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Red Pumpkin Beetle, *Aulacophora foveicollis* Lucas; A Review of Host Susceptibility and Management Practices

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Abstract: *Aulacophora foveicollis* is polyphagous feed voraciously on leaves, flower buds and flowers which may reach upto 35-75% at seedling stage. In some cases the losses of this pest have been reported to 30-100% in the field. Current effort was made to get a comprehensive note on the control strategies adapted to date for red pumpkin beetle and its host variation.

Key words: Know about the possible control measures · Different ways of control used by different scientist · Period of investigation when studies done on the pest

INTRODUCTION

Aulacophora foveicollis is polyphagous and attacks more than 81 plant species including pumpkin, squash, cucumber, bottle gourd, snake gourd, wax gourd, water melon, etc. and a wide range of fruit crops. The adult beetles feed insatiably on leaves, flower buds and flowers [76]. So, it can be called as one of the most serious pest of cucurbits because it attacks every stage of cucurbits and it can cause heavy loss to all cucurbits except bitter gourd. If it is at seedling stage then crop needs to be resown. It feed underside the cotyledonous leaves by biting holes into them. Percent damage rating gradually decreases from 70-15% as the leaf canopy increases. Percent losses are obvious from the percent damage, which may reach upto 35-75% at seedling stage [49]. In some cases the losses of this pest have been reported to 30-100% in the field [76].

Reviews: In Bombay, research was performed on red pumpkin beetle and reported it to be the serious pest of the crop that is a more or less constant pest [1]. It becomes sporadically serious on young tender shoots, leaves and flowers of various cucurbits. Experiment was carried out to check the damage, different life stages and effective control measures of the red pumpkin beetle on cucurbitaceous vegetable, those are comparatively safe, health friendly and easily available in local eco-system. In the experiment the span of different stages of the pest was monitored at field conditions under laboratory conditions at variable temperatures and humidities conditions. Different agronomic, chemical and non-chemical control measures were applied for the control of *Aulacophora foveicollis*. These control measures were ploughing and planking operations, application of kerosine oil, road dust, wood dust, fine tobacco dust or snuff, wood and cowdung ash, spray of led-arsenate and water spray for the control.

[2] Melamed-Madjae performs an experiment to study *Aulacophora (Rhaphidopalpa) foveicollis* (Lucas) adults feeding on the fruits and leaves of cucurbits in Israel, as in other Mediterranean countries. An investigation was done during 1955-57 and revealed that the adults of this beetle hibernate. Females beetle oviposit in May-August and egg stage last about 10, larval stage about 20 and pupal stage 16 days at 28°C [82.4°F.]. Egg laying capacity of female ranges from 100 to 800.

[3] Nath and Thakur performs an experiment involve field trials and cage studies to evaluate the resistance of gourds against red pumpkin beetle, *Aulacophora foveicollis*. The beetle was said to be the most injurious pest of cucurbits in India. Thirteen different experiments were performed in which six cage experiment were also involved in it during spring, summer and rainy season of 1963. Ridge gourd, bottle gourd and sponge along with different lines of these crops were selected. Lines of ridge

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gourd NR 1, NR 2, NR 4, NR 5 and NR 7, lines of sponge gourd were NS 7, NS 10, NS 11, NS 12, NS 14, NS 16 and NS 17, lines of bottle gourd were NB 19, NB 21, NB 22, NB 25, NB 28, NB 29, NB 30 and NB 33. Response of different lines were different that varies from the other and also variation were present among varieties.

[4] Singh and Gupta performs an experiment on *Aulacophora* (*Raphidopalpa*) *foveicollis* (Lucas), in Uttar Pradesh, India studied its life stages, damage to target crop and control of this pest on the crop. It is widely distributed over India, is a severe pest of cucurbits and also recorded from leguminous crops. This pest was found for the first time damaging Japanese mint (*Mentha arvensis* var. *piperascens*) in 1967-68 in Uttar Pradesh, where it is grown as a cash crop for medicinal use. Adults of the pest were observed in small groups on the lower surface of the leaves and by their feeding caused transparent patches and eventually holes; they also consumed small buds. Different control measures were adopted for the control of *Aulcaophora foviecollis* and for control, sprays of 0.02% endrin or 0.1% malathion at 1000 litres 1/ha or a 5% dust of malathion at 2 kg/ha were recommended. It was also recommended that the endrin application should not be applied less than three weeks before harvest.

[5] Dutt and Dalapati observed in India that both the adults and the eggs of *Aulacophora foveicollis* (Lucas) (*Raphidopalpa foveicollis*) overwinter. Beetle is a significant pest of cucurbits and was studied in the field on *Cucurbita pepo*, *Lagenaria siceraria* (vulgaris) and *Benincasa hispida* and also in the laboratory. Majority of adult population enter soil to overwinter, though some remained, on the plants feeding at a reduced rate. Body weight of both sexes fell before overwintering began but was restored when the beetles fed actively in the following year. Growth of the reproductive organs ceased when body weight fell. Eggs which were exposed at 30°C and relative humidity up to 40% failed to hatch. It was observed that when relative humidity is low during the winter it appears that the eggs also become dormant and development is arrested.

[6] Pal *et al.,* locate the source of resistance in among pumpkin germplasm against red pumpkin beetle. During 1975-77 in India the resistance of 287 indigenous and exotic pumpkin germplasms to *Aulacophora foveicollis* (Lucas) (*Raphidopalpa foveicollis*), a pest that severely damages the cotylendonary leaves resulting in the death of seedlings, was evaluated in pot tests in insect-proof cages. 596-2 and 613 lines had promising level of resistance calculated by observing percentage damage caused by artificial infestations to cotyledonary leaves. It was observed that level of resistance was linked with cucurbitacin content of the cotyledonary leaves.

Field trials were performed to evaluate insecticidal spray against red pumpkin beetle, *Aulacophora foveicollis* in India [7]. Red pumpkin beetle, *Aulacophora foveicollis* is a most destructive polyphagous and widely distributed pest of cucurbits in India. During the field trial efficacy of 14 different insecticides against this pest, including carbaryl and lindane at 0.2% and dichlorvos, methyl demeton, monocrotophos, phosalone and thiometon at 0.03% were evaluated. The compounds were applied in 750/ spraying liquid/ ha. Among 14 different insecticides tested, phosphamidon was most effective one with over 64% reduction in the beetle population even after 15 days treatment. Phosphamidon followed by Carbaryl and endosulfan were the most effective insecticides

[8] Al-Ali *et al.,* carried out an experiment to determine the host preferences and biology of red pumpkin beetle. Experiment was performed at Abu-Ghraib Farm, Iraq, the adults of *Aulacophora foveicollis* broke their overwintering during first week of April 1975 at 21.2 °C and second week of April in the next year (1976) at 21.2 °C too. Beetles start feeding on seedlings and mature plants of melon (*Cucumis melo*), snake cucumber (*C. m.var. flexuosus*), cucumber (*C. sativus*) and bottle gourd (*Lagenaria siceraria*) and preferred flowers to leaves. Egg laying started by the third week of April and continued for 44 days, while the pre-oviposition period ranged between 2.3 and 4.2 days and the number of eggs per female ranges between 5.1 and 14.1. Larval infestation started by the last week of April at 22.3 °C and became very severe during the first week of May at 25.8 °C. Best suited temperature for the beetle was around 27-28 °C. With the gradual increase in the temperature its population decreased until it completely disappeared throughout July at 35.2 °C which seems to be lethal or semi-lethal to it. Beetle seems to be capable of tolerating wide ranges of relative humidity fluctuations, on the other hand. The number of beetles on 10 plants of each crop was set to be a standard for host preference studies and descending order was *C. m. var. flexuosus, C. melo, C. sativus* and *L. siceraria* for both 1975 and 1978 seasons. However, *C. m. var. flexuosus, C. melo, C. sativus* did not differ significantly in their preference from each other and, thus collectively regarded as the beetle's first choice.

[9] Singh and Gill carried out field trials in the Punjab, India, between March and May 1978 on losses in growth and yield of muskmelon in plots sprayed with carbaryl at between 100 and 1000 g a.i./ha against *Aulacophora foveicollis* (Lucas) according to the stage of the crop and in control plots. Mean number of beetles killed on each plant in the plots treated with carbaryl ranged from 11.0 to 44.3, whereas there was no mortality in the untreated ones. Percentage infestation to the leaves, measured by leaf perforation and it was ranged from 0.26 to 1.33 in the treated plots and from 4.66 to 17.00 in the check plots. Mean number of branches per plant, mean number of leaves per plant and mean length of stem per plant were also higher in the treated plots than in the untreated ones.

[10] Chandravadana performs an experiment to test the effectiveness of teriterpenoid (bio chemical) extracted from *Momordica charantia* against *Aulacophora* foveicollis (Lucas) (*Raphidopalpa foveicollis*). Severe damage caused by red pumpkin beetle to the cotyledons and tender leaves of many cucurbits in India but not to those of bitter gourd (*Momordica charantia*). In laboratory, beetles were exposed to feed on pumpkin leaves which were treated with extracts of the leaves and cotyledons of this plant. Triterpenoid glucoside was identified as feeding deterrent that was different from known momordicosides; it had a bitter taste and concentrations above 2 mg completely inhibited feeding by *A. foveicollis*.

[11] Sinha and Chakrabarti carried out field trials in India in 1978-80 to compare the effectiveness of seed treatment against *Aulacophora foveicollis* (Lucas) (*Raphidopalpa foveicollis*) with carbofuran on muskmelon and bottle gourd [*Lagenaria siceraria*] seed with soil treatment. Results obtained from the trials indicated that seed treatment with a wettable or flowable powder formulation of carbofuran at 3 or 4% a.i. was as effective against the pest as soil treatment with a granular formulation of the compound at 0.5 kg a.i./ha and did not adversely affect germination.

[12] Mavi and Bajwa used emulsifiable concentrates for the control of red pumpkin beetle, *Aulacophora foveicollis.* Effectiveness of 4 insecticides applied as sprays with a hand-held battery-operated sprayer at rates of 125 and 187.5 g a.i./ha 17, 24 and 34 days after sowing for the control of red pumpkin beetle, *Aulacophora foveicollis* on melon (muskmelon) was determined in field-plot tests in India. Both chemicals Phoxim and pirimiphos-methyl, at the higher rate, were the most effective treatments, protecting the crop from attack for 10 days.

[13] Alikhan and Yousuf performs an experiment to test the mortality and development of red pumpkin beetle, *Aulacophora foveicollis* by rearing it on different hosts. Feeding of beetle was done on leaves and flowers of five different hosts, named *Citrullus vulgaris*, *Cucumis melo*, *Lagenaria vulgaris*, *Luffa aegyptica* and *Momordica charantia*. Experiment was completed in the laboratory by maintaining the temperature 21.5°C and relative humidity 52-60%. The beetle, *Aulacophora foveicollis* had four larval instars and its growth curve on *L. vulgaris* was S-shaped. Number of viable eggs and the survival of the larvae were comparatively high on *L. vulgaris*, *C. melo* and *C. vulgaris*. The larval developmental time was similar whereas, percentage of malformed adults was low on *L. vulgaris* and *C. melo*. Insect feeding on *M. charantia* was having lowest number of viable eggs and newly hatched larvae were unable to survive for more than 3 days.

[14] Raman and Annadurai in an experiment checked out food utilization of red pumpkin beetle during 1985. During the study the red pumpkin was analyzed for host plant relationship based on the role of receptors those are involved in host selection and food utilization by the pest due to biochemical parameters involved in food selection. Movement of red pumpkin beetle was largely affected when the receptors were ablated/ coasted which are present on mouth parts and antenna. Whereas for food utilization the observations were carried out on different aged leaves to study the preferences by the beetle. Beetle mostly prefers the mature leaves and flowers as compared to the senseless flowers and leaves of small (young) aged. Similarly, the plant parts especially flowers and leaves having high rate of nitrogen, protein and low proportion of sugars and moderately high phenol contents in them.

[15] Ali *et al.,* during 1987 performed an experiment on some cucurbit crops to test their susceptibility against red pumpkin beetle and to test the seasonal presence of the beetle. Experiment was performed in spring and fall season. Results obtained from the experiment revealed that melon varieties were most preferred hosts for adult beetle followed by snake cucumber, while cucumber varieties showed less preference during both fall and spring seasons. Whereas, water melon and squash when grown in the spring season, were not preferred to the beetle. The number of generations differs according to host and season of red pumpkin beetle but mostly it has at least 4 generations in the year starting at mid-April to mid-November. Experiment provided additional information on the biology and ecology of the pest for its management.

Research work on Red Pumpkin Beetle (*Raphidopalpa atripennis*) to check the life span, percentage consume rate, fecundity rate and trend of beetle towards different host plants was done during 1987. [16] Annadurai performed an experiment on the *Raphidopalpa atripennis* to estimate the trend of this insect toward three different host plant and one weed as food source for the pest. Three main food source or host plant involved in the study were *L. acutangula*, *L. cylindrica* and *M. scabrella. M. scabrella* is basically a weed plant and during experiment it was affirmed that beetle only present to this plant when no other host plant is available. Biochemical analyses of these plants were carried out to get the composition of different organic materials in these plants. Rate of consumption of different leaf ages was done. Biochemical analysis showed that beetle's tendency of feeding was more towards plants having more chlorophyll contents and palmitic acid. That is why; damage was proficient to full grown leaves as compared to immature leaves.

[17] Chandravadana druing 1987 conducted a study on red pumpkin beetle for its management using some deterrents as repelling agent. The study was performed to keep the population of the pest under limit by reducing its feed source. *Momordica charantia* was the principle plant used for the extraction of repellent chemical. Triterpenoid were the chemicals which were identified by the scientist to act as feeding inhibitor for red pumpkin beetle. Among Triterpenoids the deterrents identified were momordicine II, 23-O-glucopyranoside of 3, 7, 23-trihydroxycucurbita-5,24-dien-19-al. A concentration of 3200 g/ml and above of the triterpenoids caused significant reduction of feeding by red pumpkin beetles in in vitro bioassay experiments.

[18] Dhillon and Sharma conducted a study on summer squash (Cucubita pepo L.) in 1987. They reported that the pest is serious and cause heavy infestation to different crops and can be controlled with different control measures among those chemical control is one. But they conducted a different aspect of pest control of this particular insect and that was through genetic resistance. They get through screening of available varieties in field and in laboratory for controlled feeding in feeding cages. Then inbreeding of F1 and then crosses in F2 were made basis on each variety will cross with other to get an optimum characteristics of the variety. After that they got line which was resistant to red pumpkin beetle. Twenty inbreed plant were used in F1 and same number was used in F2.

[19] Pande *et al.,* during 1987 performs an experiment to check the effect of different concentrations of leaf extracts against red pumpkin beetle. Adult beetles which were collected from local field fed on fresh leaves of a local pumpkin variety treated with 0.1, 0.2, 0.3, 0.4, 0.5 and 0.6% of *Ageratum conyzoides* leaf extract. Mortalities of insects were assessed every 12 h up to 84 h. No mortality was caused when concentration of leaf extract lower than 0.2% was used and no mortalities were recorded at any concentration up to 24 h. Mortalities recorded after usage at 0.3, 0.4 and 0.5% concentration were not significantly different at 24, 36, 48, 60, 72 and 84 h. Highest mortality (100% after 84 h) was observed at the 0.6% concentration and this rate was significantly higher than mortalities recorded for the other concentration at all-time intervals. Results concluded from the trials were that the 0.6% concentration possesses good insecticidal properties and could be used to control a variety of insect pests.

[20] Gujar and Mehrotra performed an experiment on the management of red pumpkin beetle (*Aulacophora foveicollis*) by using plant extract especially neem (*Azadirachta indica*) extract. Experiment was performed during 1988 on muskmelon crop as feeding host. Different forms of neem (*Azadirachta indica*) was applied, *i.e.* as neem seed kernel extract, as neem oil. Plant extracts was used as repellent and repellency was measured by 50% anti-feeding activity of red pumpkin beetle. Percentage of neem (*Azadirachta indica*) extracted from neem seed kernel extract was 0.1% which reduce the feeding activity upto 50% percent and the percentage of neem oil to obtain similar results was 0.4%. Whereas the other aspect of this experiment was, to test neem (*Azadirachta indinca*) as killing pupose. For this purpose, muskmelon leaves was treated with 0.5-2.0% neem seed kernel extract and up to 50% of the population was undergoes mortality, when no-choice feeding was done within 7 days. But there was no effect of neem oil on the mortality of the pest until 11 days.

[21] Pareek and Kavadia during field experiments in 1988 used two agroclimatic regions of Rajasthan (the semi-humid Udaipur in 1979 and 1981 and the semi-arid Jobner-Jaipur in 1980 and 1981) to evaluate the insecticides, chlorpyrifos at 0.05%, ethion at 0.05%, phosalone at 0.035%, dicofol at 0.1%, carbaryl at 0.2%, toxaphene at 0.1%, malathion at 0.05%, endosulfan at 0.07% and dimethoate at 0.03% for the control of the pumpkin beetle and the fruitfly damaging musk melon var. *Durgapura madhu.* Four spray applications of carbaryl @ 0.2% at 3, 5, 9 and 11 weeks after sowing proved most effective against both the pumpkin beetle and resulted in increased yield of between 79 and 89 q/ha, over the check. Sprays of dimethoate and phosalone were found to be effective against the pest and also gave higher benefit/cost ratios because of low costs.

Resistance of summer squash was determined by [22] Dhillon and Sharma during 1989 against red pumpkin beetle, *Aualcophora foveicollis* Lucas in Ludhiana, India. Different squash lines were used to evaluate the difference in attack rate in lines. There were 22 different squash lines which were evaluated for genetic resistance against the pest in laboratory and field condition as well. Infestation of red pumpkin beetle *Aulacophora foveicollis* Lucas was recorded by considering the leaf damage by the beetle. Recommended of cage evaluation for red pumpkin beetle, *Aulacophora foveicollis* Lucas can be used easily for its screening against any host plant.

[23] Khan and Hajela conducted an experiment to check the preference of red pumpkin beetle for food utilization among different host and extent of damage. In laboratory trials, preference of *Aulacophora foveicollis* for several species of Cucurbitaceae was studied in single- and multiple-choice tests. Preference ordered by beetle, in the single-choice test was *Cucurbita maxima* > cucumber > *Citrullus vulgaris* var. *fistulosus* > loofah > bottle gourd. In the multiple-choice test, *Cucurbita maxima* was found to be most vulnerable host, while *C. vulgaris* var. *fistulosus* and bottle gourd were the least preferred. No feeding response by the beetle given to *Momordica charantia* was observed in either test.

[24] Chaudry and Alikhan test the effects of 4 constant temperatures at 70% RH and 4 relative humidities at 30°C on the oviposition and life-stage durations (oviposition to adult emergence) of *Aulacophora foveicollis* on *Lagenaria vulgaris* [*L. siceraria*]. Experiment was performed in the laboratory and 4 different temperatures tested at 70% humidity were 20, 25, 30 and 35°C whereas the 4 different relative humidities tested against the beetle were 30, 50, 70 and 90% RH at 30°C. It was found that the beetle had the highest number of viable eggs and the shortest development period at 30°C and 70% RH.

[25] Mehta and Sindhu carried out a study to monitor red pumpkin beetle by using cucurbitacin as kairomones using in poison baits. the kairomones responsible for bitterness are cucurbitacins and feeding stimulants for the red pumpkin beetle, *Aulacophora foveicollis*, a serious pest of cucurbits. Trials were conducted to explore the possibility of invading the beetle of utilizing cucurbitacin in poison baits. Carbaryl or malathion were used as seed treatment to cotyledons of melon cv. Hara Madhu and watermelon cv. Sugar Baby after standardizing. Number of beetles on an average trapped in the melon mixture alone was 1.75 compared with 6.75 and 3.25 when carbaryl and malathion, respectively, were added. Carbaryl and malathion when mixed with watermelon homogenate average number of trapped beetles were 8.19 and 5.37, respectively, compared with 2.75 in the control. Results revealed that poisoned baits were better than unpoisoned ones but they remained effective for only 24 h.

[26] Roy and Pande studied biology of red pumpkin beetle, *Aulacophora foveicollis* Lucas during 1991 in India as used pumpkin seedlings as host. Insect prevails in the field round the year. An average of 27.5°C was determined to be the most favorable temperature for the development and survival of red pumpkin beetles. Egg, larval and pupal stages lasted for 8.3 to 15.8; 12.6 to 18.1 and 10 to 15.2 days, respectively indifferent seasons. Complete life span of one generation, from laying of the egg to the emergence of adult varied from 27 to 56 days. They also reported that insect completes 6 to 8 overlapping generations in a year.

[27] Khan and Khattak performed an experiment to test the efficacy of different chemical control measures on muskmelon for the control of red pumpkin beetle (*Aulacophora foveicollis*). Experiment was carried out during 1992 in Faculty of Agriculture farm, Gomal University, Dera Ismael Khan, Pakistan. Research scheme was based on five different chemical control measures including Cropgard, Cypergard, Sunmerin, Stinger and Mavrik. Three different concentrations of these five chemicals was tested against the beetle, *i.e.* 0.1%, 0.5% and 1%. Cypergard was found to be the most effective among all the other control measures at each concentration. Data was collected by counting total number of beetles per plant.

Nine different cucurbitaceous crops (bitter gourd, bottle gourd, cucumber, muskmelon (B), muskmelon, round melon, small gourd, sponge gourd, water melon) were selected to test against red pumpkin beetle, *Aulacophora foveicollis* Lucas for its attack to the host plants in relation to cucurbitacin and other biochemical by [28] Mehta and Sandhu during 1992. Cucurbitacin content were different in each variety, the lowest value of the chemical was found in sponge gourd (0.177 mg/g) whereas the maximum was found in watermelon crop (0.29 mg/g). The attack of the beetle was compared with the amount of curcurbitacin present in respective plant and correlation was found positive. Correlation with between insect injury and total sugars, phenols, orthodihydroxy phenols flavonoids and total free amino acids were also positive but comparatively of lower order. These are effective for the damage/ attack of the beetle but cucurbitacin is more important as compared to these compounds. Effect was found positive while topical application of cucurbitacin B and E was done on non-preferred host. Hence, this experiment confirms the attack of red pumpkin beetle, *Aulacophora foveicollis* Lucas on the plant having cucurbitacin in it. Maximum attack was found on watermelon and minimum attack was found on bitter gourd which was less than the other of first.

[29] Dhillon performs an experiment to study relationship between bitterness and resistance of cucurbits against red pumpkin beetle but the results were unusual. During the trials cucurbitacin B and E in purified form used as feeding stimulants for the red pumpkin beetle, but no relationship was found to be existing between the bitterness gene and the degree of damage caused by this beetle on testing three pairs of isogenic bitter (Bi) and non-bitter (bi) lines of cucumber. Both resistant and susceptible lines contain cucurbitacin at the susceptible plant growth stage (cotyledon) in summer squash, but there was no correlation between the quantity of total phenols, reducing sugars or free amino acids in this material and resistance. It is reported that beetle do not prefer bitter gourd, while cucurbitacin was present in the cotyledons.

[30] Chaudhary carried out some field trials to test the efficacy of polyethylene cages for the protection of cucurbitacecous crops against red pumpkin beetle. Field trials were carried out in Uttar Pradesh, India, in 1989-91 and use of polyethylene sheet was done as preventive against *Aulacophora fovicollis* at different heights. Result revealed that polyethylene cages protected cucumber seedlings were protected effectively against infestation by *Aulacophora foveicollis* for up to 1 month after germination. 3 different cage heights were used as control measures and were 30, 45 and 60 cm. Among these three cage heights tested against the beetle, 30 cm (with a 120 cm perimeter) height of polyethylene sheet act as most effective and economic control measure against this pest.

[31] Guruswamy *et al.,* performed an experiment on red pumpkin beetle for the determination of host preferences by red pumpkin beetle in India during 1995. Pest was said to be one of the seriously attacking pest among cucurbits insect pests. Plants roots, stem and leaves are attacked as well. Larval and adult both stages cause damage to the plants, where larval stage cause damage to roots while adult harms the plant by eating leaves, flower and stem due to its gregarious feeding behavior. The damage of the beetles was counted by counting the damaged leaves over total leaves as also reported by [32] Bogawat and Panday (1967). Ten different hosts were observed for feeding preference by the beetle by allowing feeding in two conditions; free feeding and no-free feeding and data was recorded at 24 hours and 48 hours and 72 hours of feeding. Different host used in the study were bitter gourd, bottle gourd, little gourd, long melon, musk melon, pumpkin, ridge gourd, sponge gourd, squash, water melon. In case of free feeding the long melon (*Cucumis melo* Var. *utilissimus*) was most attacked and lowest was bitter gourd (*Momordica charantia*) whereas in no-choice leaf area maximum damage was done on musk melon (*Cucumis melo*) and minimum damage was done on water melon (*Citrullus lanatus*).

[33] Lewis and Metcalf used some attractant to check the response of *Aulacophora* spp. They used kairomones and parakairomones those act as effective lure for *Diabrotica* and *Acalymma* were investigated. No apparent result were found on beetles captured on sticky traps baited with single and multicomponent lures from the control traps for two species of *Aulacophora*. Yellow colored traps and squash blossoms were attractive to *Aulacophora* beetles those detect sub-microgram quantities of cucurbitacins on silica gel. Leaf feeding behavior and flight activity data was correlated with varietal preference of three *Aulacophora* species. The common response by *Diabrotica* and *Aulacophora* to cucurbitacins was almost same.

Different host plants of red pumpkin beetle, *Aulacophora foveicollis* Lucas was observed in addition to pumpkin (*Cucurbita moschata*) by [34] Das and Ishahaque during 1998 in north India, around and inside Assam Agriculture University. Different host plants recorded were bottle gourd (*Lagenaria siceraria*), cucumber (*Cucumis sativus*), watermelon (*Citrullus lanatus*), ridge gourd (*Luffa acutangula*), pointed gourd (*Trichosanthes dioica*) and ash gourd (*Benincasa hispida*). Infestation of the beetle was observed in variation during the different time of the year and ranging from 3-20%. Other plant which were recorded as collateral host of the pest are, okra (*Abelmoschus esculentus*), sweet potato (*Ipomoea batatas*) and green gram (*Phaseolus aureus* [*Vigna radiata*]).

[35] Kemper and Chiou conducted a study on the benefits and other useful aspects of *Aloe vera*. They reported that *Aloe vera* is useful for human being as treatment for many diseases/mishaps like burns, abrasions, canker sore, laxative as topical treatment and ulcer, HIV and immune-stimulant as experimental treatment. It is also discussed that plant is also prevalent for the microbial control. It is a major part of some health and environment friendly pesticides, used to control annoying pests.

[36] Abe and Matsuda performed an experiment using four different species two were from *Aulacophora* and two from *Epilachna*. During 2000, the study was aimed to test the methanolic extract of *Momordica charantia*. Methanolic extract of leaves of this plant recorded as highly feeding deterrent in nature. Firstly, the methanolic extract was partitioned into water and organic solvent and cholorform fraction. Then cholorform fraction was chromatographed with silica gel to have momordicines I and II. Effect of momordicine I and II was observed on four species. Strong deterrence was observed by *Aulacophora nigripennis* towards momordicine I than mormordicin II while the reaction of *Aulacophora femoralis* was observed reverse. But the feeding of *Epilachna admirabilis* and *Epilachna boisduvali* was not deterred by any of two chemicals.

A study on the efficacy of different concentration of Seven Dust for management of red pumpkin beetle (*Aulacophora foveicollis*) on muskmelon (*Cucumis melo*) was done by [37] Khan and Jehangir. Research was carried out at farm of Agriculture, Gomal University, D. I. Pakistan under controlled conditions. Though seven dust is one the most effective chemical control against red pumpkin beetle, therefore different concentrations of this chemical was tested to have economic, safer and effective concentration. Three different concentration used in the experiment as insecticides were 2.0, 1.0 and 0.5%. Muskmelon variety Bukhara, was used in the experiment and RCBD was used as default experimental design. Data was recorded, number of red pumpkin beetle/ plant basis after one, three, five and seven of dust application. Result obtained in their experiment can be briefed as; although high concentration of seven-dust show high control but less concentration, which was quite safer, was also better than check even after 7 days of insecticide application.

[38] Rajak conduct some trials on population variation of the red pumpkin beetle (*Aulacophora foveicollis*) on muskmelon in India. Experiment revealed that hibernating beetle becomes active at an ordinary temperature of 20°C and relative humidity of 89%. Beetle's population was found to be at an average temperature of 28.8°C. Relationship of pest population with temperature was positive and that with relative humidity was negative. Regression analysis done to check the effect of temperature and relative humidity and it revealed that there was a non-significant effect of relative humidity on the pest population and significant effect of temperature.

The host preferences of the red pumpkin beetle (*Aulacophora foveicollis*) and melon fruit fly (*Dacus cucurbitae*) were studied using different cucurbits during the summer of 1997 in India. Experiment performed by [39] Singh *et al*. Data collection based on number of red pumpkin beetles per leaf and percentage infestation on the vines, leaves and flowers of cucurbits. Collection of data done at every morning for fruit fly, while observations on the melon fruit fly made weekly. Observations of the host preferences of the red pumpkin beetle ranked bitter gourd (*Momordica charantia*) as least preferred, whereas cucumber, musk melon, bottle gourd (*Lagenaria siceraria*) and pumpkin as medium in preference, round gourd (*Citrullus lanatus* var. *fistulosus*) and long melon (*Cucumis utilissimus*) as highly preferred and watermelon as the favorite host. Percentage fruit damage by the melon fruit fly was under 50% in all cases.

[40] Khan and Wasim conduct a study on muskmelon (*Cucumis melo* L.) to evaluate the repellency of different botanical extracts against red pumpkin beetle. They was having seven treatments like neem extract in ethanol and benzene, bakain extract in ethanol and benzene, hermal extract in ethanol and benzene and check. Among these treatments, the maximum repellency was reported, in plots treated with neem mixing with bezene and repellency percentage was 60%.

Host preferences studies were performed by [41] Rajak by drawing an experiment using RCBD with four replication and 23 treatments. Treatments were comprised of 23 different crops, which covered with mosquito net to protect intrusion from free moving insects in field. Red pumpkin beetle (*Aulacophora foveicollis*) was collected from field and then releases to the mosquito net barrier protected plots. Beetles released to plot when plants were exactly at 2-4 leaf stage, beetle was release @ 30 insect/ replication. The damage leaf areas of crops, measured using graph paper after 3 and 10 days of beetle release. Data collected from 23 different crops revealed that red pumpkin beetle infesting 11 crops *i.e.* pumpkin, cucumber, bottle gourd, snake gourd, water melon, ridge gourd, round melon, pointed melon, sponge gourd, brinjal and berseem. Red pumpkin beetle has not been found infesting bitter gourd. He also reported that tomato and sweet potato have reported as host plant by different scientists in various areas.

[42] Rai *et al.,* performed and experiment in India for screening purpose of different lines against red pumpkin beetle, so that those can be moved further. This experiment showed us that how much wide range of

host preferences in *Aulacophora foveicollis*. Sixty-eight line of Cucumber (*Cucumis sativum*) were selected at the start of the project for purpose of having resistant lines. Data regarding red pumpkin beetle infestation was collected based on the damage at different stages *i.e.* cotyledonary, true leaf, flowering and fruiting stage of the crop. It was observed that beetle cause damage to all other line except eight lines, which were PCUC-7, PCUC-36, PCUC-47, PCUC-66, PCU-99, PCUC-102, PCUC-108 and PCUC-110.

[43] Rivera conducted a study of natural extracts, their effect on the control of different kinds of insects and their way of use as bio-chemicals. Study was based on the different control measures either these were biological, non-chemicals, cultural practices and mechanical control measures. Chemical was only involved in study as sex attractants; else use of chemicals was avoided. Naturally existing chemicals *Aloe vera*, Neem, Garlic, Tobacco, Ginger, etc products as extracts were the part of study. All of the biochemical was used as extract application separately and in combination with other biological ingredients. Descriptions of different pest species was done, in which it was elaborated that what is the extent of each species presence on each plot treated with extracts. Almost 20 beetle species were controlled by Neem extract.

[44] Atwal and Dhaliwal suggest the management of red pumpkin beetle using agronomic practices and chemical control methods. In agronomic practice they discussed deep ploughing, to kill the grubs in soils and winter season sowing in November, while in chemical control, carbofuran after germination in soil or spray or irrigation application of carbaryl 50WP for effective control of the pests.

[45] Mahmood *et al.,* during 2005, reported the trend of red pumpkin beetle towards eight cucurbit crops *i.e.* cucumber, watermelon, long melon, redgourd, bottlegourd, spongegourd, muskmelon and tindagourd. Experiment was performed in Islamabad during 2002. Long muskmelon and melon was the most favorable host and no plant reached to 5 true leaves stage after germination when they receive beetle's attack. Red pumpkin beetle also prefer cucumber, watermelon, tindagourd and redgourd but less damage and medium preference reported by them to muskmelon and long melon, bottle gourd while sponge gourd was the least preferred host.

[46] Lakshmi *et al.,* conducted studies in Bapatla andhra Pradesh, India, during rabi 2003-04 to evaluate some eco-friendly pesticides for the management of red pumpkin beetle, *R. foveicollis*, on pumpkin (*C. maxima*) crop. The treatments comprised of carbaryl at 0.2%, monocrotophos at 0.54%, chlorpyriphos at 0.05%, Nimbecidine (a neem [*Azadirachta indica*] formulation) at 0.2%, *Bacillus thuringiensis* at 0.20%, thiodicarb at 0.075%, Bt at 0.1%+thiodicarb at 0.0375%, Nimbecidine+thiodicarb, spinosad at 0.015% and untreated control. Two sprays at fortnightly interval were done and carbaryl (46.53%) was found to be the most effective control measure in reducing the beetle population as well as in reducing the leaf damage (10.61%) followed by monocrotophos (39.93%), chlorpyriphos (35.02%) and Nimbecidine (28.66%).

[47] Sharma in 2006 and deals with the insect pests causing serious damage to the biodiesel plant, *Jatropha curcas*, in India. The scutellarid bug, *Scutellera nobilis*, which is an emerging problem, devastates this crop and causes flower fall, fruit abortion and seed malformation. Another scutellarid bug, *Agonosoma trilineatum*, is also a serious problem due to its seed-feeding habit was found. Red pumpkin beetle (*Aulacophora foveicollis*) was also recoded as infesting the leaves of *J. curcas.*

[48] Kumar and Nadrajan conducted trials during 2004-06 in Karaikal, Tamil Nadu, India, to study biology of the red pumpkin beetle, *Aulacophora foveicollis*. Beetle was reared on pumpkin and revealed that beetle undergo holometabolous type of metamorphosis. Yellow colored oval shaped eggs were incubated for 11.7±0.2 days. Eggs were laid loosely in batches and hatching percentage was 86.14±1.24. On an average, a female laid 75.15±2.68 eggs. Grubs hatched from eggs were pale yellow in colour with dull brown head and also had urogomphi. Larval period was 12.25±0.14 days. Earthen cell used for pupation. Exarate types of pupae are present in red pumpkin beetle with naked appendages. Pupa changes its changes its color to yellowish with red eyes when it is fully-developed. A monsoon change the pupal period of beetle and it is different in different monsoon periods. Adult emerges from the pupa with dull-brownish in coloured wings, later, with the advancement of adult age, wings turned bright orange-red. Sexual dimorphism is present in adults. Life span of male and females was 62.70±2.70 and 63.05±1.68 days, respectively. A single couple of red pumpkin beetle able to mate 15 times. It was reported that in case of numerous mating, 7 virgin females can meet to a single male, whereas, a single female can mated by 6 virgin males. Beetles take 7±0.23 days after hatching to unveil premating behaviour and first mating was found on 9.2±0.24 days after emergence. Hence the period of premating was 2.25±0.12 days. From the day of first

mating, copulation period was continued up to 12.15±0.47 days. 6.75±0.28 days were mean preoviposition period. Female continue egg laying activity up to 8.7±0.55 days, which was the oviposition period. 25.7±1.62 were mean post-oviposition period (last egg laying to death of females). Life span of females adult was slightly higher than the male (63.05±1.68 days for female and 62.70±2.4 days for male). Sex ratio was mainly depending on female beetle.

[49] Rahman and Prodhan conducted an experiment to check an effective control for red pumpkin beetle, the most destructive pest of the cucurbits. During the trials of the experiment farmer's field was selected at Jalchatra, Madhupur and Tangail in Bangladesh during 2005. All other agronomic practices were made according to the local standard. The experiment was having four different control measures including check. Treatments include effect of mosquito net barrier, application of carbofuran by mixing with soil and application of diazinon (60EC) as foliar spray application. The carbofuran gave outstanding results among other control measures. Diazinon was less effective than carbofuran but more effective than that of mosquito net barrier treatment.

[50] Saljoqi and Khan carried out studies on the relative abundance of Red Pumpkin Beetle, *Aulacophora foveicollis* L. During 1998 in the Peshawar valley, different cucurbitaceous vegetables were monitored from the first week of May, 1998 to the second week of August for the abundance of beetle. Among eleven varieties, Squash and Cucumber varieties were found highly vulnerable host for red pumpkin beetle and hosted more population during whole cropping season. Two Cucumber (*Cucumis sativus*) varieties, F1-Beitalpha, SK-Marketmore and two Squash (*Cucurbita pepo*) varieties, Light Green Zucchini, Local Round Green were found to be more vulnerable to the attack of the Red Pumpkin Beetle and supported 8.48, 8.20, 8.52 and 7.29 average number of Red Pumpkin Beetle respectively. Two Sponge Gourd (*Luffa scutannils*) varieties, RKS-6, RKS-7 and three Gourd (*Lagenaria siceraria*) varieties, DIK Round Green, SW Sweet Yellow and Bottle Gourd Long varieties were found moderately resistant to the attack of the Red Pumpkin Beetle, on which 4.00, 4.50, 3.54, 5.47 and 3.56, average number of Red Pumpkin Beetle were recorded, respectively. 0.12 and 1.02 average number of Red pumpkin Beetle were found on two Bitter Gourd (*Momordica charentia*) varieties Jaunpuri, Jhalri, respectively and found comparatively more resistant to the Red Pumpkin Beetle. Attack of *Aulacophora foveicollis* was high from May 7 to June 18, 1998, while from June 25 to August13, 1998, the population gradually declined.

[51] Anonymous performed an experiment to get evidence about the female of red pumpkin beetle either is produces sex pheromones or not to attract its male. Report indicate that red pumpkin beetle is a serious pest of the crops especially cucurbits and cause damage to plants at every stage either is floral, vegetative or reproductive stage. Larval and adult stages of the beetle both cause damage to the plant as well. Larval stages cause damage to roots and immature stages of the plant whereas the mature beetle cause damage to plant parts such as leaves, flowers and fruits. Beetle is mostly controlled by chemical measures of control but those are not ecofriendly so that must be discouraged and ecology based pest management program must be launched/ adopted.

[52] Fusire conducted Integrated Pest Management techniques for control routine crops pests. Different techniques involved in his Integrated Pest Management program were cultural and mechanical control measures, biological control measures, treatment in storage and precautionary measures. Regarding biological control measures, he used different non-chemical control strategies. Forty five different biological techniques were involved in his biological control list. *Aloe vera*, Ginger, Chilies, Pyrethrum, Tobacco and similar plants were used.

[53] Luna *et al.,* experiment was conducted during 2008 on red pumpkin beetle *Aulacophora foveicollis* and report it a serious pest of cucurbitaceous vegetables. It feeds on wide range plant species leaves including Cucumber (Cucumis sativus), Ridge gourd (Luffa acutangula) Pumpkin (Cucurbita moschata), Bottlegourd (Langeneria siceraria) etc. Drek (*Melia azedarach*) was used in two different ways to check the effect as repellent or anti-feeding. Firstly as ethanol extract and secondly as aqueous extract of seeds was tested against this pest on Cucumber in Punjab. Ethanol extract 1% and aqueous extract 3% of the plant were found effective in managing this pest. These extracts were found to be at par with commercial formulations of Neem (*Azadirachta indica*) viz. Econeem and Nimbecidine in the field trials in managing red pumpkin beetle. In another experimental unit ethanol extract 4ml/1 was found to be at par with Econeem against *Aulacophora foveicollis* on Cucumber, Ridgegourd and Bottlegourd.

[54] Shivalingaswamy *et al.,* perform a study on bottle gourd varietal screening against red pumpkin beetle during 2008. During the study 27 different cultivars of bottle gourd was screened against the pest and their respective damage was noted and undergoes statistical analysis. Different cultivars used by them were DVBG-1, DVBG-2(1), PSPL, NDBG-56, VRBG-17, VRBG-36, VRBG-26-1, VRBG-33, VRBG-42, VRBG-43, VRBG-46, VRBG-47, VRBG-48, VRBG-50, VRBG-55, VRBG-103, VRBG-108, VRBG-109, VRBG-111, VRBG-112, BRBG-17, VBGH-1, VBGH-2, VBGH-3, BGH-8, BGH-9, BGH-7. Percent damage was fluctuating for different plant species, but the average %age damage recorded at lowest was 17.45% in VRBG-50 and highest damage was 34.32% in NDBG-56. Data was recorded from the leaves based on percentage damage. Data collection initiation was done after 15 days of sowing.

[55] Sami and Shakoori conducted a research on red pumpkin beetle. During the experiment they studied different aspect, but the main focus was on biological characterization of eno-1, 4-β-D-glucanase activity of the pest. They have reported that the pest is most seriously damaging to crops especially to green plant cucurbits. Through the execution of the project they studied the repellency of this pest with the help of flavonoid compound extracted from *Psidium guajava*. They reported two control measures for this notorious pest that are helpful to manage its population. First was application of chemical based insecticides like carbofuran and they have found it effective this pest control. Second control was the use of non-chemical control measure. It was the use of biological agents to limit the pest population. The biological control agensts Tachinid fly (*Medinodexia morgani*), mite (*Histiostoma* spp.) and reduviid bug (*Rhynocoris fuscipes*), were important.

[56] Rai *et al.,* conducted a study on different cucubitaceous crops either used as fruit or vegetable. During their study they include different plants from this family, namely Luffa, Momordica, Citrullus, Cucumis, Coccinia, Cucurbita and Trichosanthes. Red pumpkin was mentioned as serious damaging pest of cucubitaceous vegetables and they recommend 0.1% Carbaryl or 0.1% Malathion for its control.

[57] Chandel *et al.* conducted a study on red pumpkin beetle to check the bio-efficacy of different indigenous plant extracts. The experiment was executed during 2008. Experiment was conducted to test the anti-feedant efficacy of selected indigenous plant extract of family Lamiaceae viz. leaves of *Ocimum basilicum, Ocimum canum, Pogostemon heyneanus, Salvia officinalis, Coleus amboinicus* and aerial part of *Mentha longifolia, Mentha piperita* and *Mentha spicata*. Third instar 24 hrs starved grubs and adults of red pumpkin beetle, *Aulacophora foveicollis* under laboratory trials were treated. Among all plant extracts, *Coleus amboinicus* (AI 50= 0.013) had highest anti-feedant activity than the other plant extracts. Order of anti-feedancy index can be arranged in the following descending order on the basis of their respective AI 50 values, *i.e.*, *Mentha piperata* (0.018) > *Pogostemon heyneaus* (0.141) > *Mentha longifolia* (0.213), *Mentha spicata* (0.375) > *Ocimum canum* (0.452) *Ocimum basilicum* (0.477) > *Salvia offficinalis* (0.626) and *Coleus amboinicus* (0.013), respectively.

[58] Devi conducted a research on the *Aloe vera*. During the research she clarified the importance of the plant, its composition, its uses, its cultivation and extraction of juice from the plant. In the magazine she also gave the commercial propagation methods and control of different pests on the plant. *Azadirechta indica* is recommended for the control of insect pests of the plants.

[59] Joshi *et al*. conducted a study on the different natural dyes to check its effect as antimicrobial for textile finishing products. This study was mainly revolving around the functionalities of different natural plant extracts used for finishing purpose in textile industry. For this purpose, they have used different plant served as source of these natural chemicals. During their study the most prevalently used plants as antimicrobial activity were *Aloe vera* and Neem (*Azadirachta indica*). Mainly the extracts of *Aloe vera* and Neem were involved in the study. They also reported that these plants are used for the control of different notorious insect pests due to their repellent effect and among these plants Neem (*Azadirachta indica*) has been familiar as most promising source for these kinds of compounds.

[60] Tandon and Sirohi conducted an experiment to evaluate the ethanol extracts of four plants in the laboratory for repellence property of the most destructive pests of melons, *Aulacophora foveicollis* Lucas (Coleoptera: Chrysomelidae). Its purpose is to further explore natural management program, a natural insecticide for control of red pumpkin beetle. Survey was done during June 2008, Department of Zoology Research Laboratory at Kanpur, India. Adults were exposed to 5% and 10% concentrations of extracts of *Azadirachta indica* (Neem), *Annona squamosa* (Sweat-pineapple), *Convolvulus microphyllus* (Sankhanushpi) and *Melia azedarach* (Bakain) in laboratory bioassays. Repellency analysis was conducted using the area preference method on filter

papers. Result revealed that *Azadirachta indica* produced repellency of class IV (60.1-80%), *Anona squamosal* and *Melia azedarach* caused class III (40.1-60%) and *Convolvulus microphyllus* provoked repellency of class II (20.1-40%). All of these plant extracts were found significantly effective in repelling red pumpkin beetles.

[61] Rathod *et al.,* perform an experiment to check the efficacy of neem (*Azadirachta indica*) based and synthetic insecticides for to the control of red pumpkin beetle while using bottle gourd as host plant. Different concentrations of neem were used, some comes from market in the form of commercial sold product and some by directly extracting spray able contents. 8 different sources with 8 different concentrations of neem were used, named as NeemAzal-F(0.1%), Gronim(0.5%), Vangaurd(0.5%), Econeem(0.1%), Achook(0.5%), Azadex(0.5%), NSKE(neem seed kernel extract)(5.0%), NLE (neem leaf extract)(10.0%). Highest mortality on average basis were recorded in Gronim (49.89) and minimum was recorded in NLE(20.16).

[62] Khan *et al.,* in a study on cucurbits checked out the influence of red pumpkin beetle, *Aulacophora foveicollis* and influence of different plant stages to the incidence of beetle. Experiment was performed in Ghazipur, Bangladesh. Ten different cucurbitaceous crops named as; sweet gourd, bottle gourd, ash gourd, bitter gourd, sponge gourd, ribbed gourd, snake gourd, cucumber, khira and muskmelon were cultivated in the experiment. Data regarding beetle count was divided into three aspects; beetles at seedling stage, beetles as vegetative stage, beetles at reproductive stage. Maximum number of red pumpkin beetle was recorded in muskmelon at seedling stage and population was 3.75 per plant and lowest was in snake gourd, 0.25. Similarly beetles recorded at vegetative stages were more on muskmelon (4.5/ plant) and minimum was 0.00 in snake gourd, whereas the population of beetle recorded at reproductive stage were 8.74 in muskmelon at highest and 0.75 at minimum in bitter gourd, ribbed gourd and snake gourd. Leaf infestation percentage recorded during the experiment was 89.25 % in muskmelon and lowest was 0.00 in bitter gourd.

[63] Mahmood *et al.,* conduct studies on the comparative efficacy of different plant extracts (neem seed, neem leaves and tobacco leaves) and insecticide permethrin dust alone and after mixing with dung. Experiment was conducted against red pumpkin beetle in the field at National Agricultural Research Centre, Islamabad during kharif 2008. Permethrin (0.5%) alone or mixed (0.05%) with dung ash as dust controlled the attack of *Aulacophora foveicollis* on the crop with no mortality of plants by the beetle. Peak mortality of plants due to foliage eaten by red pumpkin beetle (*Aulacophora foveicollis*) observed in control where no application of permethrin was done. Dust alone or mixed with dung was found most effective as compared to all other control measures in this study for controlling *Aulacophora foveicollis* attack. Permethrin dust (0.5%) alone and ash + permethrin dust (2000: 1 a.i. w/w) gave a significantly higher yield of 18.07 and 18.63 t per ha in cucumber, respectively.

[64] Rathod and Borand perform an experiment, to study the population dynamics of red pumpkin beetle (*A. foveicollis*) in relation to weather parameters by using pumpkins as host crop. Field trials were conducted during kharif 2004 and summer 2005 in Anand, Gujarat, India. The highest attack of the beetle was noticed during August to September in kharif and March to April in summer. Relative humidity and vapour pressure had significant positive relationship with the beetle population during kharif, while they were negatively correlated in summer on pumpkin. Increase in temperature had significant positive correlation with the beetle population on pumpkin crop during summer. Rainfall, vapour pressure, sunshine hours and wind speed were negatively and non-significantly correlated with the pest population.

[65] Khorsheduzzaman *et al*. conduct a research on red pumpkin beetle on sweet gourd in vegetable research field of Horticulture Research Centre in Joydeb pur during 2006-07 and 2007-2008 cropping seasons. Their six treatments were, soil application with Furadan 5G @ 5 g/plant at 3 days before planting, mechanical control with sweeping net at 3 days interval for 45 days, spraying neem seed oil @l0ml/l+5m1 trix (detergent) at 7 days interval, spraying neem seed karnel extract @ 50g/l of water at 7 days interval, seedling bed covered with mosquito net barrier upto 45 days old seedlings, control. Results obtained from the study revealed that mosquito net barrier provides the best control whereas among extract neem kernel extract perform outstandingly.

[66] Saleem and Shah recommended the use of carbaryl, deltamethrin, endosulfan and dichlorvos as chemical and deep plough & winter cultivation of vegetables as non-chemical control method for the control of red pumpkin beetle (*Aulacophora foveicollis* Lucas.)

[67] Rathod and Borad during their study on red pumpkin beetle, *Aulacophora foveicollis* Lucas in 2011 checked out the susceptibility of pumpkin cultivars. They tested six different cultivars against the beetle for their susceptibility; cultivars were APKL-2, APKL-4, APKL-6, APKL-7, APKL-00-06 and local variety. Result obtained from the experiment revealed that among six genotypes of pumpkin screened during the *Kharif* season, genotype APKL-7 and APKL-2 attacked by less number of beetles and hence showing less attack. Whereas the cultivars APKL-6 and APKL-4 received more number of red pumpkin beetle and indicating high infestation which was equal to the infestation of the local variety.

An experiment was performed to study the efficacy of Malathion at different doses against red pumpkin beetle, *Aulacophora foveicollis* (Lucas) in field of Department of Entomology, Bangladesh Agricultural University, Mymensingh by [68] Hasan *et al.,* in 2011. Sweet gourd (Var. BARI sweet gourd1), bitter gourd (Var. HybridNepali) and bottle gourd (Var. Kajla) were selected as cucurbit host to conduct the research with three different dose rates of Malathion viz. 0.4%, 0.5% and 0.6% of. Attack among three doses of Malathion was recorded as number of leaf attack per plant, number of twig attack per plant and minimum leaf area damage by red pumpkin beetle when plants were treated with 0.5% and the maximum damage was observed in case of 0.4% Malathion application. Efficacy of the insecticide reduced with increasing interims of spraying. Considering the efficacy in reducing the leaf area damage at all the time intervals spraying 5% Malathion was found as the most effective in controlling red pumpkin beetle in all three cucurbit hosts. Efficacy of Malathion was not affected by different cucurbit hosts.

[69] Vishwakarma *et al.*, were conducted to assess the bio-efficacy of two indigenous plant products, viz. seed extracts of *Strychnos nuxvomica* and *Pachyrrhizus erosus*, using petroleum ether as solvent and two entomopathogenic fungi, viz. *Beauveria bassiana* and *Metarhizium anisopliae*, in controlling red pumpkin beetle, *Raphidopalpa foveicollis* on bottle gourd (cv. Narendra Rashmi). Botanicals were used @ 2.0, 3.0 and 4.0 ml/lit. of water while the entomopathogenic fungi, were used @ 2.0 g, 2.5 g and 3.0 g/lit. of water. Significant reduction in damage (70.2%) was achieved in treatment with *B. bassiana*, when used @ 3.0 g/lit of water as compared to untreated control, followed by *S. nuxvomica* (65.4% at 4.0 ml/lit), *M. anisopliae*(64.7% at 3.0 g/lit.) and *P. erosus* (60.9% at 4.0 ml/lit.), respectively. *B. bassiana*@ 3.0 g/lit. of water recorded to be most economic control measure during the experiment.

[70] Khan *et al*., conducted a study on red pumpkin beetle in 2011. Study was aimed at host preferences of red pumpkin beetle in different cucurbitaceous crops. Experiment was carried out at Bangladesh under semi-controlled conditions, *i.e.* under net case conditions. It was reported that this red pumpkin beetle is serious pest of many crops mainly including ash gourd (*Benincasa hispida*), pumpkin (*Cucurbita pepo* L.), tinda (*Citrullus vulgaris* var. *fisulosus*), ghia tori (*Luffa aegyptica*), cucumber and melon. During the experiment ten different hosts of red pumpkin beetle was studied for host preferences, *i.e.* sweet gourd, bottle gourd, ash gourd, bitter gourd, sponge gourd, ribbed gourd, snake gourd, cucumber, khira and muskmelon. Result revealed that lowest population on mean basis was recorded in bitter gourd and was 0.00 while the maximum preference goes to sweet gourd with mean population data 3.60. Data was recorded basis on the release of red pumpkin beetle to plant after 1, 6, 12, 24 and 48 hour of release and based on leaf area damage.

[71] Khan 2011 performed an experiment on red pumpkin beetle using its ten different host plants for their consumption ratio based on chlorophyll contents present in each species. Experiment laid out according to RCBD in the area of Banghabandu Sheikh Mujibur Rahman Agricultural University, Ghazipur, Bangladesh during 2007-08. Ten different host species involved in study were sweet gourd (*Cucurbita moschata* L.), bottle gourd (*Lagenaria siceraria* L.), ash gourd (*Benincasa hispida* L.), bitter gourd (*Momordica charantia* L.), sponge gourd (*Luffa cylindrica* L.), ribbed gourd (*Luffa acutangula* L.), snake gourd (*Trichosanthes anguina* L.), cucumber (*Cucumis sativus* L.), khira (*Cucumis sativus* L.) and musk melon (*Cucurbita melo* L.). Estimation of leaf consumption made in entomology laboratory of the department. Samples were collected from growing plots by visiting the plots and noting the damaged the adult and emerging leaves. Number of red pumpkin beetle was counted manually present on each plot in the field and this operation continues throughout the growing season. Leaf consumption estimation of red pumpkin beetle was calculated under controlled conditions in laboratory. For leaf consumption estimation, red pumpkin beetle was starved for 12 before release. Maximum preferences were given to musk melon (*Cucurbita melo* L.) which was also high in chlorophyll contents.

[72] Ali *et al.,* conducted a study on bitter gourd against red pumpkin beetle. Experiment was conducted during April 2009 at research farm of Khyber Pakhtunkhwa Agriculture University Peshawar. Experiment was laid out according to RCBD in split plot arrangement pattern. The main purpose of the experiment was to evaluate the effectiveness of different botanicals against red pumpkin beetle. They used 3 different plant extracts as control measures. The botanicals used in the experiment were as; *Azadirechta indica*, *Parthenium* spp. and Eucalyptus leaf extracts having one chemical control as standard was also incorporated to standardize the results. Comparative efficacy of three different extracts, one chemical control measure and a check was calculated. Although chemical show a knockdown effect but botanicals also found to be effective control measure against the pest. The results obtained from the experiment can be summarized as that the application Parthenium spp. extract was found to be highly effective in controlling the red pumpkin beetle while compared with other botanicals sprayed.

[73] Ramanuj *et al.*, conducted field trials to assess the potential plant extract and entomopathogenic fungi for the control of red pumpkin beetle on bottle gourd from cucurbits. Research trials were conducted to determine the bio-efficacy of two indigenous plant products, viz. seed extracts of *Strychnos nuxvomica* and *Pachyrrhizus erosus*, using petroleum ether as solvent and two entomopathogenic fungi, viz. Beauveria bassiana and Metarhizium anisopliae, for the management of red pumpkin beetle, Aulacophora foveicollis on Narendra Rashmi bottle gourd. Both the botanicals were used @ 2.0, 3.0 and 4.0 ml/lit. of water while the entomopathogenic fungi, were used @ 2.0 g, 2.5 g and 3.0 g/lit. of water, keeping an untreated control. Significantly maximum decline in damage (70.2%) was achieved in treatment with *B. bassiana*, when used @ 3.0 g/lit of water along with crop yield of 315.36 q/ha, as compared to untreated control, followed by *S. nuxvomica* (65.4% at 4.0 ml/lit), *M. anisopliae* (64.7% at 3.0 g/lit.) and *P. erosus* (60.9% at 4.0 ml/ lit.), vis-a-vis crop yield of 298.18, 286.48 and 278.81 q/ha, correspondingly. *B. bassiana* @ 3.0 g/lit. of water recorded the highest economic return with a B:C ratio of 21.54:1 as compared to control plot.

Study to find out preferred cucurbit host(s) of pumpkin beetle and to determine susceptibility of ten different cucurbits to the pest, a trial was performed under field conditions by [74] Khan during 2012. Results obtained from the experiment revealed that most preferred host of the red pumpkin beetle (*Aulacophora foveicollis*) was muskmelon followed by khira, cucumber and sweet gourd and said to be most susceptible hosts. Bitter gourd, sponge gourd, ribbed gourd and snake gourd were least or non-preferred hosts of *Aulacophora foveicollis* and these may be said as resistant hosts. Other two crops, the bottle gourd and ash gourd were moderately preferred hosts of red pumpkin beetle and these may be graded as moderately susceptible hosts. During the study the host range of blue pumpkin beetle was also observed and it was provoked that the hosts most preferred to red pumpkin beetle are less preferred or not preferred to the blue pumpkin beetle. Data obtained from filed trials revealed that the listing of red pumpkin beetle presence for ten tested cucurbit hosts was; muskmelon> sweet gourd> cucumber > khira > ash gourd > bottle gourd > sponge gourd ≥ ribbed gourd ≥ snake gourd > bitter gourd.

[75] Hassan *et al*., in experiment studied the host preferences of red pumpkin beetle against selected plant in field conditions and laboratory conditions as well. Host susceptibility of the pest was determined in Department of Entomology, Bangladesh Agriculture University. Three selected varieties from Cucurbitaceous family were cultivated in the field. Results showed that sweet gourd was more preferred as compare of bottle gourd by the beetle and bottle gourd was more preferred in compare of bitter gourd.

[76] Khan *et al*., performed an experiment on the influence of weather factors against red pumpkin beetle for its distribution in field. Study was conducted in the experimental field of Bangabandhu, Sheikh Mujibur Rahman Agriculture University, Ghazipur. Various cucurbit crops like sweet gourd (*Cucurbita mosehata* L.), bottle gourd (*Lagenaria siceraria* L.), bitter gourd (*Momordica charantia* L.), sponge gourd (*Luffa cylindrica* L.), ribbed gourd (*Luffa acutangula* L.), cucumber (*Cucumis sativus* L.) and muskmelon (*Cucurbita melo* L.) were grown in experimental area. Randomized complete block design was followed in experiment with four replications. Muskmelon was the most preferred host by red pumpkin beetle (*Aulacophora foveicollis*) and weekly average number of beetles found was almost 14 beetles/ plant during the peak infestation periods.

[77] Nath and Ray conduct a survey to get estimate about the traditional management of red pumpkin beetle, *Aulacophora foveicollis.* Survey was focused on four villages Alenpur, Dargakona, Katigorah and Narsinghpur in Chachar district. It was obvious from the survey that 80% of the farmers were engaged in the cultivation of cucurbit crops along with other crops in Katigorah and Narsinghpur villages while the minimum cultivation was

found 65% in Dargakona district. Material used was about 77.50% of Cow dung and fly ash as control followed by red chili powder (50%). The minimum used material was *Kala maati* used about 25%. Pesticides were also the part of control strategy for the management of this notorious pest. Infestation recorded from Alenpur and Narsinghpur was cent per (100%) cent followed by 85% in Katigorah while the least infestation was recorded in Dargakona (20%).

[78] Bharathi and John during their study on momordica genus in India emphasize on red pumpkin beetle, *Aulacophora foveicollis* the annoying pest of the crops. Pest is disturbing the field crops and farmer by causing extensive damage to economic crops. Initial stages of the pest feed on young seedlings and cotyledonary part of plant whereas the adult beetle arrests the growth of the plant by feeding plant parts like leaves and roots, gregariously. *M. dioica* was found to be most attractive host by the beetle while least damage was done to *M. balsamia*. Some of control measures were also illustrated to reduce or minimize the incidence of red pumpkin beetle. Mixing of carbaryl 10 % WP in pits before sowing the seeds destroys grubs and pupae. Spraying of Sevin 50 WP (2 g/L) was also effective control measure. Farmers practicing, dusting of ash by mixing with kerosine to repel the insect, however, heavy dusting arrests growth of seedling. Results revealed that *Parthenium hysterophorus* plant extract have the ability to minimize the population below injury level of red pumpkin beetle in bitter gourd and the extract can be used instead of synthetic pesticides or can be supplemented to avoid excessive use of chemicals for the safe and friendly environment.

[79] Osman *et al.,* perform an experiment to determine 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, *Aulacophora foveicollis.* Bottle Gourd variety BARI Lau-4 was used as host plant and it was planted at Entomology Field of Bangladesh Agricultural University (BAU). Experiment was carried out following Randomized Complete Block Design (RCBD) with three replications. Effectiveness of each treatment against the pest was evaluated on the basis of beetle population per plant and leaf infestation at 24, 48, 72 HAT (hours at treatment) and 7 DAT (days after treatment) in field level. Since, the effects of both chemical insecticides, Larvin 75 WP and Diazinon 60 EC were found to be statistically alike and highly effective in reducing beetle population. Considering the effect of botanicals, Neem @7.5% respond better for beetle population whereas beetle population was relatively higher in Bishkatali Leaf Extract treated plots. Number of beetles per plant was minimum at 24 HAT (hours after treatment) that exhibited upward trends with increasing intervals. It was also noticed that percent leaf infestation declined only in the chemicals preserved plots other than few omissions.

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