The Journal of Plant Protection Sciences, **8**(1-2) : 1-6, 2016

Ecofriendly biointensive pest management modules in cowpea under sub-Himalayan West Bengal, India

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Received: 15 October 2016; Accepted: 29 November 2016; Availabale Online: 03 December 2016
DOI: http://dx.doi.org/10.17582/journal.jpps/2016/8.1-2.1-6

ABSTRACT

A field experiment was conducted at Regional Research Station (Terai Zone), Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar (India) during the summer season of 2016 to determine the utility and economics of biointensive pest management modules against major insect-pests of cowpea in comparison to conventional pesticide based pest management modules. The pesticide based management modules proved better as compared to the biopesticide based modules in managing the attack of sucking pests and pod borer of cowpea. The pesticide based IPM-II module resulted in the highest per cent reduction of pod borer population (91.17%) and the highest pod yield (9.85 t/ha). The IPM and biopesticide based management modules resulted in poor cost-benefit ratio. However, the biopesticides and new ecofriendly molecule flubendiamide were found to have less hazardous effect on the population of natural enemies as compared to the pesticide based treatments; thus this approach is augmenting the natural control of pests.

Keywords: Cowpea, insect pests, biopesticides, bioefficacy, cost-benefit ratio, natural enemiesl

Introduction

Cowpea (*Vigna unguiculata*) is one of the most important legume crops cultivated by many resource-poor farmers in many countries of tropical Africa, Asia and South America (Kabululu 2008). Insect-pests are one of the major biotic stresses in cowpea growing regions in both developing and developed counties (Dauost *et al*. 1985). As many as 21 insect pests of different groups have been recorded damaging the cowpea crop from germination to maturity. The avoidable losses in yield due to insect pests have been recorded in the range of 66 to 100 per cent in cowpea (Pandey *et al.* 1991). The important insect species attacking cowpea crop include aphid (*Aphis craccivora* Koch), leafhopper (*Empoasca kerri* Pruthi), thrips (*Megaleurothrips* spp.), whitefly (*Bemisia tabaci* Gennadius), leaf miner (*Acrocercops caerulea* Meyrick), spotted pod borer [*Maruca vitrata* (Fabricius)], tobacco leaf eating caterpillar (*Spodoptera litura* Fabricius) and blue butterfly (*Euchrysops cnejus* Cnidus). Synthetic insecticides are the widely followed means of controlling the pest complex of cowpea. But growing concerns over the hazardous effect of rampant pesticide use, risk of residues in the products and banning of some conventional insecticides have prompted growers to adopt alternative pest control methods. In present days, the Biointensive IPM (BIPM) incorporates proactive and reactive measures for managing the pest problems in the agroecosystem. The reactive options mean that the grower responds to a situation, such as an economically damaging population of pests, with some type of short-term suppressive action. In accordance with this principle the BIPM approves the use of reduced-risk pesticides if other tactics have not been adequately effective, as a last resort, and with care to minimize risks. Combining cultural practices and spraying once each at budding, flowering, and podding stages is more effective and profitable than spraying cowpea weekly throughout the growing period (Nabirye *et al*. 2003). Therefore, the present study was conceptualized to assess the comparative efficacy and economics of different ecofriendly biointensive pest management modules in comparison to conventional pesticide based management modules against the major insect-pests of cowpea along with their impact on the natural enemies.

Materials and Methods

Experimental site

The field experiment was conducted at the farm of Uttar Banga Krishi Viswavidyalaya (North Bengal Agriculture University), Pundibari, Cooch Behar ($89^0$23'53" E longitude and $26^0$19'86" N latitude with an altitude of 43m amsl, situated in sub-Himalayan West Bengal in the north-eastern part of India) in sub-tropical pre-humid type of climate with high annual rainfall (higher than 3000mm), high relative humidity (average maximum and minimum RH of 95 and 65%, respectively) and moderate temperature (average maximum and minimum Temperature of 31 and 11^0C, respectively).

Experimental details

The crop was raised during the summer season of 2016 following normal agronomical practices. The seed of cowpea cv *Sundari Bangla* was sown in plots of 4m x 3m with a row to row and plant to plant spacing of 40cm x 20cm. The experiment was laid out in randomized block design with seven treatments. Each treatment replicated thrice.

Treatment details

T1: (Profenofos 40EC + Cypermethrin 4EC) (1 ml/lit) twice during vegetative and reproductive stage (Farmer's practice)

T2: Thiamethoxam 25WG 0.2 g/lit once during vegetative stage+ Lambda cyhalothrin 5EC (0.5 ml/lit) once during reproductive stage (Pesticide intensive management)

T3: Vermicompost during first top-dressing at 25 DAS + Neem oil 90% (2 ml/lit) once during vegetative stage + Malathion 50EC once during reproductive stage (Pesticide based IPM-I)

T4: Vermicompost during first top-dressing at 25 DAS + Neem oil 90% (2 ml/lit) once during vegetative stage + Flubendiamide 480SC (0.1 ml/lit) once during reproductive stage (Pesticide based IPM- II)

T5: Vermicompost during first top-dressing at 25 DAS + Neem oil 90% twice during vegetative and reproductive stage (Biointensive management-I)

T6: Vermicompost + Tobacco decoction twice during vegetative and reproductive stage (Biointensive management-II)

T7: Control

Preparation of tobacco decoction

Tobacco leaf extract is used for controlling aphids and other soft-bodied insects infesting vegetable crops. For preparing the tobacco decoction, 100 g tobacco leaf powder was soaked in 1 litre of water for 24 hours. The resultant crude leaf extract was diluted with fresh water for 5 times at the time of spraying. Moreover, 125 g ordinary bath soap was added with the solution before spraying for getting better results.

Data recording and analysis

Pre-treatment count on the pest infestation was recorded one day before spraying selecting 10 plants at random from each plot. Post treatment count on pest population was recorded 1, 3, 7 and 14 days after spraying. The data thus recorded were subjected to appropriate transformations and then analyzed using OPSTAT statistical package. The treatment means were compared with Least Significant Difference (LSD) at 5% level of significance. Per cent population reduction over control was calculated by using the formula (Fleming & Retnakaran 1985):

Per cent population reduction over control =

$$[1-(\frac{\text{Post treatment count in treatment}}{\text{Pre treatment count in treatment}}\times\frac{\text{Pre treatment count in control}}{\text{Post treatment count in control}})]\times 100$$

The observations on healthy marketable pod yield/ha were recorded after spraying. The economics of different pesticidal treatments was calculated on the basis of prevailing price of produce, pesticides and labour charges for pesticidal application. Incremental Cost Benefit Ratio (ICBR) for different pesticidal treatment modules was calculated.

Results and Discussion

Effectiveness of different pest management modules against major insect pests of cowpea

The perusal of results reveal that the pesticide based

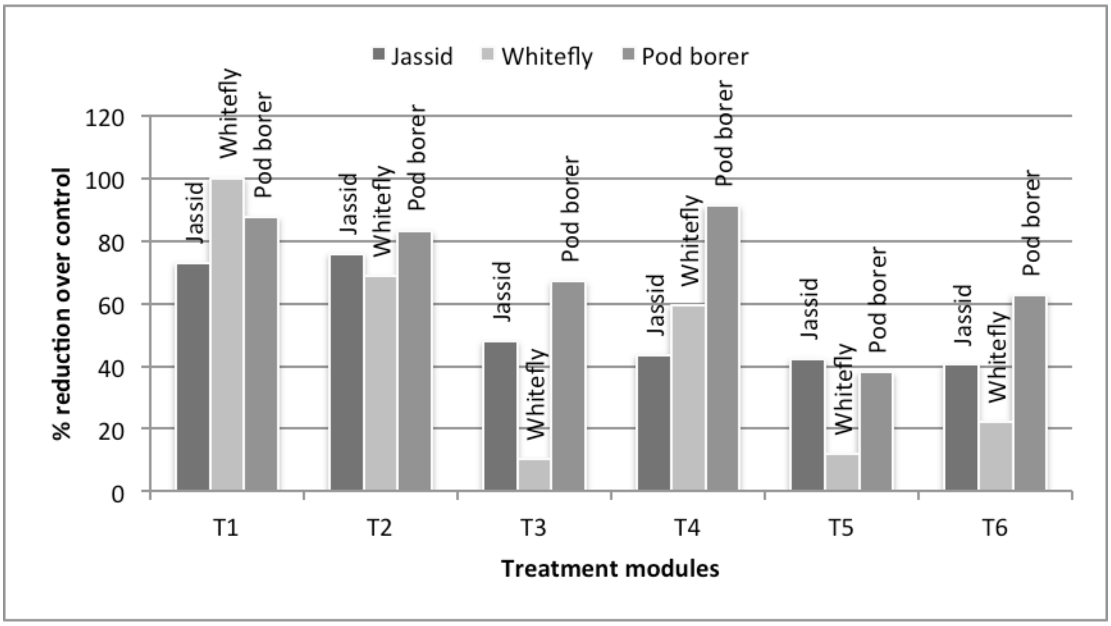

Fig 1. Effectiveness of different pest management modules against major insect pests of cowpea

management modules proved better as compared to the bio-based modules in managing the attack of sucking pests and pod borer of cowpea (Figure 1). However, the pesticide based IPM II (module T_4) particularly the treatment with flubendiamide once during the reproductive stage of the crop resulted in the highest per cent reduction of pod borer population (91.17%) as compared to other treatments. Halder *et al*. (2016) while studying the impact of different pest management modules against the sucking pests of chilli also found the integrated pest management module to be superior to biointensive module. Earlier, flubendiamide has been found superior in reducing the infestation of lepidopteran bud borer, *Helicoverpa armigera* in carnation (Pal *et al*. 2013). From this figure it is found that the treatment module T_2 was the most effective resulting in 76.00% reduction of jassid population over control. This findings supported earlier works; thiamethoxam was considered as the best insecticide for controlling jassid and aphid in okra (Misra 2002) and whitefly in mungbean (Ganapathy & Karuppiah 2004).

Economics of different pest management modules against major insect pests of cowpea

The perusal of Table 1 reveals that the yield of healthy pods varied significantly amongst different treatment modules. Significantly the highest pod yield was obtained with the module T_4 (9.85 t/ha) which was statistically at par with the modules T_3 and T_1. Amongst the biointensive management modules the treatment module T_6 provided the lowest yield (6.33 t/ha) which was statistically identical to the pod yield recorded from other biointensive module (T_5) and control. However, Swarnalata *et al*. (2015) reported that the highest marketable pod yield (30.37 q/ha) and maximum per cent increase in pod yield of cowpea over control (84.28 %) was recorded from the plots treated with insecticides like thiamethoxam 25 WG @ 0.01 per cent. The net profit and cost benefit ratio varied depending on the cost of pesticidal application (Table 1). The highest cost benefit ratio was obtained with T_1 (1:10.41) followed by T_2 (1:8.13) which are basically pesticide intensive treatment modules. The lower net profit/cost benefit ratio for biointensive management modules could be attributable to comparatively less efficacy as well as higher cost of biopesticides thereby increasing the cost of pesticidal application. The IPM and biointensive management modules resulted in poor cost benefit ratio. But keeping the favourable effect of these measures on the ecological health particularly in terms of higher natural enemy population in the agricultural landscapes in view, the biointensive treatments should be integrated with some other

Table 1.
Economics of different pest management modules against major insect pests of cowpea

Treatments		Yield of healthy pods(t/ha)	Increase in yield over control(t/ha)	Increase in yield per cent over control	Cost of increased Yield (Rs. /ha)	Cost of treatment (Rs. /ha)	Net profit (Rs. /ha)	Cost benefit ratio
T_1	Profenofos + Cypermethrin (Farmer's practice)	8.17	2.75	50.74	27500.00	2410.00	25090.0	1: 10.41
T_2	Thiamethoxam+ Lambda cyhalothrin (Pesticide intensive management)	7.56	2.14	39.48	21400.00	2345.00	19055.0	1: 8.13
T_3	Vermicompost + Neem oil + Malathion (Pesticide based IPM-I)	8.47	3.05	56.27	30500.00	27865.00	2635.00	1: 0.09
T_4	Vermicompost + Neem oil + Flubendiamide (Pesticide based IPM II)	9.85	4.43	81.73	44300.00	28710.00	15590.0	1: 0.54
T_5	Vermicompost + Neem oil (Biointensive management-I)	6.58	1.16	21.40	16240.00	26790.00	-10550.0	1: -0.39
T_6	Vermicompost + Tobacco decoction (Biointensive management-II)	6.33	0.91	16.79	12740.00	27916.00	-15176.0	1: -0.54
T_7	Control	5.42						
	SEm±	0.73						
	CD (P=0.05)	2.28						

Average cost of cowpea: Rs. 10/kg; Rs. 14/kg (Organic product for biointensive management treatment)
Cost of biopesticides and insecticides: Profenofos 40EC + Cypermethrin 4EC @ Rs.700/lit, Thiamethoxam 25WG @ Rs.500/100 g, Lambda cyhalothrin 5EC @ Rs. 600/lit, Vermicompost @ Rs. 5/kg, Malathion 50EC @ Rs.500/lit, Neem oil 90% @ Rs.800/lit, Flubendiamide 480SC @180/10 ml, Dried tobacco leaf extract @ Rs. 150/kg; Spray volume: 650 lit/ha; Labour charges for insecticidal application: Rs. 750/spray/ha

economically viable pest management tactics. Gopali *et al*. (2013) also found that the broad spectrum insecticides were more effective than biorationals against pod bug (*Clavigralla gibbosa*) in pigeonpea and recorded higher grain yield with higher net profit and ICBR.

Impact of different pest management modules against natural enemies

The impact of pest management modules on natural enemies (coccinellids and spiders) have been depicted in the Table 2. The biopesticides and new ecofriendly molecule flubendiamide were found to be less hazardous on the population of natural enemies as compared to the pesticide treatments. In case of T_1 *i.e.* (profenophos+cypermethrin) highest reduction (89.00%) of natural enemies population was recorded and T_3 proved to be the safest for natural enemies, where the natural enemies population was increased (56.53%) as compared to other pesticidal treatment modules. The highest number of natural enemies was observed in control plots (0.60) followed by neem oil and malathion (0.37), neem oil and flubendiamide (0.37), neem oil (0.36), thiamethoxam and lamda cyhalothrin (0.28), tobacco decoction (0.22) and (profenophos+cypermethrin) (0.06) sprayed plots. In the treatment T_1 (profenophos+cypermethrin) lowest number of natural enemies was noted; it being broad spectrum insecticides caused toxicity to natural enemies. Among biointensive modules, tobacco decoction treated plots had the lowest number of natural enemies, neem oil sprayed plots also showed relatively more number of natural enemies visiting to the plots. Roy and Sarkar (2017) also recorded highest

Table 2.
Impact of different pest management modules against natural enemies (coccinellids and spiders) (Mean of three replications and two sprayings)

Treatments		Number of natural enemy/plant						
		Pre- treatment count (1 DBS)	Days after spraying				Post-treatment mean	%Reduction/ Increase over Control
			1	3	7	14		
T_1	Profenofos + Cypermethrin	0.30(1.14)*	0.00(1.00)	0.03(1.02)	0.03(1.01)	0.20(1.09)	0.06	-89.00
T_2	Thiamethoxam+ Lambda cyhalothrin	0.47(1.21)	0.00(1.00)	0.07(1.03)	0.53(1.23)	0.50(1.22)	0.28	-67.23
T_3	Vermicompost + Neem oil + Malathion	0.13(1.06)	0.17(1.08)	0.20(1.09)	0.40(1.17)	0.73(1.31)	0.37	+56.53
T_4	Vermicompost + Neem oil + Flubendiamide	0.17(1.08)	0.37(1.15)	0.43(1.20)	0.27(1.12)	0.40(1.18)	0.37	+19.70
T_5	Vermicompost + Neem oil	0.27(1.12)	0.20(1.09)	0.53(1.22)	0.40(1.18)	0.30(1.14)	0.36	+26.66
T_6	Vermicompost + Tobacco decoction	0.04(1.20)	0.13(1.06)	0.13(1.06)	0.30(1.14)	0.33(1.15)	0.22	+20.25
T_7	Control	0.33(1.15)	0.30(1.14)	0.97(1.39)	0.67(1.29)	0.47(1.20)	0.60	-
	SEm±	0.06	0.05	0.07	0.06	0.05		
	CD(P=0.05)	N.S	N.S	0.22	N.S	N.S		

DBS – Day before spraying, * Figures in parentheses are $\sqrt{(x+1)}$ transformed values

number of coccinellids and spiders in IPM compatible bio-rational module over bio-intensive and farmers practice modules against major pests of okra in the Gangetic alluvial plain of West Bengal. Earlier, Kavitha *et al*. (2013) found biointensive pest management modules to be promising for effective conservation of natural enemies even though, farmer's practice and IPM modules initially supported less larval populations of *H. armigera* and minimal damage indicating the suitability and feasibility of BIPM for pigeonpea ecosystems.

The study demonstrated further that pesticide based management modules is better than bio-based modules in respect of reduction of pest and favourable ICBR. However, the IPM compatible bio-based modules are less hazardous to the natural enemies in the cowpea ecosystem. Therefore, IPM compatible modules with ecofriendly pesticides could be considered as an effective and economic approach of insect-pest management in the cowpea ecosystem.

Acknowledgement

The authors thank to the *In-charge*, Regional Research Station (*Terai* Zone) and Director of Research, Uttar Banga Krishi Viswavidyalaya, Pundibari, India for providing the necessary facilities for carrying out this research work.

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