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Intensive Management of Red Pumpkin Beetle (*Aulacophora foveicollis* Lucas) in Different Ecological Regions

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Abstract.- Heavy infestation caused by red pumpkin beetle starting from the emergence of cucurbit crops to harvesting mainly cause yield reduction. Sever infestation may cause failure of crop emergence. Experiment was designed to have an appropriate control strategy by the integration of different control measures. Treatment included Carbaryl as dust application, Neem Seed Kernel Extract (NSKE) as botanical, Yellow Sticky Traps (YST) as mechanical control. Sheikhupura (SHK) landrace of Indian snap melon was used as host. Experiment was laid out according to RCBD. This landraces was grown in Faisalabad, Sargodha and Multan districts and similar control techniques were applied in each district. Application Carbaryl + NSKE + YST in single plot was most acceptable control module which show minimum population in Faisalabad (2.46), Sargodha (2.49) and Multan (2.49) district and also minimum infestation was recorded in the same treatment in Faisalabad (8.57), Sargodha (8.57) and Multan (8.36) district. Temperature variations were non-significant among three districts, so the population was not affected by the temperature across the different ecological regions.

Keywords: Neem as spray, Mechanical control of red pumpkin beetle, chemical control of red pumpkin beetle., IPM of red pumpkin beetle.

INTRODUCTION

Pumpkin beetle can be said as one of the serious pests of Cucurbitaceae family because it attacks at every stage of the cucurbits and heavy losses can be done by it to all cucurbits except bitter gourd (Saleem and Shah, 2010) damage to fruits also reported in many crop species (Melamed-Madjae, 1960). There are many factors like, physical and chemical factors of plant resistance (Raman and Annadurai, 1985) which effects its population. Increase in the concentration of these plant factors affect directly or indirectly to the red pumpkin beetle population and infestation (Annadurai, 1987; Mehta and Sandhu, 1992). Beside humidity effects to its growth (Rajak, 2000), the survival at low temperature (Alikhan and Yousuf, 1985) and endemic host range make it calamity for cucurbit crops (Al-ali *et al.*, 1982; Pal *et al.*, 1978). Red pumpkin beetle is also resistant some of the plant extracts which are used for its management (Pande *et al.*, 1987).

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Red pumpkin beetle attack almost on every stage of the plants. If beetle attacks at seedling stage then crop needs to be recultivate. It feeds underside the cotyledonous leaves by biting holes into them (Chandravadana and Pal, 1983). Percent damage ranges from 70-15%, which gradually decreases to lower value as leaf canopy increases (Saljoqi and Khan, 2007; Yamaguchi, 1983). Management of this pest can be done using different chemical, botanical, mechanical control measure or the integration of these control measures (Mehta and Sandhu, 1990; Xue *et al*., 2006; Sami and Shakoori, 2008). Present experiment was designed to control menace of cucurbits in an integrated way that is economical and health friendly by the involvement of botanical spray and mechanical traps.

MATERIALS AND METHODS

Chemical control (carbaryl), botanical control (Neem [neem seed kernels extract]) and mechanical control (yellow sticky traps) with all possible combination were used for the management of red pumpkin beetle. Sowing of susceptible landrace of Sheikhupura (SHK) of Indian snap melon was done on March 9, 2012 in three ecological regions. Size of each plot was 6m X 3m and sown using RCBD. Data regarding population per plant and % leaf

infestation per plant was recorded on every 5th days beginning 15 days after sowing. Population of red pumpkin beetle was counted on each plant and similarly % leaf infestation was calculated on each plant. Then mean was calculated. Application of these treatments were done on every 15th day beginning 15 days after sowing and continued till the harvesting of the crop. Data were collected after every 5th day beginning 15 days after sowing. Multiple applications and multiple sampling events were done. Data was analyzed using Statistica 8.0. Means were compared using DMR at $P \leq 0.05$. Treatment combinations and applications are shown in Table I.

Table I.- Treatments and their possible combinations.

Treatments combination	Combinations detail	Treatment application interval
T1	Carbaryl as dust application	After 5 days interval
T2	Neem Seed Kernel Extract (NSKE) as spray	Do
T3	Yellow Sticky Traps (YST) as mechanical control	Renewed after 15 days
T4	Carbaryl as dust + NSKE as spray	As mentioned above
T5	Carbaryl as dust + YST as mechanical control	Do
T6	NSKE spray+ YST as mechanical control	Do
T7	Carbaryl as dust + NSKE as spray + YST as mechanical control	Do
	Check	

Treatments preparation

Seed kernels of neem were used. These plant material were air dried, grounded into power form using an electric grinder (Westpoint blender, model WF-7381). Then the powder (100g) of these plant materials were taken in conical flask, Acetone was used as solvent into the flask. These flask were placed on rotary shaker and were shacked continuously for 48 hrs at 1200 rpm. After that filtration was carried out, the filtrate was further placed on rotary shaker to evaporate the solvent. The final obtained extract of the plant material was mixed up with water to prepare 5% solution, that was sprayed on the crop (Omotoso and Oso, 2005; Prabhu *et al.,* 2011). Carbaryl (30%) was available in the market and applied as dust @ 3% of active material. Then applied by broadcast method on the crop.

Cost benefit ratio

Cost benefit ratio (CBR) was calculated for each treatment/plot basis in order to determine the most economical and effective control methods for recommendation to the growers. Cost and benefit both were calculated in rupees (PKR) on per plot basis (6m X 3m). Fruit produced from each plot calculated in kilograms then multiplied with the price of sold fruit/kg. Return per area and % return per treatment was calculated for each treatment. Cost benefit ratio was calculated as;

$$CBR = \frac{\text{Net income}}{\text{Total expenditures of the treatment}}$$

RESULTS

Variation in ecological regions was present for each treatment both for % leaf infestation per plant and population of the beetle per plant. Axiomatically, treatment 7 was the most appropriate for red pumpkin beetle management. Effect of each treatment in each district was measured in percentage reduction of population and infestation due to that specific control measure.

Each control measure for the control of red pumpkin beetle was applied separately and in combination with other to estimate the effect of treatments on population and infestation of the beetle. Similarly the effect these treatments was calculated in term of population and infestation reduction percentage by these control measures. Although significant differences were recorded between the treatments and treatment combinations when compared to population and infestation recorded in each zone. Axiomatically, treatment 7 (Carbaryl + NSKE + YST) was the most appropriate for red pumpkin beetle management. Population and infestation trend of the beetle in different districts can be collectively explained as control > yellow stick traps > neem seed kernel extract > neem seed

kernel extract + yellow sticky traps > carbaryl > carbaryl + yellow sticky traps > carbaryl + neem seed kernel extract > carbaryl + neem seed kernel extract + yellow sticky traps.

Population reduction after different treatments

Different treatments used for control of red pumpkin beetle responded varyingly in population and infestation reduction comparison. Maximum population (6.29) per plant was recorded in Multan district in control plot and minimum population (2.46) per plant was recorded in the same district in T7 treated plots on mean basis. In Sargodha district, maximum population per plant was 6.50 recorded in control plot and minimum population per plant of red pumpkin beetle was recorded 2.46/ plant in T7 treated plots. Minimum population per plant in Faisalabad district was 2.49 in T7 treated plots and maximum population per plant was 6.63 in control plots.

Population reduction of red pumpkin beetle over control treatment due to the application of different treatments was calculated and shown in Table II. Population reduction percentage was calculated maximum in T7 (60.23) in Multan district at par with T4 in the same column. Minimum percentage reduction (23.45) was calculated in plot treated with T3 in Multan district leaving check behind. Maximum population reduction percentage in Sargodha district was calculated in T7 (61.52) and minimum population reduction percentage (23.01) was calculated in plots treated with T3. In Faisalabad district, population reduction was maximum in T7 (62.71) was at par with the population reduction percentage of T4 (62.14) and minimum population reduction percentage of the district was calculated in T3 (22.23).

Leaf infestation reduction after different treatments

Infestation of red pumpkin beetle was tried to reduce with usage of different treatments for control of red pumpkin beetle. Different treatments had different rate % leaf infestation per plant and similarly had different % leaf infestation reduction (%). Maximum % leaf infestation (16.27) was recorded in Multan district in control plot and minimum % leaf infestation/plant (8.36) was recorded in the same district in T7 treated plots on mean basis. In Sargodha district, maximum % leaf infestation/plant was 16.64 recorded in control plots and minimum % leaf infestation/plant of red pumpkin beetle was recorded 8.57 in T7 treated plots. Minimum % leaf infestation in Faisalabad district was 8.57 in T7 treated plots and maximum % leaf infestation/ plant was 16.61 in control plots.

Percent leaf infestation reduction (%) of red pumpkin beetle over control treatment due to the application of different treatments was calculated and shown in Table III. % leaf infestation reduction percentage was maximum in T7 (48.57) of the beetle in Multan. Minimum % leaf infestation reduction percentage (15.56) was calculated in plot treated with T3 in Multan district. Maximum % leaf infestation reduction percentage in Sargodha district was recorded in T7 (48.45) and minimum % leaf infestation reduction percentage (15.49) was calculated in plots treated with T3. In Faisalabad district, % leaf infestation reduction percentage was maximum in T7 (48.38) and minimum % leaf infestation reduction percentage of the district was calculated in T3 (15.77).

Cost benefit ratio after different treatments

Cost benefit ratio of each treatment and their combination was calculated (Table IV). Cost and benefit ratio for treatment was calculated using rupees (PKR) invested/returned from single plot of 6m X 3m size. Maximum benefit ratio was calculated in plot treated using T2 (9.6%) followed profit percentage of T4 (7.46%) and profit wise third ranked treatment was T1 with profit 7.2 percentage. Similarly maximum benefit (Rs. 136) was calculated in plots treated using T7.

DISCUSSION

Different control measures independently and in combination to each other were used for red pumpkin beetle management. Populations observed in each treatment and population reduction in each treatment calculated. Population and infestation trends in districts can explained as control > mechanical > botanical > botanical + mechanical > chemical + mechanical > chemical > chemical + botanical > chemical + botanical + mechanical.

Table II.- Comparison of the mean values of the data regarding population/plant and population reduction (%) of red pumpkin beetle among different treatments in Multan, Sargodha and Faisalabad Districts in 2012.

Treatment No.	Treatment name	Multan		Sargodha		Faisalabad	
		Population /plant	Population reduction (%)	Population /plant	Population reduction (%)	Population /plant	Population reduction (%)
T1	T1	2.78 ± 0.10 d	55.59 ab	2.91 ± 0.07de	55.17 bc	2.74 ± 0.14 e	58.50 a
T2	T2	3.47 ± 0.04 c	44.73 c	3.61 ± 0.03 c	44.38 d	3.77 ± 0.11 c	43.01 c
T3	T3	4.81 ± 0.06 b	23.45 d	5.00 ± 0.07 b	23.01 e	5.15 ± 0.09 b	22.23 d
T4	T1 + T2	2.51 ± 0.10 d	59.88 a	2.53 ± 0.12 e	60.92 ab	2.50 ± 0.13 e	62.14 a
T5	T1 +T3	2.67 ± 0.10 d	57.41 ab	2.80 ± 0.12de	56.74 abc	2.89 ± 0.13de	56.20 ab
T6	T2 + T3	2.93 ± 0.25 d	53.18 b	3.12 ± 0.28 d	51.94 c	3.26 ± 0.29 d	50.66 b
T7	T1 + T2 + T3	2.49 ± 0.12 d	60.23 a	2.49 ± 0.11 e	61.52 a	2.46 ± 0.12 e	62.71 a
T8	Control	6.29 ± 0.16 a		6.50 ± 0.14 a		6.63 ± 0.13 a	

***** values in the same column differ significantly from each other.
**comparison was within the district but displayed as combined table 29a in spite of three separate tables. *** $P \leq 0.05$

Table III.- Comparison of the mean values of the data regarding % infestation /plant and % infestation reduction (%) of red pumpkin beetle among different treatments in Multan, Sargodha and Faisalabad Districts in 2012.

Treatment No.	Treatment name	Multan		Sargodha		Faisalabad	
		% leaf infestation /plant	% leaf infestation reduction (%)	% leaf infestation /plant	% leaf infestation reduction (%)	% leaf infestation /plant	% leaf infestation reduction (%)
T1	T1	9.31 ± 0.33 e	42.79 b	9.48 ± 0.30 e	43.03 b	9.44 ± 0.27 e	43.17 b
T2	T2	10.44 ± 0.09d	35.80 c	10.76 ± 0.15d	35.36 c	10.47 ± 0.05d	36.92 c
T3	T3	13.74 ± 0.46b	15.56 e	14.06 ± 0.53b	15.49 e	13.98 ± 0.54b	15.77 e
T4	T1 + T2	8.93 ± 0.14 ef	45.10 ab	9.32 ± 0.20 e	43.96 b	9.29 ± 0.17 ef	44.07 ab
T5	T1 +T3	8.72 ± 0.10 f	46.39 ab	9.17 ± 0.08 ef	44.88 ab	9.13 ± 0.10 ef	44.99 ab
T6	T2 + T3	11.85 ± 0.39c	27.21 d	12.27 ± 0.47c	26.28 d	12.22 ± 0.48c	26.41 d
T7	T1 + T2 + T3	8.36 ± 0.17 f	48.57 a	8.57 ± 0.20 f	48.45 a	8.57 ± 0.19 f	48.38 a
T8	Control	16.27 ± 0.20a		16.64 ± 0.17a		16.61 ± 0.18a	

***** values in the same column differ significantly from each other.
**comparison was within the district but displayed as combined table 29a in spite of three separate tables.
*** $P \leq 0.05$

Table IV.- Comparison of the cost benefit ratio for the control of red pumpkin beetle of Sheikhupura (SHK) landrace of Indian snap melon of different treatments.

Treatment	Cost (Rs.)	Sheikhupura (SHK) landrace		
		Benefit (Rs.)	Return/area	% return
T1 (Chemical)	10	72	62	7.2
T2 (Botanical)	6	48	42	9.6
T3 (Mechanical)	7	32	25	4.57
T4 (Chemical + Botanical)	16	112	96	7.46
T5 (Chemical + Mechanical)	17	88	71	5.17
T6 (Botanical + Mechanical)	12	56	44	4.66
T7 (Chemical + Botanical + Mechanical)	22	136	114	6.8

Mean population of red pumpkin beetle of Multan district recorded in treatment T7 was 2.49 per plant and percentage population reduction was 60.23. This population mean was followed by T4 having 2.51 number of the beetles per plant and percentage population reduction 59.88. Maximum population and minimum reduction by the treatment was recorded in T3 having 4.81 number of beetles per plant and percentage population reduction 23.45 on Indian snap melon. % leaf infestation percentage was on same trend as population. Minimum % leaf infestation per plant was recorded in T7 8.36 and % leaf infestation reduction percentage was 48.57. Maximum % infestation excluding check plot was in T3 (13.74) and % infestation reduction percentage was 15.56 in the Multan district.

Minimum population of red pumpkin beetle per plant and maximum population reduction was worked out in T7 (2.49) and population reduction percentage was 61.52 in Sargodha district. % leaf infestation per plant of the beetle was 8.57 and % leaf infestation reduction percentage was calculated 48.45. Maximum population per plant of the beetle was recorded 5.00 in plot treated using T3 and minimum population reduction was 23.01 when check was ignored. % leaf infestation per plant was 14.06 record in T3 and % leaf infestation reduction percentage was 15.49.

Minimum population per plant of red pumpkin beetle was calculated in T7 (2.46) while population reduction percentage was 62.71 in Faisalabad district. % leaf infestation per plant was 8.57 in plot treated using T7 and % leaf infestation reduction percentage was 48.38. Maximum population per plant leaving check behind was calculated 5.15 in the plots treated using T3 and population reduction percentage 22.23. % leaf infestation per plant was 13.98 in plots treated using T3 with % leaf infestation reduction percentage was 15.77.

Cost and benefit was calculated in rupees (PKR) for each treatment and combination of treatments for Sheikhupura landrace (SHK). Cost benefit ratio was calculated on per plot basis (6x3m). Maximum cost was involved in the application of T7 because that involved the integration of all control measures. In landrace (SHK) maximum benefit was calculated in plots treated using T7 (136Rs) similarly maximum return per area maximum (114Rs) in the same treatment. Maximum return percentage for susceptible landrace (SHK) was calculated in T2 (9.6) followed by T4 (7.46). Minimum return percentage was calculated in T3 (4.57).

Present studies are not in line but can be compared to the studies of Khan and Jehangir (2000) tested three different concentrations (2.0, 1.0 and 0.5%) of carbaryl for the management of red pumpkin beetle and effect of insecticide was checked after three, five and seven days of application, Lakshmi *et al.* (2005) checked out the effect of carbaryl @ 0.2%, monocrotophos @ 0.54%, chlorpyriphos @ 0.05%, nimbecidine (a neem formulation) @ 0.2%, *Bacillus thuringiensis* @ 0.20%, thiodicarb @ 0.075%, Bt @ 0.1% + thiodicarb @ 0.0375%, nimbecidine + thiodicarb, spinosad at 0.015% for the management of red pumpkin beelte. Carbaryl (46.53% a.i.) was the most effective control measure in reducing the population and infestation of red pumpkin beetle, Khorsheduzzaman *et al*. (2010) checked out the effect of six treatments including, soil application + Furadan 5G @ 5 g/plant @ 3 days before planting, mechanical control + sweeping net @ 3 days interval for 45 days, spraying neem seed oil @l0ml/l+5m1 trix (detergent) at 7 days interval, spraying neem seed kernel extract @ 50g/l of water at 7 days interval, seedling bed covered with mosquito net barrier up to 45 days old seedlings, Nath and Ray (2012) surveyed red pumpkin beetle management practices and reported that cow dung and fly ash as control was used by 77.50% of people followed by red chili powder (50%). The minimum used material was *Kala maati* by 25% by the local growers, Bharathi and John (2013) studied management of red pumpkin beetle using; mixing of carbaryl 10 % WP in pits before sowing, spraying of carbaryl (sevin 50 WP [2 g/L]), dusting of ash mixed with kerosine oil and application of *Parthenium hysterophorus* plant extract, and Osman *et al.* (2013) studied the effect of neem oil, mehagoni oil, bishkatali leaf extract, larvin 75 WP and diazinon 60 and their performance for the management of red pumpkin beetle.

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