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Research Paper

Environment

Formulation and validation of integrated pest management (IPM) modules for better economic return of cabbage crops in kullu valley, Himachal Pradesh

Sarla Shashni

Scientist C G. B. Pant Institute of Himalayan Environment and Development, Himachal Unit, Mohal-Kullu, Distt Kullu, Himachal Pradesh

ABSTRACT *Integrated Pest Management (IPM) modules of different chemical, bio pesticides and insecticides were formulated to check its effects on the insect, pest, disease incidence and yield attributes of cabbage crop in Kullu valley, Himachal Pradesh. The study was carried out in field condition of rabi season, 2011 with five modules viz. M1, M2, M3, M4 and M5 (control). Yield in q/ha, net additional return and net return per rupee invested was analyzed statically using appropriate transformation. Result shows that the implementation of IPM modules reduces the number of insecticide/pesticide application with good economic return to the farmers with added advantage to environment and human health.*

KEYWORDS : IPM, modules, insecticide and bio-pesticides

Introduction:

Agriculture is the corner stone of hill economy as it forms the major sector of livelihood and employment to the large chunk of population. However, the increasing population pressure and heavy dependence on agriculture sector are some of the major concerns in hill agriculture system. Cabbage (*Brassica oleracea*) is one of the important vegetable crops in Kullu valley of Himachal Pradesh. These vegetable crops are attacked in every season by number of fungal disease, bacteria, virus, insects and pests causing high damage to the produce (Ram, 2012). In cabbage crop catterpiller (*Spodopetera*) has been the most difficult insect to control with head borer, atlternaria leaf spot and damping off (Monobrullah et al., 2007; Kohl et al., 2010). Due to this, farmer in region applying 7-8 sprays, more than the permissible limit, which is also reported by Weinberger and Srinivas, 2009. Due to excess use of pesticides, level of toxicity in the vegetables are increases, which through food chain causing health problems (Cesnik et al., 2009; Islam et al., 2009). One-side farmers are trying to save their crops from pest by applying pesticides more than permissible limits to avoid economic loss, on the other side public are getting aware and concern about the adverse effects of chemical pesticides on the human health, environment and biodiversity (Ram, 2012). These issues need to be address by proper management system to minimize the economic loss to the farmer keeping health issues at highest concern.

In the current study, Integrated Pest Management (IPM) modules of bio pesticides and inorganic insecticides/pesticides were formulated to check the effect on the incidences of insect/pest and also its yield attributes of cabbage crop in the Kullu valley of Himachal Pradesh.

Material and Methodology:

Present study was conducted in the field condition during the Rabi season of 2011. The study was conducted in the different locations at farmer's field to check the effect of IPM modules on the insect pests and yield in cabbage crop. For this study, 2 farmers were selected for the trial of cabbage. Plot size was restricted to 3.15 x 2.70 m for each trials and the spacing during transplantation was taken 45 x 30 for cabbage (cv varun).

Nursery and Seed treatment:

Nursery treatment was done with formaldehyde @ 1:7 and covered with polyethylene sheet for 10 days for proper fumigation. After 10 days of removing polythene, sowing was done. Seed treatment in hot water at 52°C for 30 minutes followed by treatment with streptocycline @ 200 mg / litre of water for 30 minutes was given before sowing to the nursery bed.

Nursery management:

To control the disease incidence during nursery raising following treatments were given:

- Dipping seedlings in a mixture of Streptocycline (0.2 g) + Carbendazim (1g) per litre of water for 30 min before transplanting;
- Drenched nursery beds with Companion @ 0.25% after 7 days and 14 days of seedling/ plant emergence with the appearance of damping off;
- Sprayed with Ridomil M Z @ 0.25% after 25 days of plant emergence for the control of downy mildew.

Modules:

M1

- Lambda-cyhalothrin @ 0.004% (Bravo 5%) after 45 days of transplanting;
- Mixture of Lambda-cyhalothrin @ 0.004% (Bravo 5%) and Difenconazol @ 0.02% (Score 25 EC) after 15 days of 1st spray;

M2

- Azadirachtin @ 5ml/L (Neembaan 0.15%) after 45 days of transplanting;
- Mixture of Azedarachtin @ (Neembaan 0.15%) and Difenconazol @ 0.02% (Score 25 EC) after 15 days of 1st spray;
- Mechanical destruction of infested leaves for egg clusters/ young larvae of cabbage butterfly at frequent intervals;

M3

- Lambda-cyhalothrin @ 0.004% (Bravo 5%) after 45 days of transplanting;
- Mixture of Malathion (0.05%) and Dithane Z 78 @ 0.25% (Dithane 75 WP) after 15 days of 1st spray;

M4

- Azadirachtin @ 5ml/L (Neembaan 0.15%) after 45 days of transplanting;
- Mixture of Btk (15g/10 L) and Dithane Z- 78 @ 0.25% (Dithane 75 WP) after 15 days of 1st spray;
- Mechanical destruction of infested leaves for egg clusters/ young larvae of cabbage butterfly at frequent intervals;

M5. Control.

Integrated Pest Management Method:

Experiments on the formulation and validation of integrated pest management for cabbage were carried out at different sites of farmer's field in Kullu. Two sprays of each pest management modules were spread on all the sites. Among the insects, larvae of *Pieris brassicae*, *Spodoptera* larvae, larvae of diamond back moth, cabbage semi-looper and fruit borer on cabbage and cauliflower are some of the major pests in farmers' fields. Data on the incidence of lepidopterous larvae, black rot and Alternaria blight were recorded on 10 plants per plot. Pre-treatment data on the incidence of lepidopterous larvae, Black rot and *Alternaria* blight was recorded 1- day before and post- treatment data after 7 –days and 14 -days of each spray were recorded. Data were recorded on the plant stand (%), plants (%) that formed heads/curds, plants (%) that did not form the heads/ curds, marketable heads/ curds and unmarketable heads/ curds due to insect/ disease attack. Yield was recorded plot wise and converted to q/ha.

Economics of crop yield:
Economics of different pest management modules was calculated on the basis of market price of cabbage (Rs. 500/q) and cauliflower (Rs. 1,000/ha); insecticides /fungicides viz: Lambda-cyhalothrin (Bravo 5%) @ Rs. 520/L, azadirechtin (Neembaan 0.15%) @ Rs. 320/L, difenconazol (Score 25 EC) @ Rs. 3,000/L, malathion (Malathion 50 EC) @ Rs. 320/L, streptocycline @ Rs. 5,500/Kg, Companion (Carbedazim 12% + Mancozeb 63%) @ Rs. 560/Kg, *Bacillus thuringiensis var kurstaki* (Lipel SP) @ Rs. 1,500/Kg, Dithane Z- 78 @ Rs 320/Kg , Ridomil MZ @ 1,300/kg, and labour charges for pesticide application (Rs. 1,200/ha @ Rs. 120/day: total 10 man days/ha). Net additional return (Rs/ha) of each module was calculated by subtracting the total cost (Rs/ha) of pesticide application from net return (Rs/ha) in the pesticidal treatments over the control. Net returns per rupee invested was calculated by dividing the net additional return (Rs/ha) with the cost of pesticide application. Data were analyzed statistically after appropriate transformation using significant difference at 5% probability using CPCS-1 data analysis package.

Results:
Data presented in Table 1, 3 and 5 showed that module M3 has been found to be the most effective in protecting the cabbage crop from insects and diseases with 86.45% marketable head (Table 5) and economical (Rs. 73,368/- average net additional returns and Rs. 20.65 net returns per rupee invested). It was followed by module M1 with 82.61% marketable heads Table 7 (Rs. 70,971/- average net additional returns and Rs. 19.60 net returns per rupee invested). Table 5 shows that the incidence of lepidopterous larvae in M3 were also decreased to 0% after 2 sprays and alterneria blight to 5.62% and black rot incidence to 11.39% respectively before the 2nd spray which further restrict the application of pesticides 3rd time.

Comparatively modules M1 and M3 were found most effective in comparison to the M2 and M4 Neem based formulation (azadirechtin) was also found effective in controlling insect and diseases in good extent which was also reported by Mohapatra *et al.,* 1995 but the chemical based modules M1 and M3 was found bit superior.

Conclusion:
Implementation of the IPM module showed reduction in the number of sprays in the cabbage crop by 50-60%. Increased net returns per rupee invested also validate the good economic return to respective farmers. As a result there can be a reinforcement of sustainable and stable pest control warranting less pesticide application with good economic gain. Farmers were also educated about the proper timing of application, proper doses and about the right choice of pesticides with good profit. Validation of these IPM modules will also increase the awareness among consumers and the high price of insecticides to the farmers while lowering the inputs. Further research and development of biological pest control method must be given priority and the entire agriculturist must be educated about the use of such control measures.

Table 1: Effect of different pest management Modules on the Yield attributes, Yield and Economics of cabbage in Haat village (Site I)

Modules	Plant Stand (%)	Head Formation (%)	Plant (%) that did not formed the heads	Marketable Heads (%)	Unmarketable Heads (%) Due to		Average Marketable Yield (q/ha)	Net Additional Return (Rs/ha)	Net Return per Rs. invested
					Insect attack	Disease Incidence			
M1	98.94 (10.00)	96.80 (9.89)	3.20 (2.02)	90.05 (9.54)	6.63 (2.75)	3.32 (2.05)	460.58	81324.33	19.60
M2	98.41 (9.97)	97.84 (9.94)	2.14 (1.76)	84.28 (9.23)	9.32 (3.20)	5.50 (2.54)	423.67	61093.33	10.31
M3	99.47 (10.02)	98.94 (10.00)	1.06 (1.40)	92.47 (9.67)	4.30 (2.28)	3.22 (2.03)	443.27	73263.00	20.63
M4	96.30 (9.86)	98.35 (9.97)	1.65 (1.63)	88.26 (9.45)	8.39 (3.34)	3.35 (2.08)	403.10	51686.00	10.25
M5	97.88 (9.94)	97.82 (9.94)	2.17 (1.77)	77.37 (8.85)	17.11 (4.25)	5.51 (2.54)	289.64	0.00	0.00
CD (5%)	NS	NS	NS	(0.36)	(0.79)	NS	43.71		

Figures with in the parentheses are: √n+1 transformation

Table 2: Incidence of lepidopterous larvae and diseases on cabbage in Haat village (Site I)

Modules	Pre- Treatment larval incidence		Post-Treatment larval incidence after						Disease incidence after 14 days of 1st spray	
		7 -days of 1st spray		14- days of 1st spray		7 -days of 2nd spray				
	No. of larvae/ 10 plants)*	Plant infestation** (%)	No. of larvae/ 10 plants)*	Plant infestation** (%)	No. of larvae/ 10 plants)*	Plant infestation** (%)	No. of larvae/ 10 plants*	Plant infestation** (%)	Alternaria blight* severity (%)	Black Rot* incidence (%)
M1	56.00 (7.47)	43.33 (41.14)	0.66 (1.24)	3.33 (6.14)	28.33 (5.41)	30.00 (33.20)	0.00 (1.0)	0.00 (0.00)	4.35 (11.84)	5.34 (13.14)
M2	62.33 (7.95)	40.00 (39.13)	4.00 (2.09)	6.66 (12.29)	29.00 (5.47)	26.67 (30.98)	2.00 (1.55)	3.33 (6.14)	7.02 (15.00)	8.19 (16.42)
M3	55.67 (7.49)	46.67 (43.06)	0.00 (1.00)	0.00 (0.00)	23.00 (4.94)	26.67 (30.98)	0.00 (1.00)	0.00 (0.00)	5.43 (13.32)	9.27 (17.15)
M4	63.00 (7.96)	50.00 (44.98)	1.66 (1.58)	6.67 (12.29)	36.67 (6.10)	36.67 (37.21)	0.00 (1.00)	0.00 (0.00)	9.74 (17.88)	12.04 (20.28)
M5	65.00 (8.09)	50.00 (44.98)	39.67 (6.36)	30.00 (33.20)	54.33 (7.43)	50.00 (44.98)	27.33 (5.29)	26.67 (30.98)	25.12 (30.05)	24.64 (29.54)
CD (5%)	NS	NS	1.22	16.76	1.30	7.70	0.88	9.14	5.09	8.11

Figures within the parentheses are: * √n+1 transformation and ** arc sine transformation.

Table 3: Effect of different pest management Modules on the Yield attributes, Yield and Economics of cabbage in Jhiri village (Site II)

Modules	Plant Stand (%)	Head Formation (%)	Plant (%) that did not formed the heads	Marketable Heads (%)	Unmarketable Heads (%) Due to		Average Marketable Yield (q/ha)	Net Additional Return (Rs/ha)	Net Return per Rs. invested
					Insect attack	Disease Incidence			
M1	96.30 (9.86)	93.98 (9.75)	6.02 (2.62)	84.22 (9.23)	8.22 (3.03)	6.59 (2.75)	421.12	60617.67	14.61
M2	98.41 (9.97)	94.68 (9.78)	5.31 (2.44)	76.13 (8.78)	15.34 (4.04)	8.52 (3.07)	388.20	42381.67	7.15
M3	99.47 (10.02)	96.81 (9.89)	3.19 (2.02)	85.14 (9.28)	9.78 (3.27)	4.87 (2.41)	445.62	73463.00	20.68
M4	96.83 (9.89)	96.71 (9.88)	3.29 (2.04)	77.92 (8.88)	14.12 (3.87)	7.95 (2.97)	404.66	51492.67	10.21
M5	94.71 (9.78)	92.27 (9.65)	7.72 (2.90)	61.57 (7.88)	23.21 (4.80)	14.22 (3.75)	291.59	-	-
CD (5%)	(0.14)	NS	NS	(0.77)	(0.66)	(0.78)	37.35		

Figures with in the parentheses are: √n+1 transformation

Table 4: Incidence of lepidopterous larvae and diseases *on* cabbage in Jhiri village (Site II)

Modules	Pre-Treatment incidence		Post- Treatment larval incidence after						Disease incidence after 14 days of 1st spray	
		7 -days of 1st spray		14 -days of 1st spray		7 -days of 2nd spray				
	No. of larvae/ 10 plants)*	Plant infestation** (%)	No. of larvae/ 10 plants)*	Plant infestation** (%)	No. of larvae/ 10 plants)*	Plant infestation** (%)	No. of larvae/ 10 plants*	Plant infestation** (%)	Alternaria blight* severity (%)	Black Rot* incidence (%)
M1	47.66 (6.62)	46.67 (43.06)	2.00 (1.55)	3.33 (6.14)	26.67 (5.24)	26.67 (30.98)	3.00 (1.85)	10.00 (14.99)	10.05 (17.81)	12.59 (20.75)
M2	49.33 (6.87)	40.00 (39.04)	0.00 (1.00)	0.00 (0.00)	24.33 (4.98)	23.33 (28.78)	4.00 (2.08)	10.00 (14.99)	7.40 (15.76)	12.70 (20.49)
M3	36.33 (6.07)	36.67 (37.21)	0.00 (1.00)	0.00 (0.00)	26.00 (5.17)	26.67 (30.98)	0.00 (1.00)	0.00 (0.00)	5.81 (13.60)	13.52 (21.51)
M4	51.67 (7.03)	43.33 (41.05)	3.33 (1.94)	6.67 (12.85)	32.00 (5.74)	30.00 (32.06)	0.00 (1.00)	0.00 (0.00)	11.60 (19.35)	9.10 (17.25)
M5	48.67 (7.01)	50.00 (44.98)	33.67 (5.83)	33.33 (34.91)	47.33 (6.90)	46.67 (43.06)	44.33 (6.70)	40.00 (39.13)	24.46 (29.50)	26.71 (31.03)
CD (5%)	NS	NS	(1.40)	(16.90)	NS	NS	(1.26)	(16.77)	(9.38)	(7.17)

Figures with in the parentheses are: * √n+1 transformation and ** arc sine transformation.

Table 5: Average net additional return, net gain per rupee invested, incidence of insects and disease, and marketable and unmarketable heads in different IPM modules

Module	Net additional return (Rs/ha)	Net gain (Rs)/rupee invested	Average incidence (%) of Lepidopterous larvae		Average disease incidence (%) after 14 days of 1st spray		Average Marketable Head (%)	Average unmarketable head (%)	
			Pre treatment	Post treatment after 7 days of 2nd spray	Alterneria blight	Black rot		Insect attack	Disease incidence
M1	70,971	17.11	45.00	15.00	7.20	8.96	82.61	11.59	5.86
M2	51,737	8.73	40.00	6.16	7.20	10.45	80.68	14.39	4.93
M3	73,363	20.65	41.67	0.00	5.62	11.39	86.45	7.40	6.15
M4	51,589	10.23	46.65	0.00	10.67	10.57	84.03	10.53	4.64
M5	-	-	50	33.33	24.79	26.67	69.35	20.69	9.64

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