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EVALUATION OF IPM MODULES FOR THE MANAGEMENT OF POD BORER COMPLEX IN HYBRID PIGEONPEA

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ABSTRACT: A study on the evaluation of IPM modules for the management of pod borer complex in hybrid pigeonpea, ICPH 2671 was conducted during 2011-12. The data indicated that pesticide based IPM module comprising of thiodicarb 75WP, rynaxypyr 18.5SC, spinosad 45SC, DDVP 76EC and flubendiamide 480SC proved to be cost effective by recording highest grain yield (2819 kg/ha) and benefit cost ratio (4.09) followed by recommended package of practice comprising of biopesticides like NSKE and *Ha*NPV and insecticides like thiodicarb 75WP and indoxacarb 15EC with the grain yield of 2441 kg/ha and benefit cost ratio of 3.85 and biointensive IPM module involving neem seed kernel extract, *Ha*NPV, *Bacillus thuringiensis* and chilli garlic extract with 2174 kg/ha grain yield and 3.29 benefit cost ratio.

Key words: ICPH 2671, pod borers, pigeonpea, IPM modules.

INTRODUCTION

Pigeonpea [*Cajanus cajan* (L.) Millsp.], commonly known as redgram or *arhar* or *tur*, is one of the most important pulse crops in India. It is a rich source of protein and supplies a major share of protein requirement to the population of the country. It is consumed in the form of split pulse as lentil or dal; in addition the immature green seeds and pods are eaten as green vegetable. The outer covering of seeds together with the part of kernel provides a valuable feed for milch cattle. The husk of pods and woody parts of the plant are used as fuel. Being a legume, it possesses valuable properties as a restorer of nitrogen to the soil (Singh *et al*, 2005).

To achieve higher yields per unit area, the genetically diverse experimental hybrid like ICPH 2671 was developed by International Crops Research Institute for Semi Arid Tropics (ICRISAT), Patancheru (using the parent lines, ICPA 2043 and ICPR 2671) which has a potential to yield (32.50 q/ha) under irrigation. Plants of ICPH 2671 are semi-spreading and indeterminate in growth habit, which achieve a mean height of about 223 cm at maturity. On an average, it flowers in 114 to 120 days and its 75 per cent pod maturity is achieved in 166-184 days.

The pod borer complex include *Maruca testulalis* (Geyer), *Helicoverpa armigera* (Hubner), *Etiella zinckenella* Treit., *Exelastes atomosa* Wals., *Melanagromyza obtusa* (Malloch) and *Lampides boeticus* (Linnaeus). The spotted pod borer which is an important pest of grain legumes, appears on the crop at reproductive stage and causes substantial damage to flowers by webbing and also boring into the pods. The damage inflicted by *H. armigera* is generally confined to flower buds, seeds and pods. The young larvae of *L. boeticus* damage flowers and pods. The plume moth affected pods exhibit small and round holes. The larvae of *E. zinckenella* bore the pods and feed on the seeds. There are no external symptoms in case of *M. obtusa* infestation but the fully grown larvae chew holes in the pod walls leaving a "window" through which the flies emerge after the pupation in the pod. Pod borers caused 60-90 per cent grain yield loss under favourable conditions while damage due to pod fly ranged from 14.3 to 46.6 per cent (Lal *et al*, 1981).

The recently developed hybrid pigeonpea, ICPH 2671 lacks entomological investigations. Hence, to reveal pest management in hybrid pigeonpea the present study was undertaken.

MATERIALS AND METHODS

The two IPM modules *viz.*, Biointensive module and Pesticide based IPM module were tested for their suitability and effectiveness in comparison with Recommended package of practice and Untreated check during 2011-2012 season. The hybrid pigeonpea, ICPH 2671 was sown on 20th June 2011 at MARS, Dharwad. The crop was sown on four different plots of the size of 15.8 X 14 m area each. The crop was raised following all the recommended package of practices except plant

Table 1 : Spray schedule followed in different Modules evaluated.

S.No.	Modules/Treatments imposed	Dosage
	Module I: Biointensive module	
1	Neem seed kernel extract	5%
2	*Ha* NPV spray	250 LE/ha
3	*Bacillus thuringiensis*	1.00 kg/ha
4	Chilli + Garlic extract	0.5% + 0.2%
	Module II: Pesticide based IPM module	
1	Thiodicarb 75WP	0.6 g/l
2	Rynaxypyr 18.5SC	0.2 g/l
3	Spinosad 45SC + DDVP 76%EC	0.12 ml/l + 0.5 ml/l
4	Flubendiamide 480SC	0.075 ml/l
	Module III: Recommended package	
1	Thiodicarb75WP	0.6 g/l
2	NSKE	5 %
3	*Ha* NPV	250 LE/ha
4	Indoxacarb 15EC	0.3 ml/l
	Module IV: Untreated check	_

protection measures. However, the crop was protected commonly in vegetative stage against defoliating insects. Four IPM modules (Table 1) were imposed in the plots keeping one plot per module and the treatments in each module were imposed on need basis against the pod borer complex. The observations were recorded from each plot on five tagged plants at five spots. In each plot, observation on larval counts and pod damage were recorded at one day prior and at one, five and nine days after each spray. At harvest, grain yield data was recorded on net plot basis and converted into hectare basis. The data were subjected to statistical analysis after suitable transformation.

The current price of input materials and labour cost were considered for computing the cost of cultivation which is expressed in Rs/ha. The income from grain yield of pigeonpea was considered for accounting gross returns. The prices prevailed at APMC, Dharwad were considered to calculate the gross returns (Rs/ ha). Net return (Rs/ ha) was calculated by subtracting the cost of cultivation (Rs/ ha) from the gross returns. The ratio of gross return to cost of cultivation was worked out for each treatment and was used as benefit: cost ratio (B:C) to compare the performance of different treatments.

RESULTS AND DISCUSSION

Larval population of pigeonpea pod borer, *Helicoverpa armigera* : One day prior to first application, the larval population varied from 1.84 to 2.28 larvae per plant in different modules without any significant differences. However, at one day after application, the pest population in pesticide based IPM module (M_2) and recommended package of practice (M_3) recorded

Table 2 : Population of *Helicoverpa armigera* in different IPM modules

M. No.	Modules	No. of larvae per plant															
		I Application				II Application				III Application				IV Application			
		Pre treatment	1 DAS	5 DAS	9 DAS	Pre treatment	1 DAS	5 DAS	9 DAS	Pre treatment	1 DAS	5 DAS	9 DAS	Pre treatment	1 DAS	5 DAS	9 DAS
M_1	Biointensive module	1.92 (0.65)^{a}	1.64 (0.61)^{ab}	1.52 (0.58)^{a}	1.88 (0.64)^{b}	2.36 (0.71)^{b}	2.12 (0.68)^{c}	1.72 (0.62)^{b}	1.80 (0.63)^{ab}	1.96 (0.66)^{b}	1.84 (0.64)^{b}	1.32 (0.64)^{b}	1.24 (0.53)^{ab}	1.44 (0.57)^{ab}	1.32 (0.55)^{c}	1.44 (0.57)^{c}	1.52 (0.59)^{c}
M_2	Pesticide based IPM module	2.28 (0.70)^{a}	1.24 (0.53)^{a}	1.36 (0.56)^{a}	1.56 (0.59)^{ab}	1.72 (0.62)^{a}	0.92 (0.47)^{a}	1.04 (0.49)^{a}	1.16 (0.52)^{a}	1.36 (0.55)^{a}	0.72 (0.42)^{a}	0.84 (0.42)^{a}	0.88 (0.46)^{a}	1.04 (0.49)^{a}	0.24 (0.29)^{a}	0.28 (0.30)^{a}	0.36 (0.33)^{a}
M_3	Recommended package	2.12 (0.68)^{a}	1.16 (0.52)^{a}	1.28 (0.54)^{a}	1.44 (0.57)^{a}	1.52 (0.58)^{a}	1.44 (0.57)^{b}	1.36 (0.56)^{ab}	1.64 (0.60)^{ab}	1.68 (0.61)^{ab}	1.56 (0.59)^{b}	1.28 (0.59)^{b}	1.32 (0.55)^{b}	1.68 (0.61)^{b}	0.76 (0.43)^{b}	0.84 (0.44)^{b}	0.96 (0.48)^{b}
M_4	Untreated check	1.84 (0.63)^{a}	2.24 (0.68)^{b}	2.72 (0.76)^{b}	3.08 (0.81)^{c}	3.24 (0.83)^{c}	3.28 (0.83)^{d}	3.36 (0.84)^{c}	3.84 (0.90)^{c}	3.92 (0.91)^{c}	4.20 (0.94)^{c}	4.88 (0.94)^{c}	5.52 (1.07)^{c}	5.64 (1.08)^{c}	5.88 (1.10)^{d}	6.72 (1.18)^{d}	7.24 (1.22)^{d}

Table 3 : Population of *Maruca vitrata* in different IPM module.

M. No.	Modules	No. of larvae per plant															
		I Application				II Application				III Application				IV Application			
		Pre treatment	1 DAS	5 DAS	9 DAS	Pre treatment	1 DAS	5 DAS	9 DAS	Pre treatment	1 DAS	5 DAS	9 DAS	Pre treatment	1 DAS	5 DAS	9 DAS
M_1	Biointensive module	2.16 (0.69)^{a}	2.04 (0.67)^{ab}	2.20 (0.69)^{b}	2.44 (0.72)^{b}	2.48 (0.73)^{b}	2.52 (0.74)^{bc}	2.40 (0.72)^{c}	1.64 (0.60)^{b}	1.48 (0.58)^{bc}	1.32 (0.55)^{bc}	0.44 (0.36)^{b}	0.00 (0.20)^{a}	0.00 (0.20)^{a}	0.00 (0.20)^{a}	0.00 (0.20)^{a}	0.00 (0.20)^{a}
M_2	Pesticide based IPM module	2.24 (0.70)^{a}	1.44 (0.57)^{a}	1.48 (0.58)^{a}	1.64 (0.61)^{a}	1.72 (0.62)^{a}	1.04 (0.49)^{a}	0.88 (0.46)^{a}	0.76 (0.43)^{c}	0.44 (0.35)^{a}	0.12 (0.25)^{a}	0.00 (0.20)^{a}	0.00 (0.20)^{a}	0.00 (0.20)^{a}	0.00 (0.20)^{a}	0.00 (0.20)^{a}	0.00 (0.20)^{a}
M_3	Recommended package	2.36 (0.72)^{a}	1.56 (0.59)^{a}	1.72 (0.61)^{ab}	1.88 (0.64)^{a}	1.96 (0.65)^{a}	1.92 (0.65)^{b}	1.48 (0.58)^{b}	1.32 (0.55)^{b}	1.36 (0.56)^{b}	0.96 (0.48)^{b}	0.36 (0.33)^{b}	0.00 (0.20)^{a}	0.00 (0.20)^{a}	0.00 (0.20)^{a}	0.00 (0.20)^{a}	0.00 (0.20)^{a}
M_4	Untreated check	2.32 (0.71)^{a}	2.32 (0.71)^{b}	2.88 (0.78)^{c}	3.04 (0.80)^{c}	3.12 (0.65)^{c}	3.16 (0.82)^{c}	3.08 (0.81)^{d}	2.36 (0.71)^{a}	1.88 (0.64)^{c}	1.48 (0.58)^{c}	0.88 (0.45)^{c}	0.00 (0.20)^{a}	0.00 (0.20)^{a}	0.00 (0.20)^{a}	0.00 (0.20)^{a}	0.00 (0.20)^{a}

DAS- Day after spray, Figures in parentheses are $\sqrt{(x+1)}$ values, Means denoted by same letters are not significantly different by DMRT (P= 0.05).

Table 4 : Population of *Exelastis atomosa* in different IPM modules.

M. No.	Modules	No. of larvae per plant															
		I Application				II Application				III Application				IV Application			
		Pre treatment	1 DAS	5 DAS	9 DAS	Pre treatment	1 DAS	5 DAS	9 DAS	Pre treatment	1 DAS	5 DAS	9 DAS	Pre treatment	1 DAS	5 DAS	9 DAS
M_1	Biointensive module	0.00 (0.20)^{a}	0.00 (0.20)^{a}	0.00 (0.20)^{a}	0.00 (0.20)^{a}	0.00 (0.20)^{a}	0.00 (0.20)^{a}	0.00 (0.20)^{a}	1.32 (0.55)^{a}	1.36 (0.56)^{a}	1.24 (0.53)^{b}	1.44 (0.57)^{b}	1.48 (0.58)^{b}	1.56 (0.59)^{b}	1.44 (0.57)^{c}	0.96 (0.48)^{c}	1.36 (0.56)^{c}
M_2	Pesticide based IPM module	0.00 (0.20)^{a}	0.00 (0.20)^{a}	0.00 (0.20)^{a}	0.00 (0.20)^{a}	0.00 (0.20)^{a}	0.00 (0.20)^{a}	0.00 (0.20)^{a}	1.08 (0.50)^{a}	1.16 (0.52)^{a}	0.60 (0.39)^{a}	0.64 (0.40)^{a}	0.72 (0.42)^{a}	0.76 (0.43)^{a}	0.04 (0.22)^{a}	0.12 (0.25)^{a}	0.16 (0.26)^{a}
M_3	Recommended package	0.00 (0.20)^{a}	0.00 (0.20)^{a}	0.00 (0.20)^{a}	0.00 (0.20)^{a}	0.00 (0.20)^{a}	0.00 (0.20)^{a}	0.00 (0.20)^{a}	1.28 (0.54)^{a}	1.40 (0.56)^{a}	1.32 (0.55)^{b}	1.76 (0.62)^{b}	1.84 (0.64)^{b}	1.88 (0.64)^{b}	0.52 (0.37)^{b}	0.48 (0.36)^{b}	0.56 (0.38)^{b}
M_4	Untreated check	0.00 (0.20)^{a}	0.00 (0.20)^{a}	0.00 (0.20)^{a}	0.00 (0.20)^{a}	0.00 (0.20)^{a}	0.00 (0.20)^{a}	0.00 (0.20)^{a}	1.36 (0.56)^{a}	1.44 (0.57)^{a}	1.52 (0.59)^{b}	1.84 (0.63)^{b}	1.88 (0.64)^{b}	1.92 (0.65)^{b}	2.08 (0.67)^{d}	2.12 (0.68)^{d}	2.52 (0.73)^{d}

Table 5 : Population of *Clavigralla gibbosa* in different IPM modules.

M. No.	Modules	No. of nymphs and adults per plant															
		I Application				II Application				III Application				IV Application			
		Pre treatment	1 DAS	5 DAS	9 DAS	Pre treatment	1 DAS	5 DAS	9 DAS	Pre treatment	1 DAS	5 DAS	9 DAS	Pre treatment	1 DAS	5 DAS	9 DAS
M_1	Biointensive module	0.44 $(0.35)^{a}$	0.40 $(0.34)^{ab}$	0.48 $(0.36)^{b}$	0.52 $(0.36)^{ab}$	0.60 $(0.38)^{ab}$	0.64 $(0.40)^{bc}$	0.56 $(0.38)^{ab}$	0.72 $(0.43)^{bc}$	0.76 $(0.43)^{ab}$	0.84 $(0.45)^{b}$	0.88 $(0.46)^{ab}$	0.96 $(0.47)^{ab}$	1.04 $(0.50)^{b}$	0.88 $(0.46)^{c}$	0.92 $(0.45)^{bc}$	0.96 $(0.48)^{bc}$
M_2	Pesticide based IPM module	0.56 $(0.38)^{a}$	0.16 $(0.26)^{a}$	0.20 $(0.28)^{a}$	0.24 $(0.29)^{a}$	0.40 $(0.34)^{ab}$	0.16 $(0.26)^{a}$	0.32 $(0.31)^{a}$	0.36 $(0.32)^{a}$	0.44 $(0.35)^{a}$	0.40 $(0.34)^{a}$	0.48 $(0.36)^{a}$	0.52 $(0.37)^{a}$	0.56 $(0.38)^{a}$	0.16 $(0.29)^{a}$	0.20 $(0.28)^{a}$	0.24 $(0.29)^{a}$
M_3	Recommended package	0.52 $(0.37)^{a}$	0.08 $(0.23)^{a}$	0.16 $(0.26)^{a}$	0.20 $(0.28)^{a}$	0.32 $(0.31)^{a}$	0.36 $(0.33)^{ab}$	0.48 $(0.33)^{a}$	0.64 $(0.40)^{ab}$	0.68 $(0.42)^{ab}$	0.64 $(0.41)^{ab}$	0.80 $(0.45)^{ab}$	0.88 $(0.46)^{ab}$	0.96 $(0.48)^{b}$	0.52 $(0.38)^{b}$	0.56 $(0.39)^{ab}$	0.60 $(0.39)^{ab}$
M_4	Untreated check	0.48 $(0.37)^{a}$	0.56 $(0.38)^{b}$	0.60 $(0.40)^{b}$	0.76 $(0.43)^{b}$	0.96 $(0.48)^{b}$	1.00 $(0.49)^{c}$	0.92 $(0.47)^{b}$	1.12 $(0.51)^{c}$	1.00 $(0.49)^{b}$	1.04 $(0.49)^{b}$	1.16 $(0.52)^{b}$	1.20 $(0.52)^{b}$	1.24 $(0.53)^{b}$	1.28 $(0.54)^{d}$	1.32 $(0.55)^{c}$	1.36 $(0.56)^{c}$

DAS- Day after spray, Figures in parentheses are $\sqrt{(x+1)}$ values, Means denoted by same letters are not significantly different by DMRT (P= 0.05).

Table 6 : Population of *Ceuthorrhynchus asperulus* in different IPM modules.

M. No.	Modules	No. of adults per plant															
		I Application				II Application				III Application				IV Application			
		Pre treatment	1 DAS	5 DAS	9 DAS	Pre treatment	1 DAS	5 DAS	9 DAS	Pre treatment	1 DAS	5 DAS	9 DAS	Pre treatment	1 DAS	5 DAS	9 DAS
M_1	Biointensive module	0.00 $(0.20)^{a}$	0.00 $(0.20)^{a}$	0.00 $(0.20)^{a}$	0.52 $(0.37)^{a}$	0.56 $(0.38)^{a}$	0.68 $(0.41)^{b}$	0.88 $(0.46)^{bc}$	1.36 $(0.56)^{bc}$	1.44 $(0.57)^{b}$	1.48 $(0.58)^{b}$	1.64 $(0.60)^{b}$	1.76 $(0.62)^{b}$	1.80 $(0.63)^{b}$	1.44 $(0.57)^{b}$	1.56 $(0.59)^{b}$	1.64 $(0.60)^{b}$
M_2	Pesticide based IPM module	0.00 $(0.20)^{a}$	0.00 $(0.20)^{a}$	0.00 $(0.20)^{a}$	0.56 $(0.39)^{a}$	0.64 $(0.40)^{a}$	0.32 $(0.31)^{a}$	0.40 $(0.34)^{a}$	0.84 $(0.45)^{a}$	0.88 $(0.46)^{a}$	0.52 $(0.38)^{a}$	0.76 $(0.42)^{a}$	0.84 $(0.44)^{a}$	0.96 $(0.46)^{a}$	0.76 $(0.42)^{a}$	0.88 $(0.46)^{a}$	0.92 $(0.45)^{a}$
M_3	Recommended package	0.00 $(0.20)^{a}$	0.00 $(0.20)^{a}$	0.00 $(0.20)^{a}$	0.72 $(0.42)^{a}$	0.76 $(0.43)^{a}$	0.52 $(0.38)^{ab}$	0.76 $(0.43)^{ab}$	1.24 $(0.53)^{ab}$	1.40 $(0.56)^{b}$	1.64 $(0.60)^{b}$	1.72 $(0.62)^{b}$	1.76 $(0.63)^{b}$	1.84 $(0.64)^{b}$	1.24 $(0.53)^{ab}$	1.28 $(0.54)^{ab}$	1.48 $(0.58)^{ab}$
M_4	Untreated check	0.00 $(0.20)^{a}$	0.00 $(0.20)^{a}$	0.00 $(0.20)^{a}$	0.96 $(0.48)^{a}$	1.12 $(0.51)^{a}$	1.32 $(0.55)^{c}$	1.40 $(0.56)^{c}$	1.92 $(0.64)^{c}$	2.16 $(0.68)^{c}$	2.40 $(0.72)^{c}$	2.48 $(0.73)^{b}$	2.52 $(0.73)^{b}$	2.56 $(0.74)^{b}$	2.64 $(0.75)^{c}$	3.04 $(0.80)^{c}$	3.20 $(0.82)^{c}$

DAS- Day after spray, Figures in parentheses are $\sqrt{(x+1)}$ values, Means denoted by same letters are not significantly different by DMRT (P= 0.05).

Table 7 : Pod damage due to pod borer complex in different IPM modules.

M. No.	Modules	*Helicoverpa armigera*	*Melanagromyza obtusa*	*Exelastis atomosa*	*Clavigralla gibbosa*	Mean
M_1	Biointensive module	23.07(28.66)^c	34.41(35.90)^b	7.52(15.91)^b	5.70(13.81)^b	17.67(22.72)
M_2	Pesticide based IPM module	9.89(18.26)^a	24.49(29.65)^a	2.79(9.61)^a	2.58(9.24)^a	9.93(16.69)
M_3	Recommended package	18.27(25.27)^b	29.83(33.09)^b	3.37(10.57)^b	4.35(12.03)^b	13.93(21.09)
M_4	Untreated check	38.63(38.40)^d	42.71(40.79)^c	9.81(18.25)^c	8.35(16.79)^c	24.87(28.56)

Figures in parentheses are angular transformed values, Means denoted by same letters are not significantly different by DMRT (P = 0.05).

Table 8 : Economics of different IPM modules for the management of pod borers in hybrid pigeon pea.

M. No.	Modules	Cost of production (Rs/ha)	Cost of insecticide (Rs/ha)	Total cost of cultivation (Rs/ha)	Yield (k/ha)	Gross returns (Rs/ha)	Net income (Rs/ha)	B:C ratio
M_1	Biointensive module	16717	3760	20477	2174(46.64)^c	67394	46917.0	3.29
M_2	Pesticide based IPM module	16717	4640	21357	2819(53.10)^a	87389	66032.0	4.09
M_3	Recommended package	16717	2915	19632	2441(49.42)^b	75671	56039.0	3.85
M_4	Untreated check	16717	0000	16717	1558(41.94)^d	48298	31581.0	2.89

significantly lower population (1.24 and 1.16 larvae/plant) than untreated check (2.24 larvae/plant). The trend continued at five and nine days of application with significantly lower population (1.44 larvae/plant) in M_3 as compared to biointensive module (M_1) and untreated check (M_4) (Table 2).

The larval population in M_4 continued to buildup as the time advanced with 3.24 larvae per plant a day before second application to 7.41 larvae per plant after nine days of fourth application which was significantly superior over other three modules. On the contrary, the least population was recorded in M_2 (1.16, 0.88 and 0.36 larvae/plant after 9 days of 2nd, 3rd and 4th application, respectively). The next to follow was M_3 with 1.64, 1.32 and 0.36 larvae per plant at 9 days of 2nd, 3rd and 4th application, respectively. However, the biointensive module recorded moderate reduction in population (1.80, 1.24 and 1.52 larvae/plant after 9 days of 2nd, 3rd and 4th application, respectively) which was significantly higher over M_4 but lower to M_2 (Table 2).

Larval population of flower webber, *Maruca testulalis* : The larval population before one day prior to treatment imposition varied from 2.16 to 2.36 larvae per plant in different modules without any statistical difference. However, after one day of first application, the population reduced to 1.44 and 1.56 larvae per plant in M_2 and M_3, respectively which were superior over M_4 at five and nine days after application. The superiority of M_2 and M_3 as compared to M_4 and M_1 continued further with similar trend. The pesticide based IPM module brought down the population to zero after five days of third application as compared to nine days after third application in other modules. During fourth application, the population of *M. testulalis* could not be traced in the experimental field (Table 3).

Larval population of plume moth, *Exelastis atomosa* : The population of *E. atomosa* was noticed initially at nine days of second application (1.08-1.36 larvae/plant in different IPM modules). The biointensive module proved at par with untreated check during most of the observation periods. However, M_2 proved to be the best module with a population of 0.16 larvae per plant at nine days of fourth application as compared to M_3 (0.56 larvae/pl) (Table 4).

Nymph and adult population of pod sucking bug, *Clavigralla gibbosa*: With a population range of 0.44 - 0.60 bugs per plant a day prior to first application, all the four modules stood at par. However, the population reduction was significant in M_2 and M_3 (0.16 and 0.08 bugs/plant) over M_4 (0.6 bugs/plant) at one day of after first application. The population of *C. gibbosa* continued to increase in M_4 as the time advanced and it was 1.36 bugs per plant at ninth day of fourth application. The biointensive module proved inferior to M_2 and M_3. However, the other modules M_2 and M_3 with a population range of 0.32-0.88 and 0.40-0.56 bugs per plant were on par at different intervals of observation (Table 5).

Adult population of bud weevil, *Ceutorhynchus asperulus*: The population of *C. asperulus* started appearing at nine days of first application (0.5-0.96 beetles/plant). Though the pest population continued to build in untreated check (1.12 beetles/plant) a day prior to 2^{nd} application to 3.20 beetles per plant at 9 days of 4^{th} application), all the three modules M_1, M_2 and M_3 brought down the population of beetles to a moderate extent. The population of *C. asperulus* varied from 1.36-1.64 beetles per plant at nine days of second and fourth application in M_1 as compared to 0.04-0.92 and 1.24-1.48 beetles per plant at nine days after application in M_2 and M_3, respectively (Table 6).

Pod damage: The highest pod damage was inflicted by *M. obtusa* in all the modules. The pesticide based IPM module was superior (24.49%) over M_1 and M_3 (34.41 and 29.83%) which in turn were superior to M_4 (42.71%). The next predominant pod borer was *H. armigera* with the pod damage varied from 9.89 to 38.63 per cent in untreated check. The best treatment was M_3 (18.27%) followed by M_1 (23.07%). However, the pod damage due to *E. atomosa* and *C. gibbosa* was less than 10 per cent in different modules. The overall mean per cent damage was least (9.93%) in M_2 followed by M_3 (15.15%), M_1 (16.47%) and M_4 (24. 87%) (Table 7).

Cost economics : Pesticide based IPM module recorded highest net income (Rs 66,032/ha) followed by M_3 (Rs 56,039/ha) and M_1 (Rs 46,917/ha). Similarly, M_2 recorded highest BC ratio (4.09) followed by M_3 (3.85) and M_1 (3.29). The BC ratio was least in untreated check (2.89) (Table 8).

In contrast to the present findings, the reports of Yelshetty *et al.* (2003) indicated that adoptive IPM module and biointensive module were found cost effective with highest benefit cost ratio of 2.78 and 2.30, respectively. The study indicated the superiority of biointensive module during heavy pest load and adaptive module during normal pest load situation in pigeon pea. Whereas, Gopali and Lingappa (2001) reported that IPM module comprising of bird perch, *Ha*NPV (500 LE/ha), NSKE (5%) + *Ha*NPV (250 LE/ha), chlorpyriphos (0.4%), alphamethrin (0.01%) and another IPM module consisting of two sprays of *Ha*NPV (500 LE/ha), chlorpyriphos and alphamethrin (0.01%) were found cost effective as compared to recommended plant protection schedule. These variations might be due to different components used in the IPM modules and the different cultivars used by previous workers.

REFERENCES

Gopali J B and Lingappa S (2001) Integrated management of pod borer, involving *Ha* NPV and insectivorous birds. *Karnataka J. Agric. Sci.* 14(1), 58-61.

Lal S S, Yadav C P and Dias C A R (1981) Insect pests of pulse crops and their management. *Pesticides Annu. Rep.*, pp. 66-67.

Singh C, Singh P and Singh R (2005) Modern Techniques of Raising Field Crops (2nd Edition). Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, p. 241.

Yelshetty S, Patil B V and Lingappa S (2003) Evaluation of integrated pest management modules against pod borer, *Helicoverpa armigera* (Hubner) in pigeon pea ecosystem. *Karnataka J. Agric. Sci.* 16(1), 54-60.