Impact of areawide integrated pest management strategies on pests of pigeonpea and yield in Marathwada region of Maharashtra, India

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Received: 26-10-2013 Accepted: 01-03-2014 DOI:10.5958/0976-0571.2015.00017.X

ABSTRACT

Pigeonpea [Cajanus cajan (L.) Millsp.] is an important legume crop of southern Maharashtra, providing high quality protein and animal feed. Insect pests feeding on flowers and pods of this crop are the most important biotic constraint affecting yield to the tune of 60 per cent. Hitherto, focus of pest management research has been on podborer, Helicoverpa armigera (Hubner). With large scale cultivation of transgenic cotton in Maharashtra and climatic changes, pest scenario has changed requiring more attention on leaf webber, Maruca and pod fly. Hence, area wide implementation of Integrated Pest Management (IPM) in pigeonpea was implemented during 2010-11 and 2011-12 covering 5 taluks benefitting 2449 farmers of 8 villages. It was observed that use of pesticides based on the “e-Pest monitoring and its subsequent decision support tools” enabled to manage pests with judicious use of pesticides. The pest infestation (pod borer, pod fly, plume moth, flower webber, etc.) were significantly low as compared to non-IPM with appreciable high population of natural enemies (coccinellids, chrysopa and spiders) were also observed under IPM fields. Timely dissemination of advisories and action has resulted in higher grain yield of 9.89 q/ha and lower grain damage 5.69 per cent as compared to non-IPM (13.79 per cent).

Key words: Area wide integrated pest management, Helicoverpa armigera, Melanagromyza obtusa, Pesticides, Pigeonpea.

INTRODUCTION

Of late due to large scale adoption of transgenic cotton, there has been dramatic change in the occurrence of H. armigera and change in status of minor pests is becoming a major concern for yield loss in pigeonpea cotton based cropping system. Despite best extension efforts, pod borer (Helicoverpa) (Manjunath et al., 1989) and Maruca larvae continues to cause yield losses by feeding, flower buds, young pods and developing seeds (Gopali et al., 2010). The podfly lay eggs in pods and often remains undetected until the fully grown larvae chew exit holes in the pod walls at maturity. It damages grains by making bore and tunnels in them (Sharma et al., 2010).

Damaged grains shrivel and insect excreta lead to saprophytic growth of fungus, which further destroys the grain. Management of pigeonpea pests is complicated as crop is affected by three groups of insect with different biology and occurrence throughout year across pulse growing areas. More than 200 insect species have been reported feeding on pigeonpea at various stages of crop growth among which, pod borers constitute the major pests and damage amounts to 57 per cent pods and 35 per cent seeds with final yield loss up to 28 per cent. Apart from pod borer, plume moth, (Exelastis atomosa), pod fly (Melanagromyza obtusa) and spotted pod borer (Maruca testulalis) are potential insect pests causing heavy losses. Pod fly infestation is increasing in recent years and its control is difficult due to no external symptoms of infestation. Spotted pod borer also cause heavy losses in short duration varieties coupled with high humidity during flowering. Review of literature in Indian context, indicates that the primary focus of pest management has been on Fusarium wilt, Phytophthora blight, Sterility mosaic, H. armigera and M. obtusa, with emphasis on cultural practices, host plant resistance and chemical control (Lateef and Reed, 1990). Donar cultivars with partial resistance have been identified but their performance in the fields are yet to be proved and there is a long way to go for transgenic pigeonpea. Hence, in absence of adequate resistant genetic material, calendar sprays are being recommended, with the first application at 50 per cent flowering and the second and third applications at 15-day intervals and having no restriction, as usual farmers use their own discretion. Pesticides are no doubt

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effective in managing these pests but their indiscriminate use led to development of resistance in pests (Kranti, 2002), increase in the cost of plant protection and pollute the ecosystem. Most of the farmers follow plant protection practices based on the advice of pesticide dealers. Considering these, it is imperative to integrate various alternative strategies for management of pigeonpea pests. IPM which uses a combination of compatible control techniques is the best way to safe, long-term pest management with minimal adverse effects on the surrounding environment. With reports of pesticide resistance in pod borer 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 (e.g. neem (Azadirachta indica)) and insect pathogens, particularly the H. armigera Nuclear Polyhedrosis Virus (HaNPV), gained popularity as safe for applicators (Gopali, 1998), beneficial insect fauna targeting pod borer (Romeis and Shanower, 1996) and pod fly and the environment. Sahoo et al. (1991), Yadav and Daihya (2004) and Kumar and Paras (2003) and Sharma et al., (2011) conducted field studies to determine the efficacy of several insecticides for the control of pod fly and they do provide protection but if applied in early stage. The companion crops e.g., cotton, soybean, jowar, pigeon pea, sunflower etc., which in general plays a greater role in limiting pest infestation are usually harvested before pigeonpea attain its flowering stage, thus making them most attractive and vulnerable to pod borer adding further woe. Bhushan and Nath (2005) reported that intercrop of pigeonpea + sorghum + green gram + sunnhemp and application of NSKE, followed by endosulfan and NSKE, exhibited less grain damage by pod fly. Hence, present investigation was carried out for 2 years under A3P of National Food Security Mission to assess and devise pest management module, which can go as a component of widely accepted Integrated Pest Management for pigeonpea.

MATERIALS AND METHODS

The project was implemented in farmer’s participatory mode in 13 villages of Parbhani district (Chinchetakali, Mardasgaon, Gopa, Puyni, Sategaon, Sunegaon Kolhawadi, Nipanitakali, Gagalgaon, Ambetakali, Dighol, Dhamoni and Injegaon) during 2010-11 and 2011-12 in collaboration and supervision by Deprt. of Entomology, Marathwada Agril. University Parbhani (Mah.). The farmers were provided with basic INM inputs, Rhizobium, PSB, and chemical pesticides as IPM kits (pheromone traps, neem oil, HaNPV, emamectin benzoate) for 0.2 ha per farmers’ field benefiting 2449 farmers. Two fields of IPM and Non IPM each from every village were earmarked for periodical observations on 10 randomly selected plants from each field on weekly basis. All agronomic practices were followed as per recommendation of MKV, Parbhani. In IPM field, seed treatment with Trichoderma harzianum @ 10g/kg of seeds was applied. Since the soil were deficient in Zinc and Sulphur, soils were augmented with ZnSO₄ and Gypsum @ 12 and 250 kg /ha. In order to monitor the population of adult pod borer pheromone traps were installed @ 5/ha. Once 4-5 adult catches per week were observed the advisories through SMS were sent to farmers to spray the crop with HaNPV @ 450 LE/ha (1 LE=2*1⁰ POB/ml ) along with Teenopol (to minimize UV inactivation). This was followed by spray with Neem oil 3000 ppm to work as antifeedant and retardant. In certain pockets to manage H. armigera population in October, the crop was sprayed with emamectin benzoate 5 SG @ 0.2 g/l. The above mentioned IPM practices was for pod borer, plume moth, pod fly, maruca and other pod borers complex and these inputs were given to farmers whenever pest situation warranted. In non-IPM field, only recommended agronomic practices were followed and no IPM inputs were used. The number of larvae per 10 plants of pod borer (H. armigera), plume moth (E. atomosa) and spotted pod borer (M. testulalis) were recorded periodically. Pod damage due to pod borers complex, immature stages of pod fly (M. obtusa) in pods and grain damage due to pod fly (50 pods) were recorded. The observations on natural predatory enemies viz. coccinelids, chrysopids, spiders per plants were recorded and analyzed. The larvae of pod borer (300-350) were collected from each IPM and Non-IPM fields at weekly interval. These collected larvae were reared on pigeonpea buds and pods until pupation. The observations were recorded regarding the mortality of larvae because of different parasitoids and other reasons.

RESULTS AND DISCUSSION

Impact of IPM at village level has already been demonstrated; however effectiveness of Areawide Integrated Pest Management strategies on severity of insect pests and yield has been systematically recorded as per the standard sampling procedures. The economics of the IPM strategies and environmental benefits in terms of natural enemies has also been worked out in IPM vis-à-vis non-IPM fields.

Pod borer (H. armigera): The data on population of pod borer larvae in IPM and Non IPM during different meteorological weeks is presented in Table 1. The population of pod borer larvae was less in IPM fields than Non-IPM fields throughout the season. The incidence of pod borer larvae was noticed during 44th MW (29 Oct. - 04 Nov.) in 2010-11 and 42nd MW (15-21 Oct.) in 2011-12. The peak population was recorded in 48th MW (26 Nov. - 02 Dec.) in
TABLE 1: Average incidence of podborer, plume moth and spotted borer during the crop season (2010-11 and 2011-12).

<table>
<thead>
<tr>
<th>Number of Pod borer larvae* / plant</th>
<th>Number of plume moth larvae* / plant</th>
<th>Number of flower and pod webbings* by larva/plant</th>
</tr>
</thead>
<tbody>
<tr>
<td>MW</td>
<td>2010-11</td>
<td>2011-12</td>
</tr>
<tr>
<td>IPM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non IPM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>41</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>42</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>43</td>
<td>0.00</td>
<td>0.03</td>
</tr>
<tr>
<td>44</td>
<td>0.02</td>
<td>0.05</td>
</tr>
<tr>
<td>45</td>
<td>0.24</td>
<td>0.34</td>
</tr>
<tr>
<td>46</td>
<td>0.39</td>
<td>0.61</td>
</tr>
<tr>
<td>47</td>
<td>0.46</td>
<td>0.68</td>
</tr>
<tr>
<td>48</td>
<td>0.61</td>
<td>0.80</td>
</tr>
<tr>
<td>49</td>
<td>0.46</td>
<td>0.71</td>
</tr>
<tr>
<td>50</td>
<td>0.52</td>
<td>0.76</td>
</tr>
<tr>
<td>51</td>
<td>0.33</td>
<td>0.66</td>
</tr>
<tr>
<td>52</td>
<td>0.14</td>
<td>0.52</td>
</tr>
<tr>
<td>1</td>
<td>0.13</td>
<td>0.58</td>
</tr>
<tr>
<td>Mean</td>
<td>0.30</td>
<td>0.52</td>
</tr>
<tr>
<td>SD</td>
<td>0.26</td>
<td>0.37</td>
</tr>
<tr>
<td>SEs</td>
<td>0.07</td>
<td>0.10</td>
</tr>
<tr>
<td>p = 0.08532</td>
<td>p = 0.11339</td>
<td>p = 0.01624</td>
</tr>
</tbody>
</table>

*Means of four replications

IPM (0.61 larvae/plant) and Non-IPM (0.80 larvae/plant) fields in 2010-11, while in 2011-12, in 49th MW (03-09 Dec.) in IPM (1.20 larvae/plant) as well as in Non-IPM (1.60 larvae/plant). The average of two years indicates that the peak incidence was during 49th MW (3-9 Dec.) in IPM as well as Non IPM field. The overall mean was 0.35 larvae/plant in IPM and 0.61 larvae/plant in Non IPM. Pod borer monitoring based application of HaNPV, neem oil and chemical insecticides could manage the pod borer infestation to greater extent. Several other workers have also reported effectiveness of different chemical pesticides in management of pod borer with the similar strategies (Babriya et al., 2010; Sharma et al., 2011, Chaudhary et al., 2008).

**Plume moth** (*E. atomosa*): The data presented in Table 1 revealed that the incidence of plume moth initiated in 45th MW (05-11 Nov.) in 2010-11 and in 41st MW (08-14 Oct.) in 2011-12 in both IPM and Non-IPM fields. The population dynamics varied in both the years. The population ranged from 0.06 to 0.26 larvae/plant in IPM and from 0.11 to 0.40 larvae/plant in Non-IPM in 2010-11. The larval population of plume moth was 0.01 to 0.35 larvae/plant in IPM and 0.01 to 0.47 larvae/plant in Non-IPM during 2011-12. Overall the population was less in IPM fields as compared to Non-IPM fields. The maximum population was recorded in 47th MW (19-25 Nov.) during 2010-11 and in 48th MW (26 Nov. - 02 Dec.) during 2011-12 in IPM and Non-IPM fields. The overall mean indicated that the plume moth larval population was 0.09 larvae/plant in IPM and 0.15 larvae/plant in Non IPM fields. Shanower *et al.*, (1999) have reported significance of plume moth with the changing climatic conditions their population is on increase.

**Spotted pod borer or flower and pod webber** (*M. testulalis*): It causes losses to the tune of 9-84% (Ganapathy, 2010). The larvae damage leaves by rolling, webbing and continued feeding inside the rolled leaves. At flower and pod premature stages, larvae feed on buds, flower and pods by webbing them (Sharma, 1998). The number of webbings on plant due to larvae of flower and pod webber was less in IPM fields than Non-IPM fields (Table 1). The peak incidence was recorded in 52nd MW (24-31 Dec) during 2010-11 and in 49th MW (03-09 Dec) during 2011-12 in both IPM as well as Non-IPM fields. The average incidence of two years data revealed that the spotted pod borer infestation was noticed throughout the season from flowering. The mean number of webbings by larvae was less in IPM (0.09/plant) as compared to Non IPM fields (0.17/plant). Our present finding is in the line of earlier findings by Akhauri and Yadav (2002), who found that the larval population fluctuated widely in relation to seasonal changes beginning from the second week of October till the end of December. Gopali *et al.*, (2010) reported that incidence of spotted pod borer was high in early (140-150 days) and late maturing (190-200 days) varieties, moderate in medium duration (170-180 days). It is noteworthy to mention that the incidence was high in late sown conditions and also in varieties having clustering type of branching habit.

**Pod damage due to pod borer complex**: The results presented in Table 2 indicated that the percentage of pod
TABLE 2: Pod damage due to pod borer complex in IPM and Non-IPM fields

<table>
<thead>
<tr>
<th>MW</th>
<th>Duration</th>
<th>2010-11</th>
<th>2011-12</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>IPM</td>
<td>Non IPM</td>
<td>IPM</td>
</tr>
<tr>
<td>43</td>
<td>22-28 Oct.</td>
<td>0.00</td>
<td>0.00</td>
<td>4.00</td>
</tr>
<tr>
<td>44</td>
<td>29 Oct -04 Nov.</td>
<td>0.00</td>
<td>0.00</td>
<td>4.00</td>
</tr>
<tr>
<td>45</td>
<td>05-11 Nov.</td>
<td>0.00</td>
<td>0.00</td>
<td>9.00</td>
</tr>
<tr>
<td>46</td>
<td>12-18 Nov.</td>
<td>0.00</td>
<td>0.00</td>
<td>5.00</td>
</tr>
<tr>
<td>47</td>
<td>19-25 Nov.</td>
<td>0.00</td>
<td>0.00</td>
<td>9.00</td>
</tr>
<tr>
<td>48</td>
<td>26 Nov-02 Dec.</td>
<td>1.67</td>
<td>7.83</td>
<td>15.00</td>
</tr>
<tr>
<td>49</td>
<td>03-09 Dec.</td>
<td>4.50</td>
<td>14.83</td>
<td>24.00</td>
</tr>
<tr>
<td>50</td>
<td>10-16 Dec.</td>
<td>7.92</td>
<td>20.83</td>
<td>24.00</td>
</tr>
<tr>
<td>51</td>
<td>17-23 Dec.</td>
<td>10.08</td>
<td>29.33</td>
<td>24.00</td>
</tr>
<tr>
<td>52</td>
<td>24-31 Dec.</td>
<td>13.50</td>
<td>35.50</td>
<td>18.00</td>
</tr>
<tr>
<td>53</td>
<td>01-07 Jan.</td>
<td>13.00</td>
<td>34.66</td>
<td>14.00</td>
</tr>
</tbody>
</table>

Mean: 4.61, SD: 5.52, SE±: 1.67, p = 0.09265

Pod damage was less in IPM fields as compared to Non-IPM during both the years. The pod damage was observed from 48th MW (26 Nov. - 02 Dec.) during 2010-11 and 43rd MW (22-28 Oct.) during 2011-12 and thereafter increased till the end of season. The highest pod damage was noticed in 52nd MW (24-31 Dec.) in IPM (13.50 per cent) and non-IPM (35.50 per cent) during 2010-11 and in 50th MW (10-16 Dec.) during 2011-12 in IPM (24.0 per cent) and Non IPM (46.0 per cent) conditions. The data on average of both years indicated that the damage due to pod borers was noticed from last week of October and continued till the end of season. The overall mean of pod damage was less in IPM (9.12 per cent) than Non IPM (18.68 per cent). Bhoyar et al., (2004) studied on seasonal incidence of pod borer complex and reported individual losses caused by pod borer complex. Kumar and Kumar (2003) quantified pod damage and yield loss in pigeonpea by different borers. *M. vitrata* caused only 0.1 to 2.1 per cent pod damage, while *H. armigera* caused the maximum pod damage (6.4-24.7 per cent). The remaining pod borers i.e. *Apion clavipes* and *M. obtusa* caused 3.8-8.2 and 1.0-6.1 per cent pod damage, respectively. Samiyayan and Gajendran (2009) have successfully demonstrated a viable and workable IPM module for pod borer management in pigeonpea in Tamil Nadu.

Immature stages of pod fly (*M. obtusa*): The data from Table 3 revealed that the immature stages (maggot and pupa) in pods were noticed in 50th MW (10-16 Dec.) during 2010-11 in IPM and Non IPM. During 2011-12, the immature stages of pod fly were noticed in 48th MW in IPM and 47th MW in Non IPM. During 2010-11, the range was from 0.36 to 6.00 immature stages/50 pods in IPM and from 3.83 to 17.50 immature stages/50 pods in Non-IPM fields. During 2011-12, the immature stages/50 pods was 3.50 to 17.50 in IPM, whereas 1.50 to 27.50 in Non-IPM fields. The immature stages recorded were increased till the end of season. The results of two years data revealed that the immature stages of

TABLE 3: Immature stages of pod fly (*M. obtusa*) in IPM and Non-IPM

<table>
<thead>
<tr>
<th>MW</th>
<th>Duration</th>
<th>2010-11</th>
<th>2011-12</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>IPM</td>
<td>Non IPM</td>
<td>IPM</td>
</tr>
<tr>
<td>47</td>
<td>19-25 Nov.</td>
<td>0.00</td>
<td>0.00</td>
<td>3.50</td>
</tr>
<tr>
<td>48</td>
<td>26 Nov-02 Dec.</td>
<td>0.00</td>
<td>0.00</td>
<td>11.50</td>
</tr>
<tr>
<td>49</td>
<td>03-09 Dec.</td>
<td>0.36</td>
<td>3.83</td>
<td>17.00</td>
</tr>
<tr>
<td>50</td>
<td>10-16 Dec.</td>
<td>3.33</td>
<td>13.16</td>
<td>17.50</td>
</tr>
<tr>
<td>51</td>
<td>17-23 Dec.</td>
<td>5.83</td>
<td>16.33</td>
<td>13.00</td>
</tr>
<tr>
<td>52</td>
<td>24-31 Dec.</td>
<td>6.00</td>
<td>17.50</td>
<td>10.00</td>
</tr>
<tr>
<td>53</td>
<td>01-07 Jan.</td>
<td>2.22</td>
<td>7.26</td>
<td>10.36</td>
</tr>
</tbody>
</table>

Mean: 2.22, SD: 7.26, SE±: 1.06, p = 0.14462
Grain damage due to pod fly (%)

<table>
<thead>
<tr>
<th></th>
<th>2010-11</th>
<th>2011-12</th>
<th>SE±</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block</td>
<td></td>
<td></td>
<td>Mean</td>
</tr>
<tr>
<td>2010-11</td>
<td>5.02</td>
<td>11.98</td>
<td></td>
</tr>
<tr>
<td>2011-12</td>
<td>6.35</td>
<td>15.60</td>
<td></td>
</tr>
</tbody>
</table>

Grain damage due to pod fly was observed from first week of December and continued till the harvesting of crop. The overall mean was 7.15 maggots and pupa/50 pods in IPM and 13.51 maggots and pupa/50 pods in Non IPM. Many researchers have reported successful management of pod fly with timely detection and use of chemical pesticides (Mandal and Mishra, 2003; Sharma et al., 2011).

Grain damage due to pod fly could be estimated based on observations made on 50 randomly collected green pods and splitting them. The data in Table 4 indicated that the grain damage in IPM was 5.02 per cent and 6.35 per cent during 2010-11 and 2011-12, respectively, while it was 11.98 per cent and 15.60 per cent in Non-IPM during 2010-11 and 2011-12, respectively. The average grain damage due to pod fly was less in IPM (5.69 per cent) than Non IPM fields (13.79 per cent).

The results of both years indicated that the infestations of pod borer *H. armigera* and pod fly *M. obtusa* were severe and spotted pod borer was moderate. The Non IPM farmers were unaware about pod fly infestation. The IPM farmers received advisories timely about pod fly infestation and sprayed systemic insecticide. Hence, the pod damage and grain damage was less in IPM as compared to Non IPM fields.

**Status of natural enemies on pigeonpea in IPM and Non IPM:** The population of coccinellids in IPM fields were more as compared to Non-IPM fields during both 2010-11 and 2011-12 years (Table 5). During 2010-11, the coccinellid population was 0.03 to 0.51 /plant in IPM and 0.01 to 0.21 /plant in Non-IPM. While during 2011-12, it was 0.10 to 0.52 /plant in IPM and 0.02 to 0.27 /plant in Non-IPM. The overall mean of coccinellids revealed that population of coccinellids was more in IPM (0.19 /plant) as compared to Non IPM (0.08 /plant). The population of chrysopids in IPM fields was more as compared to Non-IPM fields during both both years (Table 5). During 2010-11, the chrysopids population was 0.01 to 0.07 /plant in IPM and 0.01 to 0.03 /plant in Non-IPM. While during 2011-12, it was 0.01 to 0.25 /plant in IPM and 0.01 to 0.08 /plant in Non-IPM. The overall mean of two years data indicated that the chrysopids population was 0.05/ plant in IPM and 0.02/ plant in Non-IPM. During 2010-11 and 2011-12, the spider population was noticed throughout the season (Table 5). The population of spiders was more in IPM fields than Non-IPM fields. The overall mean indicated that the population of spiders was more in IPM (0.42/ plant) than Non IPM fields (0.28/ plant).

**Parasitization of pod borer larvae:** The parasitization of *H. armigera* larvae was studied during 2010-12 from field collected life stages on pigeonpea to quantify the benefits of IPM incurred to environment. Amongst early instar larvae of *H. armigera*, the ichneumonid, *E. argenticeps* was found to be the ichneumonid, *E. argenticeps* was found to be...
the most effective and the other *Campeletis chlorideae* was observed to be active in December. Parasitism by a braconid, *Bracon* sp., was also observed from 45<sup>th</sup> to 50<sup>th</sup> MW. Similar reports have been made from the region by Bisane *et al.* (2008). The data of parasitization of larvae of pod borer collected from pigeonpea field revealed that the per cent parasitized larvae was more in IPM than Non-IPM (Table 6). During 2010-11, the range of parasitized larvae was 0.75 to 6.70 per cent in IPM and 0.50 to 3.65 per cent in Non-IPM. While during 2011-12, the range was 0.50 to 9.50 per cent in IPM and 0.50 to 5.00 per cent in Non-IPM. The average of two years data showed that the parasitization of pod borer larvae ranged from 0.38 to 8.10 per cent in IPM and from 0.25 to 4.33 per cent in Non-IPM. The overall mean was more in IPM (3.57 per cent) as compared to Non IPM (1.66 per cent).

**Economics of IPM and Non-IPM in pigeonpea:** The results presented in Table 7 revealed that the IPM fields recorded more yield than Non-IPM fields. During 2010-11, the average yield was 10.13 q/ha in IPM and 8.32 q/ha in Non-IPM fields. Whereas, it was 9.65 q/ha in IPM and 7.78 q/ha in Non-IPM during 2011-12. The insecticide sprayings required were 3.75 in IPM fields and 5.58 in Non-IPM fields during 2010-11. During 2011-12, the insecticide sprayings required were 3.79 and 6.38 in IPM and Non-IPM, respectively. The adoption of IPM resulted in savings of Rs. 645/ha during 2010-11 and Rs. 1243/ha during 2011-12 due to less cost in insecticides sprayings in IPM. An additional profit of Rs. 7240/ha during 2010-11 and Rs. 6188/ha during 2011-12 was recorded due to IPM. Overall the IPM has increased the net profit by Rs. 7885/ha during 2010-11 and Rs. 7430/ha during 2011-12.

Existing conventional extension approach consists mainly of the centrally guided transfer of technology with readymade packages which unfortunately are not validated under location specific field condition. Several workers from different parts of the country (Sahoo, 2002; Ujagir, 1999) have carried out field evaluation of different pesticides and found the generic as more effective. Sahoo and Senapati (2000) have reported high efficacy and better economics of synthetic insecticides in comparison to plant products for the control of pod borers in pigeonpea. Major reasons for high infestation

### TABLE 6: Parasitization of pod borer larvae in IPM and Non-IPM

<table>
<thead>
<tr>
<th>MW</th>
<th>Duration</th>
<th>2010-11</th>
<th>2011-12</th>
<th>Average</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>IPM</td>
<td>Non IPM</td>
<td>IPM</td>
<td>Non IPM</td>
</tr>
<tr>
<td>43</td>
<td>22-28 Oct.</td>
<td>0.00</td>
<td>0.00</td>
<td>1.75</td>
<td>0.50</td>
</tr>
<tr>
<td>44</td>
<td>29 Oct-04 Nov.</td>
<td>0.00</td>
<td>0.00</td>
<td>3.25</td>
<td>1.50</td>
</tr>
<tr>
<td>45</td>
<td>05-11 Nov.</td>
<td>2.50</td>
<td>1.25</td>
<td>4.50</td>
<td>2.25</td>
</tr>
<tr>
<td>46</td>
<td>12-18 Nov.</td>
<td>3.45</td>
<td>1.25</td>
<td>8.00</td>
<td>3.00</td>
</tr>
<tr>
<td>47</td>
<td>19-25 Nov.</td>
<td>5.00</td>
<td>2.25</td>
<td>5.50</td>
<td>2.50</td>
</tr>
<tr>
<td>48</td>
<td>26 Nov-02 Dec.</td>
<td>6.70</td>
<td>3.65</td>
<td>9.50</td>
<td>5.00</td>
</tr>
<tr>
<td>49</td>
<td>03-09 Dec.</td>
<td>4.50</td>
<td>2.50</td>
<td>9.25</td>
<td>4.50</td>
</tr>
<tr>
<td>50</td>
<td>10-16 Dec.</td>
<td>5.65</td>
<td>1.50</td>
<td>3.75</td>
<td>2.00</td>
</tr>
<tr>
<td>51</td>
<td>17-23 Dec.</td>
<td>2.50</td>
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<td>0.50</td>
<td>0.00</td>
</tr>
<tr>
<td>52</td>
<td>24-31 Dec.</td>
<td>1.25</td>
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<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>53</td>
<td>01-07 Jan.</td>
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<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>2.94</td>
<td>1.22</td>
<td>4.18</td>
<td>1.93</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>2.32</td>
<td>1.19</td>
<td>3.55</td>
<td>1.76</td>
</tr>
<tr>
<td></td>
<td>SE±</td>
<td>0.70</td>
<td>0.36</td>
<td>1.07</td>
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</table>

### TABLE 7: Economics of IPM and Non-IPM in pigeonpea

<table>
<thead>
<tr>
<th>Particulars</th>
<th>2010-11</th>
<th>2011-12</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IPM</td>
<td>Non-IPM</td>
<td>IPM</td>
</tr>
<tr>
<td>Yield (q/ha)</td>
<td>10.13</td>
<td>8.32</td>
<td>9.65</td>
</tr>
<tr>
<td>No. of sprayings</td>
<td>3.75</td>
<td>5.58</td>
<td>3.79</td>
</tr>
<tr>
<td>Cost of spraying (Rs./ha)</td>
<td>2270</td>
<td>2915</td>
<td>2900</td>
</tr>
<tr>
<td>Net income (Rs./ha)</td>
<td>40520</td>
<td>33280</td>
<td>31845</td>
</tr>
<tr>
<td>Increase in yield (q/ha)</td>
<td>1.81</td>
<td>-</td>
<td>1.88</td>
</tr>
<tr>
<td>Additional profit due to increase in yield (Rs./ha)</td>
<td>7240</td>
<td>-</td>
<td>6188</td>
</tr>
<tr>
<td>Additional profit due to savings of sprayings (Rs./ha)</td>
<td>645</td>
<td>-</td>
<td>1243</td>
</tr>
<tr>
<td>Net profit due to IPM (Rs./ha)</td>
<td>7885</td>
<td>-</td>
<td>7430</td>
</tr>
</tbody>
</table>
with pests include unrecommended cultivation practices, injudicious use of pesticides and fertilization, and prolonged use of saved seeds. The continuation of high use of pesticides often contributes together with inappropriate application practices to increased input costs, and development of resistance in pest populations against pesticides. Application of synthetic insecticides have been shown to reduce effectiveness of egg parasitoids (Abudulai et al., 2001) however, commercial neem formulations has not shown any detrimental effect (Abudulai and Shepard, 2003). Based on our experience and above results, neem oil could be successfully incorporated into IPM programme to encourage beneficial insects. Similarly use of nuclear polyhedral viruses against Helicoverpa has been advocated by several workers (Muthiah and Rabindra, 1991; Gopali, 1998) and the same were utilized in present experiment proved its worthiness as an alternative to synthetic chemicals. Several problems related to calendar based approach have limited the effectiveness and impact on further improving the intensive smallholder farming systems. Hence, in present studies, farmers were taken into confidence by involving them in problem identification and solving, planning and decision-making and advisory messages delivered the results from top-down. Farmers were equipped with improved knowledge and skills which helped them with the use of appropriate IPM practices. Altogether data from IPM and non-IPM implementation of IPM strategies based on the surveys will continue to produce better results in the pigeonpea field in future also.

ACKNOWLEDGEMENT
Authors thankfully acknowledge the funding agency, i.e. Department of Agriculture and Cooperation, Ministry of Agriculture, New Delhi, for large area validation under National Food Security Mission.

REFERENCES


