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Evaluation of Integrated Pest Management Strategies for Pod Borer Complex in Redgram

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Pod borers complex is the major biotic constraint occurs during the reproductive phase of the crop accounting 30 to 100% yield losses. Continuous chemical use may result in the development of resistance, resurgence, and secondary pest outbreaks; therefore, management of the pod borer complex with the aid of IPM practices aids in the effective control of pests. KVK, Palem has demonstrated the Integrated Pest Management Strategies for Pod Borer Complex in Redgram in various farmer's fields of Nagarkurnool District. The results revealed that IPM implementation led to

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substantial reductions in pod borer complex infestation. Pheromone based monitoring showed a consistent reduction in adult moth populations of gram pod borer in three consecutive weeks at critical stages of the crop *i.e.,* flowering to pod setting stages. There was a significant reduction in per cent incidence of pod borer complex *i.e*., the spotted pod borer (11.58%), gram pod borer (12.64%), and pod fly (12.68%), was much lower in technology demonstrated fields than the farmer's practice (21. 98%, 20.04 and 20.38%). Technological and extension gaps were analysed, showcasing farmers' adoption and implementation levels of IPM strategies. The adoption of IPM led to increased redgram yields (34.78%), additional net returns (Rs. 12,500/- per ha) with favourable benefit cost ratio (2.2:1) over farmer's practice. Further, the farmers can be able to avoid two harmful sprays and can save an amount of Rs. 3500/- per ha. The technology has been disseminated in an area of 450 acres in adopted villages and 1750 acres in the entire Nagarkurnool district by various extension aids.

Keywords: Gram pod borer; IPM; pod borer complex; pod fly; spotted pod borer.

1. INTRODUCTION

Redgram (*Cajanus cajan* L.), next to Bengal gram, is regarded as the most significant pulse crop because of its capacity to produce large, profitable yields in conditions of low soil moisture. This makes it an essential crop, particularly in rainfed and dryland agriculture [1]. It is the most versatile food legume with a wide range of applications as food, feed, fodder, and fuel. It is the fourth-most significant pulse crop in the world and plays a significant role in rainfed agriculture in India. Pulses are a significant class of food crops that are essential to national food and nutritional security since they are regarded as a source of protein for both human and animal nutrition [2]. Redgram, India's second most important pulse after chickpea, is grown on about 4.9 m ha, producing 4.2 MT with a productivity of 861 kg ha^{-1} [3].

It is mainly consumed as dry split dhal throughout the country besides several other uses of various parts of pigeonpea plant. It has been recognized as a valuable source of protein particularly in the developing countries where majority of the population depends on the low-priced vegetarian foods for meeting dietary requirements. In India, major redgram producing states are Karnataka (13.49 lakh ha), Maharashtra (11.16 lakh ha), Madhya Pradesh (4.13 lakh ha), Uttar Pradesh (3.57 lakh ha), Gujarat (2.05 lakh ha) and Telangana (1.87 lakh ha). According to Government 3rd advance estimates, India redgram production in 2022-23 is at 3.43 million tonnes.

In Telangana major redgram growing districts are Vikarabad (47645 ha), Sangareddy (32445 ha), Adilabad (26949 ha), Narayanpet (20572 ha), Asifabad (16246 lakh ha), Gadwal (7935 ha) and Kamareddy (7044 ha) [4]. According to Telangana State Government 3rd advance estimates, redgram production in 2022-23 is at 1.83 lakh tonnes from 2.29 (lakh ha) with productivity of (798 Kg/ha).

India is the world's biggest producer and consumer of pulses, yet despite this, the nation imports 6MT of the crop annually to keep up with the rising domestic demand because of a variety of biotic and abiotic factors. Pod borer complex incidence is the main issue throughout the crop's reproductive phase among the major problems and causes 30 to 100% yield loss [5]. The spotted pod borer, *Maruca vitrata*, gram pod borer, *Helicoverpa armigera* (Hubner), plume moth, *Exelastis atomosa*, (Walsh), and pod fly, *Melanagromyza obtusa*, (Mall) collectively referred as "Pod borer complex" [6].

Several strategies were assessed and documented, including the adoption of resistant cultivars [7], botanicals [8], biocontrol agents [9], sex pheromone traps [10], and chemicals [6]. However, no stable multiple resistant / resistant variety is currently available to combat pod borers in field conditions. However, farmers mostly use chemical pesticides to control these pests, which has resulted in the development of resistance [11]. Therefore, it is very much essential to establish and implement a systematic plan that integrates several pest control strategies into a single program for the effective management of pod borer complex. In light of this, KVK Palem has demonstrated evaluation of IPM module in various farmers' fields against in comparison with non-IPM/farmers' practices at Nagarkurnool district.

2. MATERIALS AND METHODS

Redgram IPM package was demonstrated and evaluated in farmers' fields of Nagarkurnool distict during *Kharif* seasons of 2021 and 2022 under the direction of Krishi Vigyan Kendra, Palem, PJTSAU. The following were the two treatments. Treatment I (Farmer's practice): Spraying of Lambda cyhalothrin 0.5ml/L, Spinosad 45%SC 0.3ml/L, Chlorpyriphos 2 ml/L for management of pod borer complex, Treatment II (IPM package): 1), this IPM package consists of Use of pheromone traps for *H. armigera* @ 12 no./ha 2) Installation of bird perches @ 50 no/ha), manual collection of pod borer larvae, 4) Spraying with Azadiractin 1500 ppm @ 5ml/L for egg masses and early instar larvae, 5) Need /ETL based spraying with Emmamectin benzoate @ 0.5g/L or Chlorantranoliprole @ 0.3ml/L of water. Observations on the incidence of pests were made by following standard procedures.

2.1 Observations Procedure

The data on *Helicoverpa armigera* and *Maruca vitrata* larval count per plant: From each plot, five plants were selected randomly and three twigs of three sides of each selected plant were tagged for recording weekly observations. The three twigs total count was considered as per plant count. The number of *H. armigera* and *M. vitrata* larvae were counted weekly from bud initiation stage to pod maturity stage *i.e.* after completions of module applications. Pod damage by lepidopteran pests: The total pods and pods having damage holes of Lepidopteran pests from three twigs of each selected plant were counted and percent pod damage was worked out. Pod damage by *Melanagromyza obtusa*: Per plot, fifty green pods excluding border rows were collected and by splitting the pods, the pod damage by *M. obtusa* were counted and per cent pod damage was worked out.

Per cent pod/grain damage = Number of infected pods/grains / Total number of pods/grains x100

2.2 Grain Yield and Economics

The grain yields per plot were recorded and on that basis yields per hectare were calculated and B:C ratio was worked out by calculating Cost of cultivation, Gross income and Net income.

2.3 Statistical Analysis

The data has been subjected to F–test in order to draw comparison between the two different treatments.

3. RESULTS

The results of the IPM practices for pod borer complex demonstrations conducted in different farmer's fields in the Nagarkurnool district during *Kharif*, 2021–2022 revealed that the gram pod borer, *H. armigera*, population was first observed during October I FN and continued until December II FN, which was during the crop's reproductive stage. The population was measured by installing pheromone traps at 4 per acre and the number of moths caught in each trap was recorded every fortnight interval. When compared to T1 (farmer's practice), the *H. armigera* population was found to be significantly lower in T2 (technology demonstrated fields) and statistically significant (P = 0.372, P = 0.311, P = 0.377, P = 0.254) at five different farmers' fields (F1, F2, F3, F4, and F5). Pod borer moth catch from October I FN to December II FN were notably low on average, ranging from 23.2 to 4.4 moths/trap, while T1 moth catches ranged from 31.34 to 6.9 moths/trap, respectively (Table 1).

By spraying azardiractin 1500 ppm @ 5ml/ l, two sprays in 10 days interval during flower initiation stage followed by ETL based application of emamectin benzoate 0.4 g/l at flowering and pod formation stage at the mid period of flower initiation to maturity with pests incidence in TI, The per cent damage of pod borer by Spotted pod borer, Gram pod borer, and Pod fly was significantly reduced and varied from 10.8 to 12.1%, 11.3 to 14.2% and 12.2 to 13.2%, respectively as compared to the TI (21.7 to 23.1%, 22.8 to 26.1% and 19.0 to 21.0%) in different farmer's fields which was also found to be statistically significant (Table 2; Fig. 1).

The results of Table 3 pertain to yield economics in TI and T2 of various farmers field revealed that the average yield (15.68 q/ha) different farmers in T2 was significantly increased by adopting the timely interventions of the technology with an increase ion yield ranged from 29.3 to 43.9%. While, the yield has been significantly reduced in T2 (11.72 q/ha). Ultimately, the technology implanted farmers could able to minimize the cost of cultivation to Rs. 42,064/- as compared to the T2 (44, 379.8/-) with higher gross returns, net returns and B:C ratio.

4. DISCUSSION

For successful management of pod borer complex under field condition cultural methods and insecticides efficient [12]. Pheromone traps helped to monitor the incidence of pod borer, there by demo plot could manage this pest in time before it reached to Economic injury level [13]. The current work is more or less in accordance with the following findings where revealed the average damage due to *H. armigera* during harvest was found minimum (12.36%) with an ICBR of 1:9.81, which was closely followed by the farmers practice (14.08% damage and 1:6.54) in a pigeonpea IPM module [14]. IPM practices for the management of *H. armigera* in pigeonpea for different Indian zones from All India Co-ordinated Pulses Improvement Project by Srivastava *et al.* 2005. Summer ploughing, timely sowing of medium maturing varieties, seed treatment with *Trichoderma*, monitoring pod borer through pheromone traps, necessary use of ovicides, use of neem based and microbial tools and lastly the use of very effective chemical insecticides recorded more yield (725-1065 q/ha) compared to farmers' practice, mainly because of the interventions made at appropriate time in management of pod borers of redgram [15]. The present studies have followed the similar trend as the that of the current work in terms of higher yields and management of pod borer in an effective manner [16]. The bio-intensive practices in Pigeonpea resulted in higher yielded 0.55 tonnes/ha (140% more) in Bio-intensive IPM plots compared to 0.23 tonnes/ha in non-IPM plots even though the overall yields were low [17]. The synthetic insecticides (Chlorantraniliprole 18.5 SC @ 30g a.i/ha, Flubendiamide 480 SC @ 30 g a.i/ha, Dimethoate 30 EC @ 600g a.i/ha) recorded lowest pod damage (0.76, 1.28 and 11.13 %) of all the three pod borers and highest pooled yield for 2018-19 and 2019-20 (1085.28 kg/ha) and per cent increase of yield over control was 87.86 per cent [18]. Among the biopesticides *Bt. Kurastaki* recorded highest pooled yield of 752.45 kg/ha with pod damage caused due to spotted pod borer (1.28), gram pod borer (2.52) and pod fly (22.6 %) followed by Azadirachtin 1500 ppm @ 5.0 ml/l recorded yield (749.31 kg/ha) with pod damage of 1.51, 2.11 and 19.95 per cent due to spotted pod borer, gram pod borer and pod fly respectively the results are more or less in accordance with the current work [18]. The present front-line demonstrations on management of Pod borer complex can be as protection technology towards the management of pod borer complex of redgram in Nagarkurnool ditrict. The "biointensive module" comprising seed treatment of Trichoderma @ 4 g/kg seed followed by spraying of Neem seed extract 5% at bud initiation stage followed by spraying of Spinosad 45 SC @ 0.01 per cent at 15 days after bud initiation stage, found most effective in reducing larval population green pod damage by pod borer complex and recorded highest yield and ICBR; followed by IPM module i.e. collection and destruction of last year residues, ploughing of soil in April, selection of resistant variety, increased seed rate by 20 per cent, seed treatment with Trichoderma @ 4 g/kg seed, spraying NSKE 5 per cent at bud initiation stage, spraying of NSEK 5 per cent at 5 % fruiting bodies damage level and spraying of HaNPV 250 LE/ha for *H. armigera* if observed and low cost

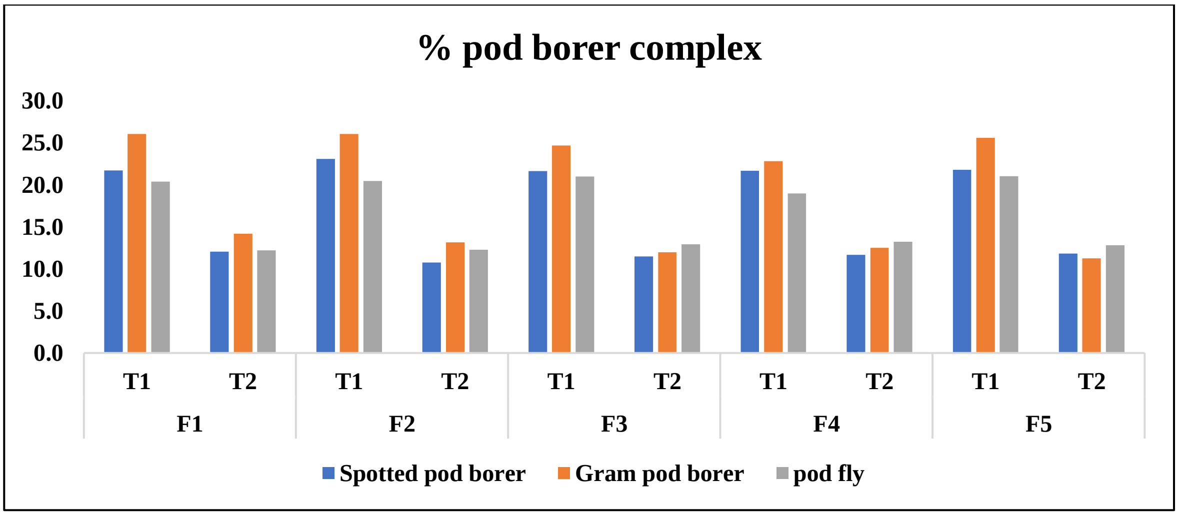

Fig. 1. Pod borer complex damage in Demonstrated and Farmer's practice fields during *kharif*, 2021-2022

T1: Farmer's practice T2: IPM package for pod borer complex in redgram

Table 1. The pod borer, *H. armigera* population during *kharif*, 2021-22 in different farmer's fields

Parameters	F1		F2		F3		F4		F5		Average	
	T1	T2	T1	T2	T1	T2	T1	T2	T1	T2	T1	T2
Oct I FN	15.1	11.1	17.6	15.6	11.2	9.9	15.3	13.2	14.4	12.2	14.72	12.4
Oct II FN	31.5	26.9	30.6	24.6	31	23.8	31.9	21.6	31.7	19.1	31.34	23.20
Nov I FN	27.6	21.7	26.7	20.1	24.1	21.7	23.4	16.5	23	17.4	24.96	19.48
Nov II FN	17.8	12.6	20	13.2	16.9	9.2	17.7	8.9	17.7	9.5	18.02	10.68
Dec I FN	10.1	8.1	10.7	7.8	8.6	6.2	10.3	6.9	12.8	6.0	10.50	7.00
Dec II FN	6.2	4.9	8.7	7.2	6.2	3.7	6.6	3.7	6.8	2.8	6.90	4.46
Mean	18.061	14.211	19.056	14.744	16.333	12.422	17.539	11.789	17.728	11.183	17.7434	12.8698
Variance	96.50	70.99	74.36	46.76	92.86	69.23	83.50	43.57	76.07	40.71	84.66	54.25
P<0.05	0.372		0.311		0.377		0.246		0.254		0.312	

T1: Farmer's practice T2: IPM package demonstrated fields
F1: Farmer 1, F2: Farmer 2, F3: Farmer 3, Farmer 4, F5: Farmer 5

Table 2. Percent damage by pod borer complex in redgram during *Kharif*, 2021-2022

Parameters	F1		F2		F3		F4		F5		Average	
	T1	T2	T1	T2	T1	T2	T1	T2	T1	T2	T1	T2
Spotted pod borer (%)	21.7	12.1	23.1	10.8	21.6	11.5	21.7	11.7	21.8	11.8	21.98	11.58
Gram pod borer (%)	26.1	14.2	26	13.2	24.7	12	22.8	12.5	25.6	11.3	25.04	12.64
Pod fly (%)	20.4	12.2	20.5	12.3	21	12.9	19	13.2	21	12.8	20.38	12.68
Mean	22.711	12.822	23.2	12.067	22.433	12.122	21.144	12.467	22.811	11.967	22.45	12.28
Variance	8.889	1.428	7.754	1.47	3.841	0.556	3.878	0.614	5.98	0.601	6.068	0.933
P<0.05	0.138		0.159		0.126		0.136		0.091		0.130	

T1: Farmer's practice T2: IPM package demonstrated fields
F1: Farmer 1, F2: Farmer 2, F3: Farmer 3, Farmer 4, F5: Farmer 5

Table 3. Yield and Economics of the demonstration during *Kharif*, 2021-2022

Parameters	F1		F2		F3		F4		F5		Average	
	T1	T2	T1	T2	T1	T2	T1	T2	T1	T2	T1	T2
Yield q/ha	10.3	14.9	12.2	15.8	12.7	16.6	11.1	14.8	12.3	16.3	11.7	15.7
Gross returns Rs./ha	86545	88280	80854	85109	82770	90169	87262	100381	86914	88452	84869.0	90478.2
Cost of cultivation Rs./ha	47750	44690	41582	39667	41967	41283	47500	44533	43100	40150	44379.8	42064.6
Net returns Rs./ha	39380	44322	38862	40842	44247	31466	33430	57048	43364	48519	39856.6	44439.4
B:C ratio	1.8	2	1.9	2.1	2	2.2	1.8	2.3	2	2.2	1.9	2.2
Yield Increase (%)	43.9		29.3		31.3		32.9		36.5		34.78	
P<0.05	0.4875		0.4667		0.4525		0.3911		0.2546		0.41048	

T1: Farmer's practice T2: IPM package for pod borer complex in redgram
F1: Farmer 1, F2: Farmer 2, F3: Farmer 3, Farmer 4, F5: Farmer 5

technology module, consisting of deep ploughing in April, mechanical collection of larvae, use of moderately pest resistant variety i.e. Asha, increased seed rate by 20 per cent, seed treatment with Trichoderma @ 4 g/kg seeds and spraying of NSE 5 per cent at bud initiation stage and 15 days after bud initiation stage. All these three modules recorded lower larval population of pod borers; reduced green pod damage and higher ICBR and net profit too [12]. Erecting of pheromone traps for monitoring of *Helicoverpa armigera* @ 4/ac. Spraying azardiractin 1500 ppm @ 5ml/ l, two sprays with 10 days interval during flower initiation stage. Spaying of *Bt* @ 2g/l at 25 per cent flowering stage of the crop followed by need based application of emamectin benzoate 0.4 g/l at flowering and pod formation stage was done in 5 locations for an On farm trial and 10 locations for front line demonstration in Bhadradri Kothagudem district of Telangana State during *Kharif* 2018 and 2019, respectively. The cost benefit ratio (BC Ratio) was higher in technology demonstrated plots with 2.5:1 and 2.3:1 whereas BC ratio was lower comparatively in farmers practiced plots with 1.8: 1 and 1.9:1 in corresponding Kharif 2018 and 2019. The results are quite similar to that of the current study [19-21].

5. CONCLUSION

From the present study, it can be concluded that by adopting improved IPM practices for management of pod borer complex in redgram resulted the average percent incidence of the pod borer complex, the spotted pod borer (11.58%), gram pod borer (12.64%), and pod fly (12.68%), was much lower in technology demonstrated fields than the farmer's practice (21. 98%, 20.04 and 20.38%). There was an increase in yield of 34.78 % over the farmers practice with higher net returns (Rs. 12,500/-per ha), and a more favourable Cost: Benefit ratio (1: 2.2) compared to farmer's practice were the results of adopting IPM. In addition, farmers can save Rs. 3500/-per hectare by avoiding two hazardous sprays. The technology has been disseminated over 1750 acres in the entire Nagarkurnool district and 450 acres in adopted villages of KVK, Palem. Hence farmers can adopt IPM package as an alternative to insecticides as economical, environmentally safe, easy to use and socially acceptable too.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declares that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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