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Short communication

Farmers-led development and validation of IPM technology in cabbage

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Cabbage is cultivated in 0.26 m ha producing 6.92 MT with a 5.4% share in total vegetable production occupying fourth rank among widely grown vegetable crops in India (Ahuja and Ahuja, 1). With the development of new hybrids and varieties, it is now being grown throughout the year. As a result, the risk of damage from the pests has greatly increased and farmers need to make pesticides spray to protect the crop from the pest damage. Development of resistance by *Plutella xylostella* and other insect pests of cabbage to commonly used insecticides (Raju, 5) and the poor knowledge possessed by the stake holders in this regard, indiscriminate sprays are being made for reducing pest density. This practice not only contaminates the harvested produce with harmful pesticides residues causing health hazards but also destroys the beneficial fauna and pollutes the environment. To overcome the problem of over use of pesticides, development and implementation of IPM technology in farmers' participatory mode may better address the problem.

Field experiments were conducted in Ananatpura village of Jaipur district in Rajasthan during late winter seasons of years 2007-08 and 2008-09. Nursery of cabbage was prepared in mid December and transplanted in mid January. Harvesting of the crop started in last week of February and continued till mid April. There were 10 locations covering ten farmers and at each location one acre area was covered for implementing IPM technology. The treatments tested and compared in each location were: (a) IPM module synthesized on the basis of available information from literature and (b) Conventional system *vis-a-vis* farmers' practice (FP), using application of agronomic factors and pest control commonly practiced by the local farmers. The IPM module comprising soil application of *Trichoderma harzianum* augmented in farm yard manure @ 250 g/100 kg, neem cake @ 50 g/m^2, soil solarization of nursery area for three weeks, seed treatment with *T. harzianum* @ 4 g/kg seed and Imidacloprid 70 WS @ 3 g/kg seed, raised bed sowing, seedling dip in *T. harzianum* @ 10 g/l, mustard as trap crop after every 25 rows of cabbage, release of egg parasitoid *Trichogramma bacatrae* at 1 lakh/ha coinciding with observations on DBM moth catches at 8-10/trap/night for a week, need-based application of azadirachtin, two application of either of the reduced risk insecticides Spinosad @ 48 SC, or Cartap hydrochloride @ 50 WP or Novaluron @ 10 EC, at action threshold level of 3-5% visual damage and one spray of Mancozeb 75 @ WP. In conventional plots, farmers solely depend upon for protection against pests on 6-7 applications of pesticides involving Chlorpyriphos, Endosulfan, Cypermethrin, Carbendazim and Mancozeb. No seed treatment of bio-control agents or Imidacloprid @ 70 WS or sex pheromone traps or mustard as a trap was adopted and nursery was prepared on flat beds.

Counts on density of major pests were made on 100 cabbage plants from each of the IPM plots as well as FP plots at 10 day interval from second fortnight of January till complete harvesting. The numbers of pesticide sprays, the amount of pesticide and various IPM inputs used during the growing season were recorded for each plot besides the cost incurred on inputs and labour. The marketable yield of cabbage per plot was recorded at harvest. An average of 0.3-0.4 kg /ha seed was used for sowing and the seedlings were ready for transplanting after 4-5 weeks. Nursery was prepared on raised bed of 15 cm height. Fields were prepared by 3-4 ploughings. Farmers were advised to apply fertilizer at 120 kg N, 60 kg P, and 80 kg K (per hectare basis), undertake three hoeing 20 days post sowing at an interval of 15-20 days. Crop geometry maintained was 30 cm and 45 cm between plant to plant and row to row, respectively. Before commencement of implementation of IPM programme, farmers in the village were chosen at random and interviewed using prepared questionnaire. Farmers were asked question related to plant protection practices and other cultural practices followed to raise their crop. Cost of cultivation included expenditure incurred on labour cost for field preparation, nursery sowing, transplanting, fertilizer application, hoeing and weeding, pesticide application, material costs like seed, pesticides, bio-control agents, fertilizers, and irrigation. The data on pest incidence,

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Table 1. Mean incidence of different pests on cabbage crop grown in late winter season in village Anantpura, Jaipur, Rajasthan.

Parameter	2008-09		2009-10		Mean		't' value
	IPM	FP	IPM	FP	IPM	FP	
No. of larvae of DBM10 / plant	0.1	0.3	0.6	1.9	0.4	1.1	3.35*
No. of aphids / plant	3.0	9.2	8.4	13.7	5.7	11.5	5.35*
% damping-off incidence	3.6	6.8	2.6	6.1	3.1	6.5	7.26*
% alternaria leaf spot incidence	1.2	2.5	1.8	3.7	1.5	3.1	6.06*

*Significant at 1% level of significance.

cost of cultivation (Rs./ha), head yield (q/ha) and cost of plant protection (Rs./ha) were subjected to paired "t test" of significance to judge the level of significance using SAS software.

Incidence of diamond back moth *Plutella xylostella* (Linnaeus), aphid *Lipaphis erysimi* (Kaltenbach), painted bug *Bagrada hilaris* (Kirk.) and cabbage web worm (*Crocidolomia binotalis* Zell) among the insects; damping off (*Pythium debaryanum* (R. hesse), alternaria leaf spot (*Alternaria brassicicola*) and downy mildew (*Peronospora parasitica*) among the diseases were recorded. Population of *L. erysimi* and *P. xylostella* tend to rise above action threshold and needed management intervention. Appearance of aphids was noticed in the first week of January that however remained low. It started increasing at the end of the January due to rise in temperature and migration of winged aphids from adjoining mustard fields till last week of February. Male moth caught in sex pheromone traps for *P. xyllostella* were also recorded that started from first week of February. Larval damage due to DBM (*Plutella xylostella*) was recorded from mid February to mid April. Data showed that number of aphids/plant (5.7) and that of mean larvae of *P. xylostella* (0.4) in IPM fields were low compared to corresponding figures of 11.5 and 1.1/plant in farmers practice (FP), respectively. Among the diseases, damping-off incidence was merely 3.1 per cent in nursery stage and 1.5 per cent due to *Alternaria* leaf spot during fruiting stage in IPM fields as compared to corresponding figures of 6.5 and 3.1 per cent, respectively in farmers practice (Table 1).

Mean head yield of cabbage was higher in IPM fields (437 q/ha) as compared to farmers' practice (393 q/ha) fields by 11.11 per cent (Table 2). Mean number of sprays of insecticides and fungicides were 3.0 in IPM plots as compared to 5.6 in conventional plots; thereby 60 per cent reduction in number of sprays was recorded. The data on head yield were subjected to economic analysis. Net returns for cabbage in winter season were Rs.1,75,489 in IPM fields as compared to Rs.1,04,676 in farmers practice. Cost: benefit ratio was 1: 3.61 and 1: 2.82, respectively in IPM and farmers practice plots. Thus, the economic analysis demonstrated that IPM technology has the potential to protect the crop from pests in more profitable manner as compared to use of toxic pesticides alone that are used indiscriminately. Moreover, IPM technology is eco-friendly and environmentally compatible and safe for human health. The results established that IPM had the economic potential to substitute chemical pesticides without demanding any enhancement in

Table 2. Mean head yield and economics of cauliflower cultivation grown in late winter season at Anatpura village Jaipur, Rajasthan.

Parameter	2008-09[1]		2009-10[2]		Pooled mean		't' value
	IPM	FP	IPM	FP	IPM	FP	
Cost of production (Rs./ha)	49,685	60,615	50,150	54,560	49,918	57,633	9.55*
Mean yield (q/ha)	435	390	439	396	437	393	3.74*
Cost of plant protection (Rs./ha)	3,644	6,110	3,823	5,718	3,733	5,913	24.57*
Total returns (Rs./ha)	1,74,000	1,56,000	1,86,575	1,68,300	1,80,481	1,62,309	
Net Returns (Rs./ha)	1,24,315	97,385	136425	1,13,740	1,75,489	1,04,676	
Cost : Benefit ratio	1:3.50	1:1.66	1:3.72	1:2.08	1:3.61	1:2.82	
Number of pesticide sprays	3.5	6.5	2.5	4.7	3.0	5.6	

*Significant at 5% level of significance; Rates of cabbage: [2]Rs. 400/q and [1]Rs. 425/q[2].

cost of cultivation and ensured higher economic returns as well as higher head yield with added advantage of no adverse effects on environment, natural enemies and human health. Baseline survey undertaken before the commencement of the project showed that famers were using chlorpyriphos, endosulfan and synthetic pyrethroids for management of pests of cabbage to which the pest has been reported to have developed high level of resistance (Raju, 5). Ineffective pesticide use and the evolution of resistance to insecticides by pests of cabbage such as diamond back moth and mustard aphid, too much insecticides usage by the famers had resulted in unacceptably high residues and environment contamination (Kole *et al*., 4), and higher cost of plant protection. Replacement of ineffective insecticides with safe insecticides such as Spinosad or Novaluron or Cartap hydrochloride in the present studies resulted in less number of sprays and lowering the cost of plant protection with minimal residual effect. Earlier findings (Asare *et al*., 2; Sathi *et al*., 6) have also concluded that united interaction of intercropping of cauliflower with non host plant and insecticide application resulted substantial reduction in pest incidence and provided higher economic returns as compared to their independent application. Birthal (3) have also reported IPM as more profitable than chemical pesticides. In the present studies too, adoption of IPM technology was found to give higher economic returns. Promotion of the IPM technology for cabbage crop need to be undertaken on area wide approach since most of the farmers still rely only on chemical pesticides to protect their crop from pests damage (Weinberger and Srinivasan, 8).

It may be concluded that growers have learnt to pay attention to what is going on in their fields, they do notice pest and realize that not all insects present are pests, and that just having a few number presents does not mean that a protection treatment is necessary. Grower views that the biggest thing he/she learned from this project is the importance of scouting, proper choice of pesticides and timing of their applications. Use of mustard as a trap crop/ raised bed sowing in both nurseries as well as after transplanting, knowledge about the beneficial insects, reduced risk pesticides and bio-pesticide such as *T. harzianum* also found favour.

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