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Validation of integrated pest management module against major insect pests of pigeonpea, (*Cajanus cajan* (L.) Millsp.)

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Abstract
Integrated Pest Management (IPM) module was validated against major insect pests of pigeonpea in farmers' fields during *Kharif,* 2011 in Warangal district, Andhra Pradesh (now in Telangana), India. IPM module included installation of pheromone traps @ 10/ha, erection of bird perches @ 50/ha, spraying of *Helicoverpa armigera* nucleopolyhedrosis virus (Ha NPV) @ 500 LE/ha, need based spraying of insecticides like acephate (@ 500 g/ha) + DDVP (@ 500 ml/ha); indoxacarb (@ 500 ml/ha), spinosad (@ 200 ml/ha). Farmers' practice included only 2 sprays of quinalphos @ 1 lt/ha at flowering and at 20-25 days after 1st spraying. Per cent pod damage by different insect pests *viz.*, gram pod borer (*Helicoverpa armigera*), pod fly (*Melanagromyza obtusa*), spotted pod borer (*Maruca vitrata*) decreased by 61.08, 37.65 and 48.66 per cent, respectively, in IPM over farmers' practice fields. IPM fields recorded 61 per cent yield increase over farmers' practice with mean Benefit Cost Ratio of 1.73.

Keywords: Benefit cost ratio, integrated pest management, pigeonpea, pod borers, pod fly

Introduction
Pigeonpea [(*Cajanus cajan* (L.) Millsp.)] is an important legume crop in semi-arid tropical and subtropical farming systems, providing high quality vegetable protein, animal feed, and firewood. In India, it is mostly grown in *Kharif* season for green vegetable or dry seed purpose, either as a sole crop or intercrop with maize, castor, sorghum, green gram, soybean and cotton. Productivity of pigeonpea is limited by several biotic and abiotic factors. Among biotic factors, a large number of insect pests infest pigeonpea crop at its various growth stages, of which, those which attack pods like gram pod borer (*Helicoverpa armigera*), pod fly (*Melanagromyza obtusa*), spotted pod borer (*Maruca vitrata*) cause considerable yield losses. Adequate resistant varieties are not available for these pests and farmers had to rely largely on chemical methods of pest management. However, being cultivated mainly by resource-poor small-scale farmers in the rainfed regions of Telangana tract, farmers spray insecticides, most of the times, untimely after the damage is already over, once or twice against pod borer complex, especially those belonging to organophosphate, carbamate and pyrethroid pesticides. Dependence on pesticides brings significant economic costs and environmental liabilities of off-target drift, chemical residues and resistance. With reports of pesticide resistance in pod borer (Kranthi *et al.* 2002) [2], the need for development of safe, economic and effective pest management strategies was emphasised. Integrated Pest Management (IPM) has long been proposed as an alternative. IPM combines different means of pest control to manage pests below economic threshold levels with the minimum possible use of chemical insecticides. Despite decades of advocating practice of IPM, the widespread use of IPM practices has not been adopted, which could be due to complexity in the concept, policy restrictions and counteracting forces of the pesticide industry. In pigeonpea, integrated management of pod borers through combination of different approaches like use of bird perches, pheromone traps, nucleopolyhedrosis virus (NPV), need based spraying of insecticides had given varied degrees of success in pigeonpea. A number of new compounds and chemical groups (eg. spinosad, emamectin benzoate, indoxacarb, pymetrozine, diafenthiuron) together with biologicals (NPV virus and Bt sprays) provide powerful IPM tools as they are less disruptive to beneficial populations. New generation insecticides are much more selective than the older suite of organophosphate, carbamate and pyrethroid pesticides. Malathi *et al.*, 2009 [3] found that the adoption of integrated approaches against gram pod borer resulted in lower infestation of the pest right from flowering to pod development stage in the research farm of Agricultural Research Station, Warangal which has resulted in lower pod damage and higher yields. Most of the farmers are not aware about the benefits of IPM technology.

The present study was done to validate IPM module in farmers' fields of pigeonpea during *Kharif,* 2011, to find out whether research findings can be replicated in farmers' fields to increase the adoptability of the concept.

Material and Methods

IPM module was validated in farmers' fields at 3 locations *viz.*, Arepalle, Hanamkonda mandal (location 1), Thakkalapahad, Atmakur mandal (location 2), Ramachandrapuram, Bachannapet mandal (location 3) of Warangal district, Andhra Pradesh (now in Telangana), India during *Kharif*, 2011. The pigeonpea variety - Warangal kandi (WRG-53) was grown as sole crop at a spacing of 33 inches x 33 inches in all the test locations. At each location, IPM module was validated in an area of 0.2 ha along with 0.2 ha of farmers' practice. Sowing was done on 28-07-2011, 03-08-2011, 11-08-2011 in the three locations, respectively. Soil type was alfisols in two of the test locations - Arepalle and Thakkalapahad while it was vertisols in Ramachandrapuram. All recommended agronomic practices were adopted in both IPM and farmers' practice plots, except plant protection measures. Harvesting was done on 16-01-2012, 28-12-2011, 02-01-2012, in the three locations, respectively.

The IPM module included installation of pheromone traps @10/ha, erection of bird perches @ 50/ha, spraying of *H. armigera* nucleopolyhedrosis virus (Ha NPV) @ 500 lt/ha, need based spraying of insecticides like acephate (@ 500 g/ha) + DDVP (@ 500 ml/ha); indoxacarb (@ 500 ml/ha) and spinosad (@ 200 ml/ha). The individual components were imposed based on the pest information and established economic threshold levels. Farmers' practice included only two calendar based sprays of quinalphos @1 lt/ha at flowering stage and at 20-25 days after first spraying. Per cent pod damage by different pod borers was recorded at the time of harvest by collecting total pods of 50 plants selected at random from IPM and farmers' practice plot at each location. Pods were segregated into healthy and damaged pods based on the nature of damage by the borers and per cent pod damage by *H. armigera*, *M. vitrata* and *M. obtusa* was calculated. Plot yield was taken, converted into kg/ha and the income was calculated by considering the prevailing market price of the produce. Cost of cultivation including plant protection measures for both IPM and farmers' practice were calculated arriving at Benefit Cost Ratio (BCR) and Incremental Benefit Cost Ratio (IBCR) in IPM over farmers' practice

Results and Discussion

Data on per cent pod damage by different borers and yield obtained in IPM module and farmers' practice plots are given in Table 1. The study revealed that per cent pod damage by all the three major insect pests *viz., H. armigera, M. vitrata, M. obtusa* was lower in IPM module than farmers' practice across all the three locations. In IPM module, total per cent pod damage ranged from 19.90 to 26.10 while that in farmers' practice, it varied from 40.20 to 47.50. Mean per cent pod damage by *H. armigera* was 6.5 in IPM module than 16.7 in farmers' practice showing 61.08 per cent decrease in IPM plots. Damage by *M. vitrata* decreased by 48.66 per cent by adopting IPM practice. Mean pod damage by pod fly was 9.62 per cent in IPM module as against 15.43 per cent in farmers' practice, thus showing 37.65 per cent reduction over farmers' practice. (Fig.1). Present results are similar to the findings of Ranga Rao *et.al*., 2005 [4] who reported that IPM components resulted in 46 per cent reduction in pod damage in IPM plots as against control plots where one neem, one Ha NPV, one manual shaking and chemical spray were applied. Individual treatments such as shaking alone, neem, Ha NPV and insecticide spray applied at 15 days interval from flower initiation resulted in 30, 33, 28 and 37 per cent reduction in pod damage, respectively. Visalakshmi *et al*., 2005[8] found that IPM components worked best in reducing the pod damage (10.4%) with highest grain yield (1264.4 kg/ha). The study thus demonstrated that the incidence of major insect pests can be reduced by adopting integrated approaches rather than calendar based conventional insecticide sprays. In the current study, need based spraying of insecticides like indoxacarb and spinosad were used which fits well with the concept of judicious use of selective pesticides. Spinosad has larger margins of safety for parasitoids and predators and fits well in Integrated pest management (Sarfaz *et. al*, 2005) [6]. The IPM programme, thus, could successfully serve as an effective way to replace the traditional use of organophosphate insecticide like quinalphos, monocrotophos with new generation novel insecticides like spinosad, indoxacarb which were found effective against pod borers along with an increased level of yield.

Higher yield was obtained in IPM module than farmers' practice plots in all the three locations. IPM plot recorded grain yield of 760, 780, 875 kg/ha, as against 480, 500, 520 kg/ha, respectively, in the three locations with mean yield of 805 kg/ha in IPM module as against 500 kg/ha in farmers' practice. Increase in yield ranged from 35.90 to 68.27 per cent in IPM module over farmers' practice with incremental benefit of Rs. 1.82 to 2.31 in IPM. BCR in IPM module ranged from 1.63 to 1.88 as against 1.54 to 1.67 in farmers' practice (Table.2). Yield increase in pigeonpea on adoption of integrated pest management was also reported in Karnataka (Giraddi *et. al*, 1994) [1], Uttar Pradesh (Singh, *et.al*, 2003) [7]. The present study showed that IPM approach is implementable, economical and viable in farmers' fields. Similarly, Samiayyan and Gajendran (2009) [5] have successfully demonstrated a viable and workable IPM module for pod borer, *H. armigera* management in pigeonpea in Tamil Nadu.

Conclusion

Adoption of IPM practices for management of pod borer complex comprising of *H. armigera*, *M. vitrata* and *M. obtusa* in pigeonpea decreased pod damage by 61.08, 48.66 and 37.65 per cent, respectively, and resulted in 61 per cent yield increase over farmers' practice with mean benefit cost ratio of 1.73. Successful validation of IPM module in farmers' fields would help to develop confidence level, increase awareness, capacity, and commitment across the farming community to adopt integrated approaches including need-based use of appropriate pesticides.

Table 1: Impact of IPM module on pod damage and yield in Pigeonpea

Module	Per cent pod damage				Yield (Kg/ha)	B:C ratio
	H. armigera	*M. vitrata*	*M. obtusa*	Total		
Location 1 : Arepalle, Hanamkonda mandal,Warangal						
IPM	6.00	6.50	8.76	21.26	780	1.68
FP	20.00	12.30	15.20	47.50	500	1.60
Location 2: Thakkalapahad, Atmakur mandal, Warangal						
IPM	3.50	7.60	15.00	26.10	760	1.63
FP	12.10	14.30	19.10	45.50	480	1.54
Location 3: Ramachandrapuram, Bachannapet mandal, Warangal						
IPM	10.00	4.80	5.10	19.90	875	1.88
FP	18.00	10.20	12.00	40.20	520	1.67
Mean over 3 locations						
IPM	6.50	6.30	9.62	22.42	805	1.73
FP	16.70	12.27	15.43	44.40	500	1.60

IPM – Integrated Pest Management; FP - Farmers' practice

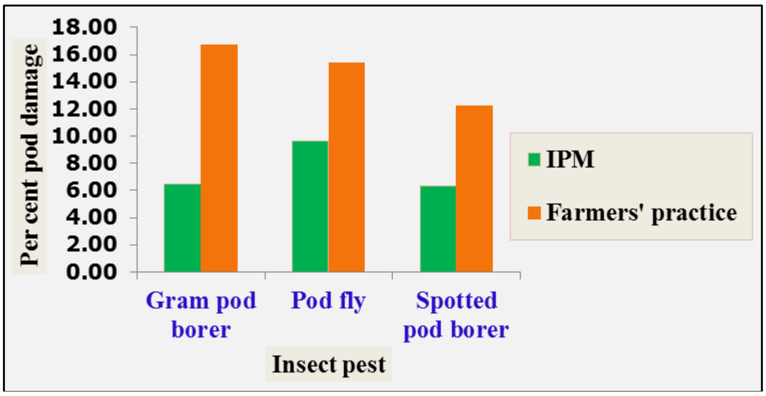

Fig 1: Pod damage by different borers in IPM plots *vis-à-vis* Farmers' practice in Pigeonpea

Table 2: Economics of Integrated Pest Management module in Pigeonpea Rs.

S. No.	Particulars	Location 1		Location 2		Location 3	
		IPM	FP	IPM	FP	IPM	FP
1	Basic cost of cultivation/ha	7200	7200	7200	7200	7200	7200
2	Cost of plant protection/ha	6750	2150	6750	2150	6750	2150
3	Total cost of cultivation/ha	13950	9350	13950	9350	13950	9350
4	Yield (Kg/ha)	780	500	760	480	875	520
5	Gross income (Rs/ha)	23400	15000	22800	14400	26250	15600
6	Net income (Rs/ha)	9450	5650	8850	5050	12300	6250
7	Benefit to Cost ratio	1.68	1.60	1.63	1.54	1.88	1.67
8	Incremental cost of IPM over FP	4600		4600		4600	
9	Incremental income in IPM over FP	8400		8400		10650	
10	Benefit accrued for every extra rupee invested	1.82	-	1.82		2.31	

* Market price of Pigeonpea (March, 2012): Rs.30/- per Kg
IPM – Integrated Pest Management; FP - Farmers' practice

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