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Management of pigeonpea pod borers with special reference to pod fly (*Melanagromyza obtusa*)

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ABSTRACT

Focus of pigeonpea pest management research has been on pod borer *Helicoverpa armigera* (Hubner), however with large-scale cultivation of transgenic cotton in Maharashtra, pest scenario has changed requiring more attention on pod fly. Pod fly *Melanagromyza obtusa* Malloch now has become important biotic constraint in increasing the production and productivity under subsistence farming conditions, irrespective of agroecological zones. The survey of Marathwada during 2007–08 revealed that the damage by pod fly ranged from 25.5 to 36% (Anonymous 2008). Hence, studies were carried out to assess and devise pest management module, which can go as a component of widely accepted Integrated Pest Management (IPM). Experimental result over two years indicate Emamectin benzoate 5 SG in combination with Acetamiprid 20 SP or Dimethoate 30 EC gave higher grain yield of 1 399 and 1 392 kg/ha and lower pod fly grain damage (13.30 and 11.95%). Similarly, all the three biopesticide preparations (crude neem kernel seed extract (5%), neem oil (3 000 ppm) and *Pongamia* oil) gave higher grain yield in comparison to control. Among these biopesticides crude neem seed extract out performed others in terms of per cent increase in yield (31.28%). Maximum percentage increase in yield has been observed in mixed spray of emamectin benzoate and acetamiprid (64.22%), followed by emamectin and dimethoate (62.56%). Effectiveness of emamectin benzoate, which is based on green chemistry, will help in achieving less yield losses through reduction in *H. armigera* incidence. Similarly, use of crude neem extract or *Pongamia* oil will give an option for organically-grown pulse crop in reducing pod borer and pod fly infestation.

Key words: *Melanagromyza obtusa*, Pest management, Pesticides, Pigeonpea, Pod fly

Worldwide, over 30 species of Lepidoptera feed on pods and seeds of pigeonpea (Shanower *et al.* 1999), among which, *Helicoverpa armigera* (Hübner), *Maruca vitrata* (Geyer), *Melanagromyza obtusa* (Malloch) are the most common ones. *H. armigera* and *Maruca* larvae feed on seedling foliage, flower buds, flowers, young pods and developing seeds. The pod fly (*M.obtusa*) lay eggs in immature pods and feeds on developing seeds. The infested immature pods do not show external evidence of damage until the fully grown larvae chew exit holes in the pod walls. It damages grains by making bore and tunnels in them. Damaged grains shrivel and insect excreta lead to development of saprophytic fungus, which further destroys the grain. Management of pigeonpea pest is complicated as crop is affected by three groups of insect with different biology and variable population dynamics occurring throughout year across wider geographical areas. Another obstacle in the process is that except for northern Karnataka, eastern Uttar Pradesh and southern Maharashtra it is being considered a marginal crop or a component of mixed cropping system (cotton, soybean and sorghum), receiving less attention by farmers and policy makers. In Indian context, the primary focus of pest management in pigeonpea has been on *Fusarium* wilt, *Phytopthora* blight, Sterility mosaic, *H. armigera* and *M. obtusa*, with emphasis on cultural practices, host plant resistance and chemical control (Lateef and Reed 1990). Losses due to pod fly damage have been estimated at US $ 256 million annually. Researchers in India have identified lines such as PDA88–2E and PDA89-2E that provide partial resistance to the pigeonpea pod fly. In absence of adequate resistant genetic material, calendar sprays are being recommended, with the first application at 50% flowering and the second and third applications at 15-day intervals. Shanower *et al.* (1999) found out that farmers in

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southern India had to spray 3–6 times/season without much success and economic benefits. Sole reliance on chemical pesticides led to development of resistance and resurgence of secondary pests. With reports of pesticide resistance in pod borer (Kranthi *et al.* 2002) and subsequent promotion of IPM, highlighted the need for development of safe, economic and effective pest management strategies. The use of alternatives, based on botanical pesticides (eg neem) and insect pathogens, particularly the *Helicoverpa* nuclear polyhedrosis virus (HaNPV), gained popularity as safe for applicators, beneficial insect fauna targeting pod borer and pod fly and the environment. Sahoo *et al.* (1991), Yadav and Dahiya (2004) and Kumar and Nath (2003) conducted field studies to determine the efficacy of several insecticides applied alone for the control of pod fly. However these findings did not find acceptability and led to partial success. Weather parameters have been analyzed by Subharani and Singh (2007) and found that the pod fly infestation is not influenced significantly by any of the environmental factors, except for relative humidity, which exerted significant negative effect with the pest infestation. Due to this limited knowledge no forewarning model could be field validated to date. The companion crops, eg cotton, soybean, sorghum etc., which in general play a greater role in limiting pest infestation are usually harvested before pigeonpea flowers, thus making them most attractive and vulnerable to pod borer adding further woe. Bhushan and Nath (2005) reported that intercrop combination of pigeonpea + sorghum + greengram + sunhemp and application of NSKE, followed by endosulfan and NSKE, exhibited less grain damage by pod fly. Hence, studies were carried out to assess and devise pest management module, which can go as a component of widely accepted integrated pest management (IPM).

MATERIALS AND METHODS

Experiments on the evaluation of chemical and

Table 1 Effect of different insecticides on pod and yield characters of pigeonpea in pod fly management over *kharif* seasons (2008–09 and 2009–10)

Treatment	Pod damage (%)		Seed damage (%)		Seed yield (kg/ha)		Increase in yield over control (%)	
	2008–09	2009–10	2008–09	2009–10	2008–09	2009–10	2008–09	2009–10
Endosulfan 0.07% + Dimethoate 0.03%	19.33 (26.07)	22.71 (26.66)	17.80 (24.94)	17.33 (24.21)	945	1532	51.93	40.55
Acetamiprid 0.008% + Endosulfan 0.07%	30.00 (33.19)	30.03 (33.20)	17.27 (24.61)	19.66 (26.06)	912	1599	46.62	46.70
Emamectin benzoate 11 g ai/ha + Dimethoate 0.03%	21.33 (27.46)	29.7 (33.01)	15.55 (23.01)	8.35 (16.73)	1010	1774	62.38	62.75
Emamectin benzoate 11 g ai/ha + Acetamiprid 0.008%	19.33 (26.05)	26.20 (30.60)	15.60 (23.23)	11.0 (19.30)	1038	1761	66.88	61.56
DDVP 0.07% + Emamectin benzoate 11 g ai/ha	21.33 (27.38)	23.60 (28.90)	19.23 (25.98)	12.33 (20.33)	962	1734	54.66	59.08
DDVP 0.07% + Endosulfan 0.07%	17.33 (24.54)	19.90 (26.45)	19.26 (26.01)	14.66 (22.05)	922	1607	48.23	47.43
Triazophos 0.04% + Endosulfan 0.07%	20.00 (26.54)	24.66 (29.70)	19.26 (26.01)	15.60 (23.12)	922	1587	48.23	45.60
Triazophos 0.04% + Emamectin benzoate 11 g ai/ha	25.00 (23.97)	31.67 (34.20)	16.96 (24.29)	15.66 (23.22)	941	1466	51.29	34.50
Neem seed extract 5%	19.33 (26.07)	31.67 (34.20)	19.50 (26.19)	12.00 (20.25)	768	1516	23.47	39.08
Neem oil 20 ml/10 lit	25.33 (32.34)	33.67 (35.10)	26.83 (31.19)	13.00 (20.68)	719	1519	15.59	39.36
Pongamia oil 20 ml/10 lit	25.33 (30.15)	44.33 (41.70)	27.50 (31.62)	20.33 (26.76)	688	1253	10.61	14.95
Control	37.66 (37.83)	52.0 (46.10)	32.16 (34.54)	29.66 (32.97)	622	1090		
SE ±	1.28	1.39	0.903	2.22	19	31		
CD (P=0.05)	3.74	4.07	2.64	6.51	55	90		

Figures in parentheses are angular transformed values biopesticides for pod fly. and pod borer infestation was conducted with cultivar 'BSMR 853' in randomized block design during two crop seasons in rainfed cropping system at A R S, Badnapur Research farm. The crop was sown in last week of July with plant spacing of 60 cm×20 cm. Review of literature indicates that there are 17 formulations of combination of chemical pesticides are registered with CIBRC, Government of India (www.cibrc.nic.in). Most of these combinations do not target pod borer and pod fly complex, as a result indigenous combinations are being used by the farmers without desired results. Green molecules such as emamectin benzoate and acetamiprid have been recently introduced holds great promises against resistant *Helicoverpa* population, however their cost is prohibitive. Hence, field experiments were carried out to find out effective pesticide or its combination. Six chemical insecticides as sole and in combination (Endosulfan 0.07% + dimethoate 0.03%, Acetamiprid 0.008% + Endosulfan 0.07%, emamectin benzoate 11 g ai/ha + dimethoate 0.03%, emamectin benzoate 11 g ai/ha + Acetamiprid 0.008%, DDVP 0.08%+ emamectin benzoate 11 g ai/ha, DDVP 0.08% + endosulfan 0.07%, triazophos 0.04% + endosulfan 0.07%, triazophos 0.04% + emamectin benzoate 11 g ai/ha along with three biopesticides (*neem* seed extract (5%), *neem* oil 3000 ppm (20 ml/10 lit), *Pongamia* oil (20 ml/10 lit) were evaluated in three replicated field (5.4 m×3.0 m) for their efficacy against pod fly and pod borer in the field conditions with recommended agronomic practices (20:40:0 Kg NPK/ha). The seeds were treated with *Trichoderma viridae* @ 5 g/kg of seeds followed by *Rhizobium* and Phosphate solubilization formulations as per local recommendation. Five pheromone traps with lure for *Helicoverpa* were also fixed for monitoring of *Helicoverpa* population for timing of management practices. During this experiment three insecticidal sprays were given starting with pest crossing ETL level (5%). The first spray was administered in last week of December after noticing the incidence and second 15th days thereafter. The observations on percentage of infestation were recorded on 15th day after each spray. High volume hand operated knapsack sprayer was used for application of insecticides by using 300 l. of water/ha. Common detergent powder was mixed in all the insecticidal solution @15 g/10 ltr. of water in order to increase efficiency and uniform coverage of the plants.

Observations on pod damage by lepidopteran borers, ie gram pod borer (*H. armigera*), and seed damage by pod fly (*M. obtusa*) were recorded during February. Pod fly infestation levels were observed on at different heights of the canopy and pod age. Pods belonging to three developmental stages were collected from each of three tiers of the canopy starting from January, and subsequently for 10 weeks at weekly intervals.

To understand status and prevalence of pod fly, pod borer and associated bioagents survey was also carried out in 20 farmers' field in each of the selected districts having major pigeonpea growing areas (Aurangabad, Badnapur, Beed, Parbhani, Osmanabad, Latur and Jalna) of Marathwada region. Growing pigeonpea as intercrop with cotton is an age-old practice making farmers rely on it in the event of failure of cotton crop. Estimate on damage of pod borer and pod fly and identification of associated natural enemies (Table 3) was also carried out. For estimating level of parasitism and species complex 50 pod fly puparia were collected from infested pods from farmers field and incubated in laboratory for emergence and identification of parasitoids.

RESULTS AND DISCUSSIONS

Seed treatment with bio-pesticides along with bio-fertilizers resulted in vigorous crop growth resulting in escape of major incidence of wilt, soft rot and *Phytopthora* blight. Pheromone trap analysis of adult male moth catches revealed that population of *Helicoverpa* fluctuated widely with occasional crossing of ETL (Table 2). The results presented in Table 3 indicated that all the insecticidal treatments reduced the damage caused by pod fly to pods (37.66%) and grain as compared to control (32.16%). Among various assays emamectin benzoate + acetamiprid and emamectin benzoate + dimethoate gave higher grain yield of 1038 and 1010 kg/ ha and less pod fly damage grain (15.6 and 15.5%). Similarly, all the three biopesticide preparations (crude need seed extract (5%), neem oil (3 000 ppm) and *Pongamia* oil) gave higher grain yield in comparison to control. Among these biopesticides crude neem seed extract (19.5%) out performed neem oil (26.83%) as well as *Pongamia* (karanj) oil (27.5%) in reducing the infestation. Percentage increase in yield in

Table 2 Pheromone trap catches of *Helicoverpa* males during two pigeonpea cropping season

Meteorological week	No. of adult moth **	
	2008–09	2009–10
40	3.0	0.0
41	5.0	3.0
42	4.2	2.0
43	14.0	3.0
44	12.0	0.0
45	4.6	2.5
46	4.0	1.0
47	5.0	6.0
48	7.0	3.0
49	5.5	1.6
50	6.0	1.0
51	5.0	1.6
52	6.0	15.0
1	4.0	8.0
2	3.0	9.6
3	4.0	2.6
4	2.5	10.0

** Weekly average of five traps

Table 3 Per cent pod borer damage by pod borer complex and occurrence of natural enemies in farmers' fields during 2009–10

District	Per cent pod damage **		Natural enemies
	Pod borer	Pod fly	
Aurangabad	15.60	39.00	*Apanteles* sp.
Badnapur	16.00	41.00	*Apanteles* sp. on plum moth
Beed	18.00	34.00	
Parbhani	12.50	32.00	*Bracon* sp.
Osmanabad	11.00	29.00	*Apanteles* sp.
Latur	16.00	34.00	*Campoletes chlorideae*
Jalna	17.00	33.00	

** Average of 50 puparia collected from five places in a village

each treatment was calculated based on check. As indicated in Table 1 maximum yield increase has been observed in mixed spray of emamectin benzoate and acetamiprid (66.88%), followed by emamectin benzoate and dimethoate (62.38%). Current evaluation of pesticides involved green chemistry and new molecules (Emamectin benzoate) isolated from actinomycetes, which has not been field tested against pigeonpea pests. Acetamiprid is also a new insecticide having special active mechanism, which can kill pod borer resistant to organophosphorus insecticides. It has low toxicity to applicator and little influence to the natural enemy of the insects and bees. Similarly, crude neem seed extract gave maximum increase in yield (23.47%). Neem as well as *Pongamia* oil has also expressed their effectiveness against pod borer as well as pod fly offering a very good solution for most sought after organically grown pigeonpea. Current review indicated by Dar *et al.* (2005) could not get significant level of control of pod fly with sorghum as intercrop; however chemical option using dimethoate, endosulfan and combination with 5% NSKE gave better control over unsprayed check. Spray of endosulfan (0.07%) at pod initiation stage, followed by monocrotophos (0.04%) proved effective with maximum yield. Das (2001) reported significantly reduction in pod borer and pod fly damage over untreated control with ready mix formulations (Cyperphos, endophos and spark) of insecticides during 1997–99. Similarly, Ganiger (2000) reported that the infestation of pod fly (*M. obtusa*) at harvest was minimum in the plots treated with 360 g ai/ha (6.10%), followed by profenophos + cypermethrin 660 g ai/ha (6.39%). However, per cent grain damage was minimum in chlorphyriphos + cypermethrin 440 g ai/ha (1.69%), followed by triazophos + deltamethrin 360 g ai/ha (2.16%) and profenophos + cypermethrin 660 g ai/ha (2.36%). Chaudhary *et al.* (2008) reported that chemical-based IPM was more effective for pod borer and pod fly management than biologically-based ones. Biradar and Navi (2006) recommended package of practices for Karnataka as (endosulfan at 2 ml, followed by quinalphos at 2 ml/litre at 15-day intervals) + dimethoate + oxydemeton-methyl + dimethoate for managing the pod fly.

Survey of farmers' field in different districts revealed that damage caused by pod borer and pod fly ranged between 11.00 to 18.00% and 29.0 to 41.0%, respectively (Table 3). Higher level of pod fly infestation clearly indicated that with large-scale growing of *Bt* cotton, pest management has under gone changes. Now farmers are not spraying against pod borer as a result pod fly is assuming status of key pest causing severe yield loss. It is difficult to identify and distinguish pod fly infestations unless and until adults makes exit holes in the pod wall and comes out of it. Although a number of natural enemies have been recorded from the key pests of pigeonpea (Minja *et al.* 1999, Shanower *et al.* 1999, Durairaj 2005). Little is known of their effect on pest population dynamics. A number of egg parasitoids (*Ormyrus* sp., *Eurytoma* sp. and *Eupelmus* sp.) have been reported from southern India, however in the above mentioned surveyed areas of Maharashtra these could not be recovered. *Apanteles* sp. and *Campoletis* have been found as most common in its occurrence in lepidopteran pests in farmer's field (Table 3). Improving the habitat and impact of natural control agents is perhaps the most neglected and needs greater attention into promotion and conservation of natural enemy fauna.

Host plant resistance based on physico-chemical traits of pod, viz thickness of pod wall, trichome density (Moudgal *et al.* 2007), hold promises as an important tool for the management of these pest and needs priority. Follow up of large scale IPM demonstration indicates that initial gain in use of neem and NPV products as alternative to chemical pesticides have suffered from poor and highly variable quality apart from their limited availability than conventional insecticides. These problems need to overcome to popularize them as effective and practical alternative to chemical based control methods for making pulse cultivation as lucrative crop. Use of botanicals and microbials will not only reduce production cost but will also help in delaying development of pesticide resistance. Integration of all compatible management practices will lead to successful management of pest and achievement of lost glory of pulse crops, which will also helps in improving soil health by adding atmospheric nitrogen apart from biomass and saving in terms of national exchequer from import bill.

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