Indian Journal of Agricultural Sciences **83** (2): 198–202, February 2013/Article

Development and on-farm validation of location specific IPM technology for rainy season cauliflower (*Brassica oleracea* var *botrytis* subvar *cauliflora*)

D B AHUJA[1], SWAROOP SINGH[2], PRATIBHA SHARMA[3], MEENAKSHI MALIK[4], R V SINGH[5] and BHARTI KALRA[6]

National Centre for Integrated Pest Management, Pusa Campus, New Delhi 110 012

Received: 22 November 2010; Revised accepted: 20 November 2012

ABSTRACT

IPM module comprising ecofriendly management practices such as soil solarization of nursery beds for 15-20 days, soil application of *T. harzianum* @ 2.50 kg/ha through FYM fortification, neem cake @ 50 g/m^2, seed treatment with *T. harzianum* @ 4g/kg seed and imidacloprid 70 WS @ 3 g/kg seed, raised bed (15–25 cm) sowing (nursery stage), seedling dip in *T. harzianum* @ 4 g/l and imidacloprid 17.5 SL @ 0.5 ml/l of water, Chinese cabbage as a trap crop and planting of seedlings on ridges of 15–25 cm height (at the time of transplanting) and monitoring of population of S. *litura* through sex pheromone traps (5/ha), hand picking of larvae and egg masses of S. *litura* , plucking of pest infested leaves, need based application of *SI* NPV (250 LE/ha), neem oil 10%, novaluron 10 EC (250 ml/ha), spinosad 48 SC (75 g a.i/ha), and Mancozeb 64% + Metalaxyl 8% l @ 2g/l (after transplanting) was developed during rainy season of 2006 and 2007. It was evaluated in farmer's participatory mode during rainy season of 2008 and 2009 with the objective to provide alternatives to synthetic pesticides and propose solution to the threat of environmental degradation. Implementation of Integrated Pest Management programme in irrigated cauliflower (*Brassica oleracea* L var *botrytis* subvar *cauliflora*) crop led to reduction in number of pesticide sprays of 50-60 percent and their replacement with safer pesticides. Lower insect and disease incidence with higher curd production was observed in the IPM fields as compared to conventional farmers practice fields. IPM module was able to cut the cost of crop protection resulting in higher benefit-cost ratio.

Key words: *Alternaria* leaf spot, *Bagrada hilaris*, Damping off, Integrated Pest Management, Rainy season cauliflower, *Spodoptera litura*

Rajasthan with its huge geographical area and diverse agro-climatic conditions favours growing of large number of horticultural crops including vegetables. Over the years, farmers have started growing several vegetables; prominent among them is cauliflower (*Brassica oleracea* L var *botrytis* subvar *cauliflora*) which is being cultivated round the year. This has resulted in higher rates of pest infestation on cauliflower, especially by diamond back moth, *Plutella xylostella* (Shukla and Kumar 2005), tobacco caterpillar, *Spodoptera litura,* cabbage leaf webber, *Crocidolomia binotalis,* cabbage head borer, *Hellula undalis,* painted bug, *Bagrada cruciferarum* (Kirkaldy) and semilooper, *Trichoplusia ni* Hubner (Abrol and Gupta 2010), leaf spot *(Alternaria brassicicola),* damping off *(Pythium* sp) , downy mildew *(Peronospora parasitica)* and stalk rot *(Sclerotinia sclerotiorum)* (Sharma *et al.* 2006). Practice of using non-recommended pesticides other than recommended ones and sole reliance on them for managing the pests of vegetables is relatively higher in India (Weinberger and Srinivasan 2009). This has contributed to development of undesirable impacts such as pesticide resistance, environmental degradation, and human health, which have triggered a growing interest in alternative management techniques such as integrated pest management technology which has the capacity to manage pests in environmentally compatible manner but it need to be economically viable. There are several promising management practices in vogue which are exclusively confined to laboratory or practiced at research farms for curtailing the menace of the above mentioned pests of cauliflower. However, in the present investigation these were implemented together in a compatible manner in farmer's participatory mode to develop a suitable pest management technology that can be adopted by the farmers with greater

[1]Principal Scientist (e mail: deshbandhu4@rediffmail.com) [4]Scientist (e mail: minaxi.2007@gmail.com), [5]Senior Scientist (e mail: rvasingh@gmail.com), [6]Former Senior Research Fellow (e mail: bhartikalra2010@rediffmail.com); [2]Professor (e mail: drswaroop.rau@gmail.com), Agricultural Research Station (Swami Keshwanand Rajasthan Agricultural University, [3]Professor (e mail: psharma032003@yahoo.co.in), Division of Plant Pathology, Indian Agricultural Research Institute, Pusa, New Delhi 110 012

ease and is economically viable.

MATERIALS AND METHODS

On the basis of results of the previous studies on management of pests of cauliflower, IPM module was prepared. It was applied in three stages, ie (1) nursery stage (soil solarization for 15-20 days, soil application of *T. harzianum* @ 2.50 kg/ha through FYM fortification, neem cake @ 50 g/m^2, seed treatment with *T. harzianum* @ 4g/kg seed and imidacloprid 70 WS @ 3 g/kg seed, raised bed sowing 15-25 cm), (2) at the time of transplanting (seedling dip in *T. harzianum* @ 4 g/l and imidacloprid 17.5 SL @ 0.5 ml/l of water, Chinese cabbage as a trap crop and transplanting on ridges of height of 15-25 cm) and (3) after transplanting (monitoring of population of S. *litura* through sex pheromone traps, hand picking of larvae and egg masses of S. *litura,* plucking of pest infested leaves, need based application of SI NPV (250 LE/ha), neem oil 10%, novaluron 10 EC (250 ml/ha), spinosad 48 SC (75 G ai/ha), and of ridomil gold @ 2g/l (Mancozeb 64%+ Metalaxyl 8% l). Chinese cabbage that was used as a trap crop was also sprayed with spinosad as and when need arose to kill the trapped insects and prevent their migration to cauliflower. IPM trials were conducted on a variety early Kuary of cauliflower belonging to September maturity group marketed by Doctor Seeds (Pvt) Ltd, Ludhiana. The IPM module was compared with farmer's practice (seed treatment with carbendazim and ten sprays of synthetic insecticides namely two each of endosulfan, cypermethrin, profenophos, chlorpyriphos and of ridomil/mancozeb) and untreated control plots. The nursery was raised in the last week of July and all recommended agronomical practices and nursery IPM practices as narrated above were applied. Fifty days old seedlings were transplanted in three blocks each measuring 15 m × 25 m size. Different components of the IPM and farmers practices were applied block wise and third block remained without any component of plant protection. Each block was divided into 10 plots of size 6 m × 5 m representing one replication. Initially it was tested during rainy season in 2006 and 2007 at research farm of Agricultural Research Station (Swami Keshwanand Rajasthan Agricultural University), Durgapura, Jaipur. The crop geometry followed was 50 cm and 30 cm between row to row and plant to plant, respectively. Observations on number of painted bugs (both nymphs and adults) on five plants per replication were counted. Ten plants per replication were observed to record plants infested with newly hatched larvae of S. *litura* and per cent plant infestation was calculated. The data on pest incidence and curd yield were recorded at weekly interval and subjected to ANOVA using SAS software. The IPM module was fine tuned and also evaluated in farmers' participatory mode in rainy seasons of 2008 and 2009 in village Ananatpura, District Jaipur (Rajasthan) and was compared with farmers practice. The village was selected on the basis of socio economic survey. Nursery of cauliflower was prepared in mid June and transplanted in mid July in both the years. Harvesting of the crop was started in last week of September and continued till end of October. There were 10 locations covering ten farmers' families and at each farmers field one acre area was covered for implementing IPM technology. The treatments tested in each location were: (a) IPM module tested at ARS, Durgapura and (b) Conventional system *vis a vis* farmers 'practice (FP), using application of agronomic factors and pest control commonly practiced by the local farmers (seed treatment with carbendazim and ten sprays of synthetic insecticides namely two each of endosulfan, cypermethrin, methyl demeton, profenophos, chlorpyriphos and of ridomil/mancozeb). No seed treatment of biocontrol agents or imidacloprid 70 WS or sex pheromone traps or Chinese cabbage as a trap was adopted and nursery was prepared on flat beds. Counts on pest density of major pests were made on 100 cauliflower plants from each of the IPM plots as well as conventional plots at 10 day's interval from second fortnight of July till complete harvesting and mean per cent incidence was calculated. 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 other inputs and labour cost. The marketable yield of cauliflower per plot was recorded at harvest time. Farmers were advised to apply fertilizer at 120 kg N, 60 kg P, 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 50 cm between plant to plant and row to row, respectively. An average of l kg/ha seed was used for sowing and the seedlings were ready for transplanting after 4–5 weeks. Fields were prepared by 3–4 ploughing. Nursery was prepared on raised bed of 15-25 cm height. 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, labour cost for field preparation, nursery sowing, transplanting, fertilizer application, hoeing and weeding, pesticide application, material cost like seed, pesticides, biocontrol agents, fertilizers, and irrigation. Cost of cultivation for both IPM and farmers practice fields were calculated and economic analysis was made to calculate cost benefit ratio. Major pests were also recorded.

RESULTS AND DISCUSSION

Development of IPM module

Several insects such as diamondback moth *(P. xylostella),* tobacco caterpillar *(S. litura),* cabbage head borer (*H. undalis*), painted bug (*B. hilaris*), cabbage butter fly (*Pieris brassicae,* L.) and diseases damping off (*Pythium* sp) and downy mildew

Table 1 Mean per cent pest incidence in various treatments on cauliflower cultivated in rainy season (2006 and 2007)

SMW	Mean population of painted bug//5 plant(2005)			Mean population of painted bug//5 plant (2007)			Mean per cent plant infested with newly hatched larvae of *S. litura* (2006)		
	IPM	FP	Check	IPM	FP	Check	IPM	FP	Check
Sep.17-23	2.13	5	5.25	3.71[a]	10.14[b]	12.29[b]	0	0	0
	(1.37)[a]	(2.30)[b]	(2.34)[b]	(1.92)[a]	(3.18)[b]	(3.50)[b]	(0.61)[a]	(0.61)[a]	(0.61)[a]
Sep.24-30	2.75	1.63	21.25	5.86	4.14	28.00	3.75	8.75	10
	(1.74) [a]	(1.33) [a]	(4.60) [b]	(2.42)[a]	(2.03)[a]	(5.29)[b]	(1.59)[a]	(2.86)[b]	(3.00)[b]
Oct. 1-7	3.38	1.5	31.88	5.43	3.86	38.14	2.5	1.25	21.25
	(1.86)[a]	(1.27)[a]	(5.60)[b]	(2.33)[a]	(1.96)[a]	(6.17)[b]	(1.26)[a]	(0.94)[a]	(4.56)[b]
Oct 8-14	3.13	1.38	37.5	5.00	4.43	42.43	2.5	1.25	26.25
	(1.84) [a]	(1.22) [a]	(6.10) [b]	(2.24)[a]	(2.10)[a]	(6.49)[b]	(1.26)[a]	(0.94)[a]	(5.06)[b]
Oct 15-21	3.50	1.25	36.13	3.43	4.43	43.14	2.5	1.25	11.25
	(1.96) [a]	(1.21) [b]	(5.97)[c]	(1.85)[a]	(2.10)[a]	(6.56)[b]	(1.26)[a]	(0.94)[a]	(3.02)[b]
Oct 22-28	3.00	1.5	7.75	3.14	5.43	7.71[a]	2.5	1.25	1.25
	(1.81)[a]	(1.23)[a]	(2.80)[b]	(1.77)[a]	(2.33)[b]	(2.77)[a]	(1.26)[a]	(0.94)[a]	(0.94)[a]
Oct 29-Nov.04	0.50	0.63	2.25	0.57[a]	0.57[a]	2.29[a]	11.25	5	2.5
	(0.87)[a]	(0.94)[a]	(1.49)[b]	(0.75)[a]	(0.75)[a]	(1.51)[a]	(3.02)[b]	(1.92)[a]	(1.26)[a]
Mean	2.61	1.13	20.81	3.87	4.71	24.86	2.14	2.14	10.89
	(1.64)[a]	(1.36)[a]	(5.78)[b]	(1.97)[a]	(2.17)[a]	(4.98)[b]	(1.21)[a]	(1.21)[a]	(2.77)[b]

(Peronospora parasitica) infested the crop but *B. hilaris* and *S.litura,* among the insects tend to be potential threat to cauliflower cultivation in nursery stage as well after transplantation. The data on number of painted bugs/5 plant is presented in Table 1. Infestation due to painted bug started from third week of September and continued till last week of October in both the years (2006 and 2007). The data on painted bug population was significantly low from the week when the appearance of the pest was recorded in IPM practice in spite of no insecticide treatment than the corresponding data in farmer's practice and unprotected treatment during both the years. It showed that Chinese cabbage transplanted as a trap crop was preferred over cauliflower resulting lower population of *B. hilaris* in IPM plots. Subsequently in the fourth week of the September, the crop in IPM plots was sprayed with neem oil @ 10 ml/l of water, mixed with sticker chemical only and crop in farmers practice plots was protected with synthetic pesticides. In spite of no spray with synthetic insecticides in IPM plots, counts of painted bugs/5 plants till the natural decline of the population in the last week of October remained significantly low as compared to the counts/ 5 plants in unprotected plots and at par with farmers practice establishing the utility of Chinese cabbage as trap crop and effectiveness of neem oil in reducing the bug population (Table 1). It also facilitated in cutting down the number of spray by 50 % and in preferring the choice of neem oil over synthetic insecticides. Damage due to S. *litura* began from fourth week of September. Chinese cabbage transplanted as a trap crop attracted the pests and resulted lower per cent plant incidence (3.75) due to newly hatched larvae of S. *litura* on cauliflower crop in IPM plots which was considerably lower than the corresponding data in farmer's practice (8.75 %) and check plots (10.0%) recorded on the main crop in the fourth week of September (Table 1). Crop was sprayed with spinosad in the first week of October when the number of male moth catches count was 8-10 moths/trap/ night and per cent plant infested due to *S.litura* was around 10%. Crop was again sprayed with SI NPV in the third week of October when again damage due to the pest was recorded. Another application of Novaluron 10EC @100 ml /acre was given in the first week of November when population of *S.litura* again started building up. In farmers practice plots, seed treatment with carbendazim and ten sprays of synthetic insecticides namely two each of endosulfan, cypermethrin, profenophos, chlorpyriphos and one of ridomil/mancozeb were made. Per cent plants infested with newly hatched larvae of S. *litura* varied from 1 to 2.5 in IPM and farmers practice adopted plots but it was 10% in unprotected plots in the last week of September that rose to 26.25% in mid October and declined in first week of November in check plots. Damage due to both the pest was low in IPM and FP as compared to untreated plots (Table 1). Among the diseases, damping off in the nursery and alternaria leaf spot and downy mildew in the main crop after transplanting was recorded but their damage was too low to be reported.

Thus data on mean incidence of major pests was similar in both IPM and farmers practice (Table 1), but in IPM module number of application were reduced by 50% establishing the usefulness and efficacy of IPM module over farmer's practice of pest management. Major role was played by Chinese cabbage which was more preferred by pests and replacement of ineffective pesticides with more effective reduced risk pesticides such as spinosad/SI NPV and

novaluron provided sustainable reduction in pest density. Curd yield recorded was 35 q/ha, 31 q/ha and 15 q/ha in IPM, farmers practice and check plots, respectively. Cost benefit ratio was higher in IPM plots (1:2.82) as compared to FP (1:2.38).

Large scale validation of IPM technology

Socio-economic information

IPM technology developed at ARS, Durgapura was validated from 2008 to 2009 on large scale at farmer's field in village Anantpura, district Jaipur (Rajasthan). It was selected for validation of IPM module for cauliflower on the basis of socio-economic survey. In this village, cauliflower is cultivated throughout the year in more than 50 hectare area around the year. Growers had no knowledge about the IPM concept and for protection against pests; farmers sought advice from local pesticide vendors. As regard frequency of plant protection sprays in cauliflower, it varies with season. Farmers make 10-13 sprays for early maturity group. Insecticides sprayed were mostly belong to chlorinated hydrocarbon (endosulfan), synthetic pyrethroids (cypermethrin, fenvalerate, permethrin, alphamethrin), organophosphate (methomyl, chlorpyriphos, lannate, triazophos, methyl parathion, quinalphos, methyl demeton and dimethoate). Among fungicides, mainly carbendazim and mancozeb were applied. While using pesticides, grower's had adopted zero tolerance concepts towards the damage due to pests to maintain quality of the vegetables. Major insect pest problems that warranted management interventions were painted bug, damping off in nursery and alternaria leaf spot, and tobacco caterpillar after transplanting. Farmers field schools were arranged from time to time and IPM assistants were trained to educate the farmers on various components of IPM technology.

Pest incidence

Observations on pest incidence are presented in Table 2. Incidence of damping off in the nursery with IPM practices varied between 2.4% to 3.6 % with a mean value of 3.0% and that of *Alternaria* leaf spot varied from 3.7% to 4.6% with a mean value of 4.2% in IPM main fields. In nursery with farmers conventional practices 5.5 to 10.2% damping off incidence with a mean value of 7.9% was observed, whereas 9.5 to 13.8% incidence of *Alternaria* leaf spot diseases with a mean value of 11.7% was recorded in main plots with farmers' practice. Counts on number of painted bug/10 plants varied from 0.8 to 2.0 with a mean value of 1.4 that were lower than the corresponding figures in farmers' practice. Mean per cent plants infested by the neonate larvae of *S. litura* was 5.7% in IPM fields and 12.5% in the FP fields. Thus the data on pest incidence was lower in IPM fields as compared to farmers' practice. Other workers have also reported these pests to cause serious damage to curd yield (Singh *et al*. 2002, Kohl *et al.* 2010). Farmers exclusively use pesticides for management of the above pests (Weinberger and Srinivasan 2009). However at research farms efficacy of biocontrol agents such as of soil and seedling treatment with *T. harzianum* has been well documented against damping off pathogens like *Pythium* sp (Bhagat and Pan 2008). Moreover, Singh *et al.* (2002) reported that these pest can also be managed through integration of the seed treatment with carbendazim @ 2 g/kg seed, raising seedling in solarized beds, crop raising in green manure field+neem cake 25 kg/ha with soil treatment by *T. viride* @ *2* kg/ha before sowing. Earlier studies by Atwa *et al.* 2009, Dabbas *et al.* (2009), Mandal *et al.* (2009), Muthukumar *et al.* (2007), Pramanik and Chatterjee (2004), Hussain *et al.* (2003) and Mohapatra *et al.* (1995) have proven the effectiveness of these IPM components against several pests under limited scale field and laboratory conditions. However

Table 2 Mean incidence of different pests, yield and its economics of cauliflower grown in rainy seasons at Anantpura, Jaipur) (2008 and 2009)

Parameter	2008[1]		2009[2]		Mean	
	IPM	FP	IPM	FP	IPM	FP
Total cost of production (₹/ha) (all inputs)	42 789	47 760	44 892	51 895	43 841	49 828
Mean yield (q/ha)	76	60	86	77	81	69
Total returns (₹/ha)	210 900	166 500	180 600	161 700	189 378	165 784
Net returns (₹/ha)	168 111	118 740	135 708	109 805	145 537	118 394
Cost benefit ratio	1:4.9	1:3.5	1:4.02	1:3.11	1:4.32	1:3.32
Number of sprays of pesticide	4.5	11	4.6	9.9	4.5	10.5
Per cent plant infested by *S.litura*	5.3	11.1	6.0	13.8	5.7	12.5
Number of painted bug/10 plants	0.8	2.12	2.0	5.8	1.4	4.0
Damping off incidence (%)	3.6	10.2	2.4	5.5	3.0	7.9
Alternaria leaf spot incidence (%)	4.6	9.5	3.7	13.8	4.2	11.7

Rates of cauliflower: ₹ 2775/q[1] ₹ 2100/q[2]. Total cost included: Labour cost for nursery sowing, transplanting, fertilizer application, hand weeding, pesticide application, material cost like seed, pesticides, biocontrol agents, fertilizers, water etc.

the results of the present studies have established these IPM components when applied together were effective against the pests and also provided their satisfactory management at farmers' fields.

Curd yield and economic analysis

Mean curd yield of cauliflower during the season was higher in IPM fields as compared to farmers practice by 14.81% (Table 2). The yield data were subjected to economic analysis. Mean net returns for cauliflower in rainy season were ₹ 135 708/ha to 168 111/ha in IPM fields and from ₹ 109 805/ha to ₹ 118 740/ha in farmers practice. The economic analysis also demonstrated that the validated IPM technology yielded higher by 12 q/ha and fetched higher cost benefit ratio over FP. Implementation of IPM programme also resulted in reduction in number of sprays by 50-60% as well as replacement of highly toxic pesticides with biopesticides like *Trichoderma,* neem based formulations and SI NPV more safer insecticides like spinosad, emamectin benzoate, and insect growth regulator such as novaluron causing less hazards to environment and safer to natural enemies. As a result there was reinforcement of natural enemies resulting sustainable and stable pest control warranting less pesticide application. Farmers were educated about the proper time of application, proper doses and about the right choice of pesticides. Farmers came to know about the biopesticides and differentiate between less harmful and more harmful pesticides. Farmers could know about the pest monitoring and application of pesticides based on action threshold. Farmers were able to identify the various stages of the pest and damage caused by them and could differentiate between the symptom of damage due to insects and diseases, thereby helping to make right choice of the pesticides. The empowerment with knowledge of the producer and consumer would further propel the adoption of the IPM modules. An increase in public awareness would also fetch a premium price for the farmers following integrated pest management strategies.

REFERENCES

Abrol D P and Gupta, Anil. 2010. Insect pests attacking cauliflower *(Brassica oleracea* var. *botrytis* L): Population dynamics in relation to weather factors. *Green Farming* **1**(2): 167–70.

Atwa A A, El-Sabah A F B and Gihad M M. 2009. The effect of different biopesticides on the cabbage white butterfly, *Pieris_rapae* (L.) in cauliflower fields. *Journal of Agricultural Research* **54**(1): 147–53.

Bhagat S and Pan S. 2008. Biological management of root and collar rot of cauliflower *(Rhizoctonia solani)* by a talc-based formulation of *Trichoderma harzianum*_Rifai. *Journal of Biological Control* **22**(2): 483–6.

Dabbas M R, Singh D P and Yadav J R. 2009. Management of *Rhizoctonia* root rot of cauliflower through IDM practices. *International Journal of Plant Protection* **2**(1): 128–30.

Hussain M A, Pachori R and Choudhary B S. 2003. Management of *Spodoptera litura* (Fab.) on cabbage with special reference to microbial pesticides. *Research on Crops* **4**(2): 263–7.

Kohl J, van Tongeren C A M, Groenenboom-de Haas B H, van Hoof R A, Driessen R and van der Heijden L. 2010. Epidemiology of dark leaf spot caused by *Alternaria brassicicola* and A. *brassicae* in organic seed production of cauliflower. *Plant Pathology* **59**(2): 358–67.

Mandal K, Gagan J and Singh B. 2009. Dissipation kinetics of spinosad on cauliflower *(Brassica oleracea* var. *botrytis* L.) under subtropical conditions of Punjab, India. *Bulletin of Environmental Contamination and Toxicology* **83**(6): 808–11.

Mohapatra S, Sawarkar S, Patnaik H P and Senapati B. 1995. Antifeedant activity of solvent extracts of neem seed kernel against *Spodopterajitura* F. and their persistency against sunlight through encapsulation. *International Journal of Pest Management* **41**(3): 154–6.

Muthukumar M, Sharma R K and Sinha S R. 2007. Field efficacy of biopesticides and new insecticides against major insect pests and their effect on natural enemies in cauliflower. *Pesticide Research Journal* **19**(2): 190–6.

Pramanik P and Chatterjee M L. 2004. Effects of novaluron on the population of *Plutella xylostella* and *Spodoptera_litura* on cabbage. *Annals of Plant Protection Sciences* **12**(1): 204–5.

Sharma, Pratibha, Sharma S R, Sain S K and Dhandapani A. 2006. Integrated management of major diseases of cauliflower *(Brassica oleracea* var. *botrytis* subvar. *Cauliflora*). *Indian Journal of Agricultural Sciences* **76**(12): 726–31.

Singh H M, Ali S, Chakraborti D K, Singh V K, Rajput S K S and Srivastava D K. 2002. Integrated pest management in early cauliflower. *Annals of Plant Protection Sciences* **10**(2): 192–3.

Shukla, Abhishek and Kumar, Ashok. 2005. The diamondback moth, *Plutella xylostella:* a problematic pest of *Brassica crop. Advances in Indian Entomology:* **3**(1): 229–40.

Weinberger K and Srinivasan R. 2009. Farmers' management of cabbage and cauliflower pests in India and their approaches to crop protection. *Journal of Asia Pacific Entomology* **12**(4): 253–9.