 9.5%, respectively during the same period. Effectivity of cuelure bottle traps for the management of fruit fly in cucurbits vegetable ecosystem has been well established (Sandeep Kumar et al., 2019; Anitha Kumari et al., 2021) (Table 1). Severity of *Cercospora* leaf spot ranged from 14.5-

Table 1. Pests and natural enemies scenario in IPM and non-IPM bitter gourd (2014-16)

Pest/ natural enemy	IPM fields				FP fields			
	2014	2015	2016	Average	2014	2015	2016	Average
D. indica/ sq m	1.2	0.8	2.0	1.3	4.2	3.0	5.6	4.2
Fruit fly (% damage)	6.7	4.5	2.3	4.5	9.4	9.5	9.5	9.5
Thrips (no./ inflorescense)	4.8	3.8	1.9	3.5	7.2	6.9	4.3	6.1
White fly (no/ 10 leaves)	2.0	2.9	4.3	3.1	6.4	5.1	11.6	6.0
Begomo virus (%)	29.8	21.6	35.7	29.0	42.5	34.5	47.7	41.5
Cecospora leaf spot (PDI)	16.6	14.5	34.9	22.0	22.0	17.9	48.7	29.5
Lady bird beetle/ sq m	0.4	2.5	1.8	1.5	0.2	1.0	0.8	0.7
Spiders/ sq m	1.0	4.6	2.5	2.7	0.4	2.0	1.2	1.2

Table 2. Economic analysis of IPM and non-IPM technologies in bitter gourd (2014-16)

Variables	2014		2015		2016	
	IPM	FP	IPM	FP	IPM	FP
Number of sprays	9.8	15.9	7.2	9.5 (17)	5.6	8.5 (15)
Cost of pesticides including labour cost (Rs/ ha)	15695	21725	12370	21467.5	9395	18590
Cost of cultivation (Rs.)	171545	177575	161395	172742.5	168320	178515
Yield (t/ ha)	31.30	29.5	22.32	20.18	18.74	17.45
Gross return / income *(Rs./ ha)	309992.5	295304.4	249505.7	225773.8	322522.2	300314.5
Net return (Rs./ ha)	138447.5	117729.4	88110	53031.3	154202.2	121799.5
Cost benefit ratio	1:1.80	1:1.60	1:1.54	1:1.30	1:1.91	1:1.68

*Sale price of bitter gourd Rs. 1000, Rs. 1118.8 and Rs. 1721/ q during 2014, 2015 and 2016, respectively.

34.9 PDI with an average of 22.0 PDI during the above period in farmers fields (FP) as against 17.9- 48.7 PDI with an average of 29.5 PDI in IPM fields. IPM fields suffered less from leaf curl i.e., 2014 (29.8%), 2015 (21.6%) and 2016 (35.7%) than the non-IPM fields. A similar observation was recorded by Sardana et al. (2012) while managing bell pepper through IPM. A large buildup of natural enemies, especially predatory spiders and coccinellids was observed in IPM fields. High population of spiders in IPM fields (1.0, 4.6 and 2.5/ sq m) than non-IPM fields (0.40, 2.0 and 1.2/sq m) was observed during 2014, 2015 and 2016, respectively (Table 1). Almost a similar trend was recorded with coccinellids. IPM technology, thus resulted in increased biodiversity. Sardana et al. (2012) and Sardana and Bhat (2016, 2017) from their studies concluded that IPM was safer to coccinellids and predatory spiders in pepper and onion ecosystems.

The mean fruit yields obtained were higher, *i.e.*, 31.3, 22.32 and 18.74 t/ ha with an average of 24.1 t/ ha in IPM fields compared to farmer's practices (FP) where it was 29.5, 20.18 and 17.45 t/ ha during 2014, 2015 and 2016, respectively. The consumption of pesticides in terms of number of sprays had also come down gradually in IPM fields; while FP/non-IPM farmers continued to give higher sprays i.e 15.9, 9.5 (17) and 8.5 (15) in a season. During 2014, the cost of cultivation including plant protection measures was slightly higher in both IPM (Rs. 171545/ ha) as well as non-IPM (Rs. 177575/ ha) fields mainly due to purchase of staking materials viz., bamboo and iron/plastic wire that served for more than two years. During 2016, cost of various inputs including labour cost had increased and hence the cost of cultivation was marginally higher. From Table 2 it was evident that IPM adopted farmers had higher gross return of Rs. 3.09, 2.49 and 3.22 lakhs/ ha during 2014, 2015 and 2016, respectively, compared to Rs. 2.95, 2.25 and 3.0 lakh/ ha in case of non-IPM farmers. Same trend was also reflected in case of cost benefit (C:B) ratio wherein IPM farmers registered higher C:B ratio, whereas non-IPM farmers had relatively lower C:B ratio. Adoption of IPM technology resulted in reducing the number of sprays to 5-6 from average number of 15 (Table 2) in FP fields. Halder et al. (2018) and Sardana et al. (2017) also reported higher yields in bitter gourd and in onion seed crop fields of IPM than non-IPM fields, respectively. Feedback from IPM farmers indicated the increased knowledge, awareness and adoption of 80% of the IPM components for bitter gourd by majority of the adopted farmers. Adoption of IPM technology enabled the farmers also to differentiate between the pests and bioagents and avoidance of widely prevalent practice of using mixtures of pesticides.

ACKNOWLEDGEMENTS

Authors thank the Director, ICAR-NCIPM, New Delhi 110012 for providing facilities and encouragement.

REFERENCES

Anitha Kumari D, V Suresh, M Hanuman Nayak, A V N Lavanya, A Mamatha. 2021. Evaluation of different pest management modules in bitter gourd. International Journal of Chemical Studies 9 (1): 587-590

Anonymous 2016. Horticultural statistics at a glance. By DAC, Ministry of Agriculture and Farmers Welfare. Government of India.

Halder J, Rai A B, Kodandaram M H. 2013. Compatibility of neem oil and different entomopathogens for the management of major vegetable sucking pests. National Academy Science Letters 36 (1): 19-25.

Halder J, Srivastava C, Dureja P. 2010. Effect of methanolic extracts of *Vinca rosea* and *Callistemon lanceolatus* alone and their mixtures against neonate larvae of gram pod borer, *Helicoverpa armigera* (Hubner). Indian Journal of Agricultural Sciences 80 (9): 820-3.

Halder, J, H R Sardana, Nagendran Krishnan, M K Pandey, M N Bhat, Kaushik Banerjee. 2018. Synthesis and area-wide validation of adaptable IPM technology and its economic analysis for bitter gourd (*Momordica charantia*) in a farmers' driven approach. Indian Journal of Agricultural Sciences 88 (9): 1378- 1382

Jamadar M M, Desai S A. 1997. Bioefficacy of dimethomorph against downy mildew of grapevine. Advances in Agricultural Research in India*,* 4: 81-85.

Kandangath R A, Garlapati P K, Nallamuthu I. 2015. Nutritional, pharmacological and medicinal properties of *Momordica charantia*. International Journal of Nutrition and Food Science 4 (1): 75-83.

Sandeep Kumar, S Nath, S K Kannaujia, S P Sonkar, A K Singh, R K Rajput, A D Gautam. 2019. Study of the integrated pest management practices against bitter gourd fruit fly in district Jaunpur (U.P.) India. Journal of Pharmacognosy and Phytochemistry 8 (4): 798-800.

Sardana H R, Bhat M N, Sehgal M 2012. Wider area validation and economic analysis of adaptable IPM technology in bell pepper (*Capsicum annum*). Indian Journal of Agricultural Sciences 82 (2): 186-189.

Sardana H R , Bhat M N. 2016. Economic analysis of sustainable IPM Technology for onion seed crop in a farmers' led approach. Indian Journal of Horticulture 73 (4): 615-618.

Sardana H R, Bhat M N. 2017. Farmers' centred approach for area-wide implementation of sustainable IPM technology and economic analysis of onion (*Allium cepa*) during rabi season. Indian Journal of Agricultural Sciences 87 (1): 83-86.

(Manuscript Received: April, 2022; Revised: July, 2022;
Accepted: July, 2022; Online Published: July, 2022)
Online published (Preview) in www.entosocindia.org and indianentomology.org Ref. No. e22216