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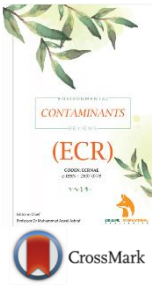

RESEARCH ARTICLE

A REVIEW ON HOST PREFERENCE, DAMAGE SEVERITY AND INTEGRATED PEST MANAGEMENT OF RED PUMPKIN BEETLE

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ABSTRACT

Cucurbitaceous vegetables are the major source of income for small holding farmers in Nepal. However, production potential of this vegetable is hindered by many pests like red pumpkin beetle, fruit fly, cucurbit stink bug, cucumber thrips, cutworms etc. Red pumpkin beetle (RPB) has been a significant concern in cucurbit production, damaging from germination up to harvesting. This paper analyses host preference shown by RPB among different cucurbits along with severity of damage. Moreover, this paper shows heavier application of insecticides to control RPB which has adverse effect on human health and agro-ecosystem. In order to reduce such haphazard application of insecticides, other control techniques need to be formulated and familiarize with farmers. Integrated pest management (IPM) is the best option that provides several measures, alternative to insecticide and facilitates sustainable environment management. Result shows different eco-friendly techniques practiced by farmers. In addition, it elicits appropriate integration of such techniques in a research station that are applicable to farmer's field.

KEYWORDS

RPB, Preference, IPM, eco-friendly.

1. INTRODUCTION

Cucurbits belongs to the family cucurbitaceae. It is the largest group of the summer season vegetable crop encompassing 130 genera and 800 species (Weng, 2011). These are largely grown in tropical and subtropical parts of the world. Next to tomato and onion, cucumber and melons are the third most widely cultivated vegetable crop in the world (Pitrat and Melon). In current scenario, cucumber, watermelon, melon and pumpkin are the four most commonly cultivated cucurbits. China, Iran and Turkey are the major producers (FAO, 2017). In Nepal, this is one of the major vegetable group occupying 20-21 % of total cultivated area of vegetable and contributing same level of production (MOALD, 2015). These are rich source of vitamin A and Ca.

Higher moisture content and lower fat percentage makes them popular with the consumer. Also, they have diversified use as salad, cooked vegetable, dessert, pickle forms, confectionary, musical instruments and indoor decorator. Seed contains 50% edible oil and 35% protein by wt (Weng, 2011). About 15 species of cucurbits are commercially cultivated in Nepal within an area of 57,144 ha with the productivity of 13.7 Mt/ha (MOALD, 2015). This level of production is lower as compared to other producing countries. Incidence and infestation by pest is the major limiting factor causing 25-35% of loss in crop production in Nepal (PPD Annual Progress Report, 2010).

Red pumpkin beetle (*Aulacophora foevicoliis*) is most serious pest of cucurbitaceous vegetable crops (Saljoqi and Khan, 2007). *Aulacophora* is Polyphagous and attacks more than 81 plant species and prefers cucurbit vegetable causing great loss in cucurbits production in Nepal. It causes damage from seedling stage up to harvesting stage. Both grub and adult are harmful to the crop. Grub feeds on root tissue and cause direct damage to the seedlings. Adult cause damage by feeding leaves, flower buds and flowers.

Most commercialized farmers rely on the use of synthetic pesticide for the control of this pest. It has been estimated that more than 90% of imported pesticide is applied in vegetable farming (Aatrya and Sitaula, 2010). The pesticide application is increasing annually by 10-20% (Diwakar et al., 2008). The statistical report shows that average weight of pesticide consumption is 396 gm a.i/ha (PPD Annual Progress Report, 2010). This level of pesticide application is low as compared to other countries. But application level of pesticide in commercial vegetable regions is unusually high about 1450 gm a.i/ha (Thapa, 1997). Many farmers are unaware of the long term and indirect effect of the pesticides on human health, crop production and environment. This indicate an urgent need of better way and strategy to minimize the improper use of the pesticide. Integrated pest management is a complement and alternative to synthetic pesticide application (Pretty and Bharucha, 2015).

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Moreover, it is careful consideration of all available pest control techniques that discourages the pest population and keep pesticide to the level that is economically justified (FAO, 2017). Although, Red Pumpkin Beetle has been serious concern in cucurbit production sector no any attempts have been made in thorough study giving complete information regarding the pest. This paper joins all the information and provide overall review about the host preference, extent of damage in cucurbits and IPM measures of Red Pumpkin Beetle.

2. Materials and Methods

This review has been made consulting relevant research papers and annual reports. Gathered information is categorized as problem identification, loss analysis, host preference, extent of damage and IPM measures. These are arranged systematically

3. Result and Discussion

3.1 Problem Identification

In the field of cucurbits insect pest like Red Pumpkin beetle, Fruit fly, Cucurbit stink Bug, Spotted beetle, cutworm, Aphid, Mealy Bug, Soybean Hairy Caterpillar, Banded blister beetle and white Grub were observed (Rajbhandari, 2015). Red pumpkin beetle is common and major pest of wide range of cucurbits (Pessarakli, 2016). It is a very destructive pest and cause substantial damage to almost all cucurbits (Khan et al., 2015). *Aulacophora* is one of the important constraint that attack cucurbits regularly.

3.2 Damage Severity

Aulacophora is a serious pest of cucurbits (Atwal, 1993). It is polyphagous and attack more than 81 plant species (Doharey, 1983; Kamal et al., 2014). Losses by the attack of this pest is obvious which ranges from 35-75% at seedling stage and it declines as canopy increases (Saljoqi and Khan, 2007; Yamaguchi, 1983). Beetle starts to attack the plant right after the germination and slows down the growth due to severe damage (Khan, 2015). In some cases it cause 30-100% yield loss in cucurbits (Khan et al., 2015; Dhilon et al., 2005). *Aulacophora* is one of the important constraint as it attack every stages causing great loss in cucurbit production. Sometime, these beetles damage to such an extent that the crop needs to be re-sown 3 to 4 times causing great loss in seed, labor and delay in crop production (Pradhan, 1969; Khan et al., 2010).

Severity of damage is more on cotyledons and young leaves, but they also feed readily on flowers and mature leaves. The destruction is very high particularly during March-April when the creepers are young (Khan, 2018). Activity of both larva and adult is responsible for the damage. Larvae feeds on the root tissue, underground parts of the plant and cause direct damage to the newly developed seedling. Also, larva feeds on rind of the fruit touching the soil surface making it unfit for consumption (Butani, 1984; Khan, 2012). The adult feed voraciously on leaves making irregular holes, cotyledons, flower buds and flowers (Butani, 1984; Khan, 2012). It may cause up to 70 % damage on leaves and 60 % damage on flowers while 100% fruit damage is also reported in most of cucurbits (Rajbhandari, 2015; Khan, 2012; Alam, 1969).

3.3 Host Preference

Aulacophora is polyhagous insect and prefers cucurbit vegetables (Butani, 1984; Khan et al., 2011). It is a major pest and cause considerable damage on almost all cucurbits (Khan et al., 2015). Originally, it is a pest of pumpkin, Bottle gourd, Muskmelon, but it feeds other cucurbitaceous vegetables as well (Annadurai and Raman, 1985). In literature significant variation for host preference of red pumpkin beetle among different cucurbits has been reported. Field trials of 10 cucurbits against red pumpkin beetle in relation to the preference shows the order as muskmelon> sweet gourd> cucumber > khira > ash gourd > bottle gourd > sponge gourd ≥ ribbed gourd ≥ snake gourd > bitter gourd (Khan, 2012). Similarly, the net cage experiment on RPB revealed that the leaf damage on ten cucurbits as

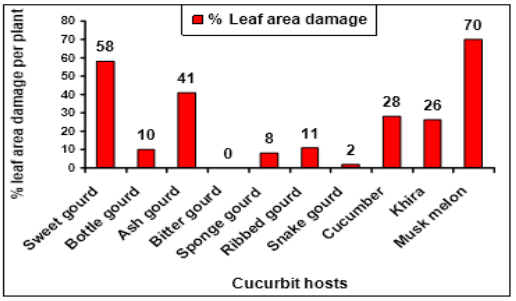

Figure 1: Leaf area damage by RPB under net cage condition (Khan et al., 2011).

The study on food preference of RPB in 11 cucurbitaceous crops showed that muskmelon as most preferred, snake gourd as least preferred while bitter gourd was not preferred (Rajak, 2001). Apart from the preference among cucurbits, Red pumpkin beetle shows variable infestation within a crop. Study on influence of growth stage in the incidence of the pest showed the result as

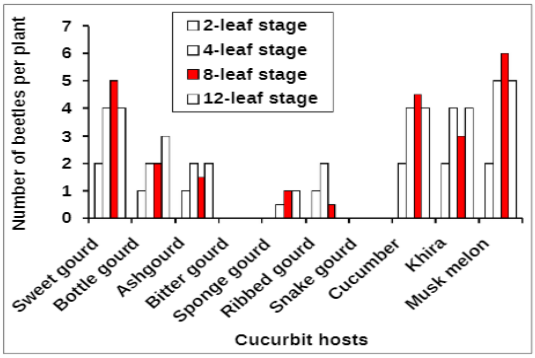

Figure 2: Population of red pumpkin beetle per plant at 2, 4, 8 and 12 leaf stage in different cucurbit host (Khan et al., 2010).

Sinha and Krishna reported the differential preference of red pumpkin beetle within cucurbitaceous crop (Sinha and Krishna, 1970). It has been demonstrated that polyphagous insect strongly prefer less nutritious mature leaf tissues (Khan, 2013; Evans, 1984). Raman and Annadurai in 1985 also reported that higher and strong preference for mature leaves and flower compared to young and senescent leaves. There is positive correlation between RPB populations per leaf with the % nitrogen, total and reducing sugar content of the mature leaves of cucurbits (Khan, 2013). Also the pattern of food consumption on a mature and senescent leaves shows a direct relationship of leaf nitrogen, protein content, carbohydrate and total phenolic contents (Annadurai and Raman, 1985). Thus the differential preference of RPB among and within a cucurbits could be due to the distribution and varied concentration of such biochemical.

3.4 Integrated Management

It is simply the integration of different control measures in a feasible way which is economically affordable and ecologically sound. It is an approach that provide number of methods to reduce damage. In addition to reduction of pest population, IPM projects have been able to increase yield (Pretty and Bharucha, 2015). IPM has been promoting since 1983 in nine countries of south east by the Food and Agriculture Organization (FAO, 2017). In Nepal, IPM was initiated in 1997 A.D as IPM-Farmer Field School in support of Food and Agriculture Organization (PPD Annual Progress Report, 2010). Also the tenth year plan mentioned that IPM will be promoted to reduce excessive dependency on synthetic agro-agrochemicals.

3.5 Mechanical Method

The traditional and older mechanical practice, collection and destruction of adult beetle is still on practice. This would be an effective approach in management if we consider the movement of this pest as the beetle shows its abundance in upper part during morning and evening while it gets reversed during day time (Khan, 2014). The investigation was carried out

to compare the performance of different control measures viz., yellow sticky trap, pit fall trap and light trap. Among them yellow sticky trap was found to be the best control measure for the reduction of percentage leaf infestation of red pumpkin beetle and number of beetles per plant (Rashid et al., 2015). As Seedling stage is the most preferred and sensitive stage, protection at this stage is considered most critical. Research on management of RPB showed that polyethylene cages protected cucumber seedlings effectively against infestation by *Aulacophora foveicollis* for up to 1 month after germination (Chaudhary, 1995). Along with this, research on different management tactics of RPB revealed that use of mosquito net barrier as the effective measure and was found to be statistically similar with the chemical Nitro 505 EC@1 ml/l water at the seven days interval (Khordheduzzaman et al., 2010).

3.6 Cultural Method

It includes manipulation of different agronomic practices that favors the crop. The tillage practice, deep ploughing expose the grubs and kill them and earlier sowing of the crops during winter season in the month of November escapes the infestation to some extent (Dhaliwal ans Atwal, 2005). Deep ploughing and winter cultivation was also recommended as a non-chemical control measure of RPB by Saleem and Shah (Saleem and Shah, 2010). Ploughing just after the harvesting destroy the hibernating adult beetle, collection and burning of remnant of creepers, clean cultivation are important cultural measures in maintaining the pest population below economic injury level (Lal et al., 2014). Application of adequate fertilizer, irrigation which facilitate the vigorous growth of the crop were more likely to outgrow the damage caused by the beetle. Heaping of earth at the base of the plant before oviposition occurs and removing it along with the eggs, flooding irrigation before sowing and planting while furrow irrigation in crop standing field which only moistened the crop root but desiccate the eggs and grubs have profound effect on reduction of pest population (Pawlacos, 1943). The host preferential behavior of this beetle among the cucurbits could be used to devise more ecofriendly and sustainable practice (Rahman et al., 2016). Different research and reports showed that the most preferred host are sweet gourd, muskmelon and cucumber and these crop can be used as a trap crop (Khan, 2018). Thus, the adoption of different agronomic techniques which makes adverse condition for RPB are crucial in its management and reduction of extent of damage.

3.7 Botanical Method

Simply, botanical materials in pest management are natural insecticide. These are naturally occurring chemicals which may act as repellant, anti-feedant, protectants, toxicants, sterilant and growth inhibitor in course of crop protection from insect pest. Unlike, the synthetic pesticide that kills both targeted and non- targeted pest, these botanicals are relatively active against former one (Guleria and Tiku, 2009). Different parts of plant can be used either in crude form or after extraction. Study report shows neem (*A. indica*) as a potent botanical pesticide and its wide use either singly or in combination with other synthetic pesticide (Khan ans Wassilew, 1987). Neem based derivative like neem oil could be used for the control of the red pumpkin beetle in cucurbits along with aqueous NSKE (Gujar and Mehrotra, 1998). A field experiment on management of RPB using botanicals showed the result as:

Treatment	% Population reduction	% leaf infestation reduction percentage
Aloe vera	26.70	13.46
Neem (*Azadirachta indica*)	36.43	37.50
Moringa oleifera	27.88	24.73
Control	-	-

Figure 3: Comparision of data regarding population reduction (%) and leaf infestation(%) reduction of red pumpkin beetle against different botanical insecticides (Rashid et al., 2016).

Similarly, study report revealed that 1% ethanol extract and 3% aqueous extract of *Melia azadirach* as effective in controlling this pest and were found to be at par with commercial formulation of neem i.e Econeem and Nimbicidine (Luna et al., 2008). Methanolic extract of leaves of cucurbit (Bitter gourd) itself were used against RPB and found to have strong deterrant property (Abe and Matsuda, 2000). Four different chemicals Methomyl (Synthetic Pesticide), *Parthenium hysterophorous* extract, Neem seed extract and Eucalyptus leaves extract were applied against RPB and found that Methomyl and *Parthenium* extract as most effective (Ali et al., 2011). A laboratory experiment on repellent property of extracts of *Azadirachta indica, Annona squamosa, Convolvulus microphyllus* and *Melia azedirach* against RPB was conducted and showed all as significantly effective. Among these *Azadirachta indica* elicited highest repellency (Tandon and Sirohi, 2009). Bio-efficacy of different indigenous plant extract like *Ocimum, Pogostemon, Salvia, Mentha, Coleus* were studied and found that *Coleus* had the highest anti-feedant activity than other plant extract (Chandel et al., 2009). Thus the plant extract can be used instead of synthetic pesticides or can be supplemented to avoid excessive use of chemicals. There occur variation in the level of protection by same bio-pesticide (neem) to various cucurbitaceous crops and this could be due to the possible interaction with the feeding stimulants and deterrents present in varying proportions in cucurbits (Gujar and Mehrotra, 1998; Abe and Matsuda, 2005).

3.8 Biological Method

Use of natural enemies, has been accepted as an effective, environmentally non-degrading, technically appropriate, economically viable and socially acceptable method of pest management (Singh, 2004). Among all, biocontrol offer as prominent alternative to the use of chemical pesticide in agricultural crop protection. It is evident that entomo-pathogenic fungus *Beauveria basiana*(B_8) is effective and is highly recommended for the management of RPB (Moorthi and Balasubramaniam, 2016). Along with *Beauveria, Metarhizium anisopliae* 3g/ltr was found to be significant in controlling the Red Pumpkin Beetle (Vishwakarma et al., 2011). Several natural enemies attack this beetle in several parts of the world. The biological agent Tachinid fly (*Medinodexia morgani*) and Reduviid Bug (*Rynocoris fuscipes*) are the important predator and the mite (*Histiostoma spp.*) act as effective parasite against this pest (Sami and Shakoori, 2008). The research on management of this beetle revealed the significant effect of egg parasitoid: *Trichogramma spp*. and larval Parasitoids: *Brachymeria tachardiae*, *Trichospilus pupivora* in controlling the population of this pest (Lal et al., 2014).

3.9 Chemical Management

Along with the cucurbits most of the vegetable producers depends upon the use of synthetic pesticide in pest management (Rajbhandari, 2015). Among different insecticide Carbaryl, Cypermethrin, Chloropyriphos and indoxcarb were found to be effective and recommended to the farmers (Ratnakar et al., 2016). Also Saleem and Shah in 2010 recommended the use of carbaryl, deltamethrin, endosulfan and dichlorvos as an effective control measure. The investigation on application of different pesticide showed two sprays of Carbaryl at 0.2% in fortnight interval as the best control measure in reducing the beetle population and severity of damage (Lakshmi et al., 2005). Field experiment on cucurbitaceous crops also recommended the Carbaryl or Malathion at 0.1% (Rai et al., 2008). Field trials of 14 synthetic pesticide against red pumpkin beetle showed Phosphamidon as the effective pesticide followed by Carbaryl and endosulfan (Dabi et al., 1980). Seed treatment of cucurbits with the Carbofuran at 3% or 4% or soil application of Carbofuran after germination of crop were found as effective control measure (Sinha and Chakrabarti, 1983 (Sinha and Chakrabarti, 1983; Atwal and Dhaliwal, 2005). Mixing of Carbaryl 10% WP in pits before sowing the seeds destroys the grubs and pupae (Bharathi and John, 2013).

4. Conclusion

Red pumpkin beetle has been a limiting factor in cucurbit production in South East Asia. It injures almost all cucurbits and the extent of damage depends on the preference shown by this pest. Major cucurbits like muskmelon, pumpkin and cucumber are damaged severely. Similarly, significant damage is observed in mature stage of crop. The extent of damage may range from negligible up to 100% causing re-sowing or re-

establishment of field. In order to control this pest, farmers are applying unusually higher amount of insecticide without any consideration of human health and environmental conditions. Therefore, IPM which is beneficial to natural agro-ecosystem need to be disseminated among farmers. For this, biological agent *Beauveria basiana* can be used effectively. Similarly, neem seed kernel extract and *Parthenium* can be used in commercial scale. Likewise, the preferential behavior can be availed in cultural control techniques like trap crop and barrier crop. Mechanical practice like handpicking is economical in small scale or subsistence farming level. Integrating all of these techniques along with the small-scale application of insecticides like Carbaryl and Carbofuran can give the best result.

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