

Studies on insect pest complex and screening of improved varieties of bottle gourd (*Lagenaria siceraria*)

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(ENTOMOLOGY)**

By

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2012

CERTIFICATE - I

*This is to certify that the thesis entitled “**Studies on insect pest complex and screening of improved varieties of bottle gourd (Lagenaria siceraria)**” submitted in partial fulfillment of the requirement for the degree of **MASTER OF SCIENCE IN AGRICULTURE (Entomology)** of Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur is a record of the bonafide research work carried out by **Mr. Dharmal Satish Shrikrushna** under my guidance and supervision. The subject of the thesis has been approved by the Student’s Advisory Committee and the Director of Instruction.*

No part of the thesis has been submitted for any other degree or diploma (certificate awarded etc.) or has been published/published part has been fully acknowledged. All the assistance and help received during the course of the investigation has been acknowledged by him.

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LIST OF SYMBOLS

Symbol	Abbreviation	Stand for
$^{\circ}\text{C}$		Degree centigrade
<		Less than
%		Percentage
\pm		Plus or minus
	CD	Critical difference
	m	Metre
	d.f.	Degree of freedom
	hr	Hour
	g	Gram
	kg	Kilogram
	m	Metre
	mm	Mili meter
	max	Maximum
	min	Minimum
	SEm \pm	Standard error of mean
	SW	Standard week
	temp	Temperature

CHAPTER – I

INTRODUCTION

India is the second largest producer of vegetables next to China. Even though, the importance of growing vegetable crops has not been fully realized and hardly about 3 per cent area of the total cultivated crops is occupied by vegetables. However, the increasing knowledge of people about the nutritive value has persuaded them to include more vegetable in their day to day diet. Vegetables contain carbohydrates, proteins, minerals, vitamins and also possess medicinal properties. The role of vegetables as an essential or supplementary food in our daily diet is great, indeed they do not only adorn the table but also enrich the health of human being. Thus, vegetables play a vital role in the balanced diet of human being. According to human dietitians about 300 g vegetables per capita per day are required. But the availability of vegetables in India is only 183 g per capita per day. The low availability of vegetables in India is due to the high population pressure, heavy post harvest losses (approximately 35 %) and majority of population, being vegetarian. To meet the demand of people, it is very necessary to increase the productivity of vegetables. This can only be achieved by adopting the modern agricultural practices and providing the facilities for protection, storage and utilization of vegetables. At present, India produces 137.68 million tonnes of vegetables from an area of 8.21 million hectares. Anonymous., (2010-11) According to estimate Madhya Pradesh produce 31.12 lakh tonnes of vegetables from an area of 2.50 lakh hectares, under different vegetable crops Anonymous., (2009-10).

Among the different group of vegetables, the cucurbits form an important and big group of vegetable crops cultivated extensively in

India. Being a warm season crops, cucurbits are of tropical origin, mostly in Africa, Tropical America and Asia, chiefly South East. This group includes cucumber, muskmelon, water melon, bottle gourd, luffa, bitter gourd, pumpkin, squashes, pointed gourd, snake gourd and large number of trailing crops, belongs to the same family cucurbitaceae. Gourd is a generic name for species cucurbita. Chakravarty (1982) described 36 genera and around 100 species of this family in India. The cucurbits or cucurbitaceous crops play a vital role in the supply of fresh vegetables and to a good source of carbohydrates, vitamin A, C and minerals. The fruits are used as salad or for cooking or for pickling or as a desert fruits or candied or preserved. It has been difficult to estimate or quantify it because of absence of reliable statistics of their area and production in India. Amongst these bottle gourd, cucumber, pumpkin, are economically important vegetable crops cultivated in Madhya Pradesh and have its own importance as a human food, because of good source of nutritional components and income to the farmers.

Amongst these bottle gourd or white gourd flower [*Lagenaria siceraria* (Molina) Stand.] is one of the important vegetable crop grown throughout India and has got several vernacular names in different regions, viz., Lauki or Ghia or Kaddu in Hindi, Dudhi in Gujarati, Anapa or Sorakaya in Telugu, Surakai in Malayalam and Kanaries, Jati Lao in Assamese, Sorekayi in Tamil, Lau in Bengali and Oriya, Dudhya Bhopala in Marathi, Kaddu in Punjabi etc. It is being cultivated since unknown time and as a proof, the remains of gourd have been found in Mexican caves dating back to 7000-5000 B.C. The rind fragments of bottle gourd have been discovered in an Egyptian tomb dated at the time of 5th dynasty about 3500-3300 B.C. Whitaker and Davis, (1962). After observing the growth of wild related forms, it has now been concluded that the bottle gourd might have originated in Africa and carried to America by the ocean

currents. In India, it has been found wild on the coast of Malabar and in the humid forests of Dehradun (Yawalkar, 1965). Now a days bottle gourd is cultivated more or less in all the states in India. It is mainly cultivated in Gujarat, Uttar Pradesh, Haryana, Rajasthan, Punjab and plains of North India.

The bottle like shape of the fruits and use of the rind of the same as basket, jugs, pots, cutlery and containers of wines and spirit in the past before the advent of pottery, gave it the common name 'bottle gourd'. The fruits in green stage are used as vegetables and also for a preparation of some sweets. The hard shells of fruits are used as a water jug, domestic utensils, making musical instruments, floats for fishing net etc. The pulp of fruits, young stems and leaves of bottle gourd have many medicinal value. During the hot season, the cut surface of small sized fruit is rubbed on the flat of the feet and hands to diminish the effect of heat and also prevent constipation. It is easily digestible and its use is recommended during convalescence. The bitter fruits are poisonous and used as a strong purgative. From the view of nutritive value, it contains 0.2 per cent protein, 2.5 percent carbohydrates, 0.1 percent fat, 0.6 percent fibre and 96.1 percent water.

Such important cucurbitaceous crops are attacked by a number of pests and diseases, which cause severe reduction in the development of crop and also the yield. The important and common pests found on these crops are fruit fly [*Bactrocera cucurbitae* Coq.], red pumpkin beetle [*Aulacophora foveicollis* (Lucas)], black pumpkin beetle [*Aulacophora atripennis* (Fabricius)], pumpkin caterpillar [*Margaronia indica* (Saunders)], American serpentine leaf miner [*Liriomyza trifolii* (Burgess)], bottle gourd moth [*Sphenarches anisodactylus* (Walker)], aphids [*Aphis* spp.], banded blister beetle [*Zonabris postulata* Tk. and *Mylabris phlarata* Pall.], dudhi bugs [*Nesidiocoris tenuis* Reut. and *Gampsocoris* spp.]. Among these,

pumpkin beetle, fruit flies and American serpentine leaf miner are only the key pests, causing substantial loss every year. The various species of pumpkin beetles like red pumpkin beetle [*Aulacophora foveicollis* (Lucas)], grey pumpkin beetle [*Aulacophora cincta* (Fabricius)] and black pumpkin beetle [*Aulacophora atripennis* (Fabricius)] have been reported to feed on cucurbitaceous vegetables in India Atwal and Dhaliwal, (2002).

The red pumpkin beetle, *A. foveicollis* is one of the most important species in Madhya Pradesh damaging cucurbitaceous crops except bitter gourd. It is widely distributed and serious pest of cucurbits. The grubs of this beetles feed on roots and underground portion of cucurbitaceous crops and also fruits touching the soil. The beetles injured the cotyledons, flowers and foliage by biting holes into them. The affected underground parts start rotting due to secondary infection by fungi, bacteria etc., while the fruits infested, become unfit for human consumption. The early sown cucurbits were severely damaged that they have to be resown several times, causing great loss of labour, seed and also great delay in the production of cucurbitaceous vegetables.

Information on population dynamics, varietal susceptibility of this pest on bottle gourd under Madhya Pradesh condition is very scanty, hence the work was carried out to fulfill these lacunae.

Objectives

1. To study the population dynamics of red pumpkin beetle (*Aulacophora foveicollis*) on bottle gourd.
2. Incidence of insect pest complex on different varieties of bottle gourd.

CHAPTER – II

REVIEW OF LITERATURE

The red pumpkin beetle, *Aulacophora foveicollis* (Lucas) belongs to the family Chrysomelidae of the order Coleoptera. There are several species of this pest reported from different countries right from East Africa through different parts of India up to Australia. This pest has been described under several generic names but the two more commonly used are *Aulacophora* and *Raphidopalpa*. The corresponding pest in the new world has been generally described by generic name *Diabrotica* and most destructive and serious pest of cucurbits Pradhan, (1994).

Cotes (1891) reported three species of this pest viz., red pumpkin beetle, *Aulacophora (Raphidopalpa) foveicollis* (Lucas), blue or black beetle, *Aulacophora atripennis* (Fabricius) and grey pumpkin beetle, *Aulacophora cincta* (Fabricius) on cucurbits in India, of which the first is more destructive Varavdekar and Dumbre, (1992). It is widely distributed in Asia, Australia, Southern Europe and Africa Atwal and Dhaliwal, (2002). In India, it is most common in Uttar Pradesh, Punjab, Madhya Pradesh, Maharashtra, Bihar, Rajasthan and Gujarat.

2.1 Host plants

Host range and food preference is a factor for outbreak of *Aulacophora foveicollis* Gram in India Cotes, (1891), maize and tomato in Greece Pavlakos, (1943), cruciferous plants in Maharashtra Patil and Pokharkar, (1979) and sweet potato in Kerala Rajamma, (1982) were reported as a host plants of *A. foveicollis*. Singh and Gupta (1970) reported first time that Japanese mint - a cash crop for medicinal use as a host in Uttar Pradesh. *Calotropis gigantea* (Linn.) noted as a new host in Andhra Pradesh

Visvanathan *et al.*, (1982). The muskmelon, long melon, cucumber, pumpkin, bottle gourd, round melon, water melon, ash gourd, sponge gourd and bitter gourd were reported as host plants of this pest in Haryana (Sandhu and Bhalla, 1974). As per the report of Bogawat and Pandey (1967) and Vishwanath and Agarwal (1982), *A. foveicollis* infested all cucurbitaceous crops except bitter gourd. In contrast to this, the normal feeding of this pest on bitter gourd has been reported by Rawat and Mehra (1967) and Alikhan and Yusuf (1985).

Sandhu and Grewal (1986) observed that muskmelon, long melon and cucumber were highly preferred hosts of this pest in Punjab. According to Khan and Haleja (1987), red pumpkin was most preferred host for red pumpkin beetle and negligible feeding on bitter gourd, kakrol, snake gourd, water melon and muskmelon. Roy and Pande (1991) from Tripura reported seven hosts of this pest, amongst these red pumpkin was most preferred and sponge gourd was least preferred host. Similarly, the muskmelon, pumpkin, cucumber and sponge gourd were the hosts of *A. foveicollis* in Maharashtra Varavdekar and Dumbre, (1992). Mineo *et al.*, (1994) recorded this pest on melons at Sicily.

The first record of *Trichosanthes dioica* as a food plant of *A. foveicollis* and okra, sweet potato and green gram were collateral hosts reported in Assam by Das and Ishahaque (1998). Red pumpkin beetle was infesting on eleven crops *i.e.* pumpkin, cucumber, bottle gourd, ridge gourd, round melon, snake gourd, pointed gourd, brinjal, water melon, sponge gourd and berseem in Uttar Pradesh Rajak, (2001). As per the report of Johri and Johri (2003a) from Uttar Pradesh, sitaphal was the most preferred and common host followed by bottle gourd. Khokhar *et al.*, (2005) from Islamabad reported that Longmelon and musk melon showed 100%

damage after 10 days of germination and none of these plants reached the 5-true-leaf stage.

2.2 Nature of damage

Adults feed voraciously on leaves by making irregular holes on leaf lamina. The grubs of these beetles fed on roots, underground portion of the host plant and fruit touching with soil Kadam and Patel, (1957). The affected underground parts start rotting due to secondary infection by fungi, bacteria *etc.* while the fruits infested become unfit for human consumption Mathur *et al.*, (1987).

Pavlakos (1943) from Greece reported that the adult feeds on leaves of young plants, causing death or retardation of growth. Larva affect on the root and stem below the ground when plant was mature and fruiting as a result of which the roots and stem rot and were invaded by fungi. The plants wither and half ripe fruit of sweet melon dry in sunlight. Bogawat and Pandey (1967) observed that larva feeds on the root and stem, whereas adults feed on the foliage and fruits damage in commercial crops. Adult attacking young melon plant as soon as first shoot appeared and in heavy infestation, destroy completely and the leaves of larger plants were perforated Lucchese, (1945).

According to Nath (1963) the beetle feeds voraciously on the lower surface of the cotyledonous leaves and tender true leaves and flowers, so replanting was often necessary. He also noted that the stem damage was negligible in the infested crops. The length of vine and number of fruits per vine in bottle gourd were associated with the degree of damage by *A. foveicollis* Nath and Thakur, (1965).

Sandhu and Bhalla (1974) observed that larvae feed on root or underground stem portion for 2-4 weeks resulting in complete mortality of vines of cucurbitaceous crops. At a time the larvae bore

into the fruits or feed on fallen or decaying leaves. Adults feed on petals but do not destroy the sexual parts, holes were nibbled in the leaves while the whole growing points of the vine were spared. Venkatarayappa and Govindan (1978) reported that terminal shoot of brinjal damaged by adults. Adult of *A. foveicollis* eat leaf lamina, later make holes in the leaves of young seedlings and grub infest in the roots as well as fruits which come in contact with the soil so plant become dry and reduce the crop yield Vishwanath and Agarwal, (1982).

Roy and Pande (1991) reported that larval stage live underground and feed on roots, leaves and stem touching soil surface. Adult damaged leaves and flowers of pumpkin, muskmelon, bottle gourd and cucumber but not damaged the leaves and flowers of ridge gourd and sponge gourd. As per the report of Rajak (2001) from Uttar Pradesh, *A. foveicollis* caused more damage to the zaid (summer) season crops than *kharif*. The damage was caused by grubs as well as beetles. The beetles were very destructive to cucurbitaceous vegetables by damaging the cotyledons, flowers and foliage by biting holes into them, particularly during March-April when creepers were very young and the early sown cucurbits so severely damaged that they have to be resown Atwal and Dhaliwal, (2002).

2.3 To study the population dynamics of red pumpkin beetle (*Aulacophora foveicollis*) on bottle gourd.

Lucchese (1945) from Salerno showed that the overwintered adults resumed activity in April and become rare towards the end of June. The red pumpkin beetle remains active during March–October and undergoes hibernation in adult stage during winter Saini, (1958), Nayer *et al.*, (1976), Shinde and Purohit, (1978) and Bajwa and Mavi, (1981) and no hibernation of insect was recorded in West

Bengal Mukherjee and Raychaudhury, (1959). The larvae and adults of *A. foveicollis* were most active from 27°C to 32.2°C, but they were unable to survive at temperature exceeding 35.2°C. Sinha and Krishna (1969). Dutt and Dalpati (1977) from West Bengal reported that beetle remains active during winter. In contrast to this, the beetle remains inactive during winter (November-February) in Ludhiana (Sandhu and Bhalla, 1974).

Shinde and Purohit (1978) from Madhya Pradesh reported that the proportion of females declined from September onwards and rose from March onwards in cucurbits. Adult beetles were active from March to October, though the peak period of activity on cucurbits was April to June (Butani, 1979). According to Al-Ali *et al.*, (1982) the larvae and adults of *A. foveicollis* were most active at 27°C to 32°C, but they were unable to survive at temperature exceeding to 35.2°C. Roy and Pande (1991), *A. foveicollis* was active throughout the year in Tripura and being most dense in December and least dense in August on cucurbits.

Roy and Pande (1991a) recorded the favourable temperature for development and survival of red pumpkin beetle as 27°C. Rajak (2000) from Andhra Pradesh reported that maximum population of beetles on muskmelon was recorded during 18th standard meteorological week (April). The studies on pest status in summer vegetables carried out by Kumar and Kumar (2002) at Karnataka. They observed adult activity of pumpkin beetle during February-April and 1-4 adults per vine were feeding on leaves of mogekai plant (13% leaf damage).

Pallavi *et al.*, (2002) from Maharashtra found that *A. foveicollis* feeding on leaves of aster in February-March and in October-December had an average population of 0.3 adult per plant. The pest was lowest during pre-monsoon followed by monsoon periods

and highest damage potential by the beetle in germinating cucurbits plant in March-May (Johri and Johri, 2003b). Singh and Kumar (2003) reported that red pumpkin beetles were noticed in 3rd week of April and peak in the 3rd week of May on cowpea. Ghathala and Bajpai (2007) reported that the incidence of red pumpkin beetle on summer squash, pumpkin and ridge gourd appeared last week of February at 19.9°C mean temperature and 58.90 percent relative humidity with 1.20, 2.00 and 1.25 beetle per plant. The peak of beetle population, 2.75 beetles per plant on summer squash was obtained during third week of April with 31.70°C temperature and 27.65 percent relative humidity. Whereas on pumpkin and ridge gourd the maximum population (4.10 and 3.8 beetle/plant) was noticed during fourth week of April at 31.25°C temperature and 31.70 percent relative humidity. According to Rathod and Borad (2010). The highest incidence of the pest was noticed during August to September in kharif and March to April in summer.

Correlation with abiotic factors

The populations of *A. foveicollis* were negatively correlated with two abiotic factors (temperature and rainfall) on red pumpkin in Tripura Roy and Pande, (1991). The correlation of *A. foveicollis* on muskmelon with temperature was significantly positive and that with relative humidity was negative but non-significant Rajak, (2000). Singh and Kumar (2003) reported that the population of red pumpkin beetles was positively correlated with relative humidity on cowpea. Dangi (2006) observed positive correlation between beetle population and temperature and negative with relative humidity. He also found that temperature ranging from 22.25°C to 34.10°C and relative humidity from 21.50 to 39.50 percent provide favourable conditions for the multiplication of the red pumpkin beetle.

2.4 Incidence of insect pest complex on different varieties of bottle gourd.

Various control measures have been suggested from time to time but none of them provide completely satisfactory solution to the problem. Hence, efforts were directed toward host plant resistance. The development of a resistant variety with a good yield and quality would be most desirable for an economic control measures. The preliminary study of plant resistance to red pumpkin beetle was first initiated by Nath in 1962 and promising results were obtained (Nath and Thakur, 1965).

Nath (1963) at New Delhi conducted seven field experiments and reported that out of sixteen lines of musk melon, none of them were found to be able to resist the attack by beetle of *A. foveicollis*. All the tested fifteen lines of sponge gourd and ridge gourd including the Pusa Chikni and Pusa Nasdar were resistant and showed normal growth and yield inspite of the heavy population of beetle. Similarly, Nath and Thakur (1965) at New Delhi carried out thirteen experiments including cage experiment also. They reported that the line of bottle gourd NB 28 was highly resistant, NB 21 and NB 30 were susceptible and NB 22 and NB 25 were highly susceptible. The sponge gourd lines NS 9, NS 10, NS 11, NS 12, NS 14, NS 16 and NS 17, whereas ridge gourd lines NR 1, NR 2, NR 4, NR 5 and NR 7 were highly resistant to the pumpkin beetle.

Vashistha and Choudhury (1971) tested eight, ten, eleven and fifteen cultivars of *Cucumis melo*, *Lagenaria vulgaris*, *Citrullus vulgaris* and other *Cucumis* species against *A. foveicollis*, respectively. They reported that *Cucumis melo* cultivars Casaba and PI 70683 were highly tolerant and *L. vulgaris* cultivar S 28, *C. vulgaris* cultivars S 72, S 98 and Afghan were highly resistant and have lower amount of cucurbitacin. Similarly, Casaba cultivar of

muskmelon was noted highly tolerant to *A. foveicollis* by Vashistha and Choudhury (1974).

Pal *et al.*, (1978) tested 287 indigenous and exotic pumpkin germplasms to *A. foveicollis* in pot experiment in Karnataka. Results indicated that lines 596-2 and 613 showed promising resistance on the basis of percentage damage to the cotyledonary leaves having low cucurbitacin content. The Pumpkin LC 28 was highly resistant to the pumpkin beetle (Grewal, 1982). Pareek and Kavadia (1993) in Rajasthan carried out field experiment and reported that out of 17 screened varieties of muskmelon, none of the varieties escaped from the damage by *A. foveicollis*. The variety Durgapura madhu was the most susceptible followed by Hara madhu, NO 45, Punjab hybrid and Hara gola on the basis of population (5-8 beetles/5 plants) and damage (4.0 damage score) in seedling stage. Wadhero *et al.*, (1998) Studies on the relative resistance or susceptibility of sesame cultivar S-17, P-18, PR-14-2 and PR-19-2 against major sesame pests leaf roller, whitefly and red pumpkin beetle (*A. foveicollis*). The population of whitefly and red pumpkin beetle was significantly lower on PR-14-2, rendering it less susceptible, PR-19-9 had moderate infestation and S-17 and P-18 harboured maximum population and were the most susceptible cultivars. The bottle gourd germplasm VRBG-91 and VRBG-105 were reported as resistant and susceptible, respectively in Uttar Pradesh by Satpathy *et al.*, (2002).

Saljoqi and Khan (2007) from Peshawar valley reported two sponge gourd (*Luffa scutannils*) cultivars, RKS-6, RKS-7 and three gourd (*Lagenaria siceraria*) cultivars, DIK round green, SW sweet yellow and bottle gourd long cultivars were found moderately susceptible to the attack of the red pumpkin beetle. The damage leaf area among test cultivars varied from 17.45% in VRBG-50 to 34.32% in NDBG-56 only four cultivars that recorded less damage were VRBG-50 (17.45%), VRBG-48 (17.79%), VRBG-43 (17.83%),

VRBG-17(18.31%) on the other extreme the cultivars manifesting greater susceptibility to the beetle damage were NDBG-56 (34.32%), PSPL (33.77%), DVBG-2(1) (29.17%) and VRBG-46 (28.55%). (Shivalingaswamy *et al.*, 2008) Hari Har Ram *et al.*, (2009) recorded the observations at seedling and adult plant stages, in various cucurbit germplasm. In bottle gourd 28 lines were screened and 6 lines were found highly resistant to pumpkin beetle at seedling stage, in muskmelon, 78 lines were screened and only PMM-144 was resistant to red pumpkin beetle at seedling stage.

Rathod and Borad (2011) Six promising genotypes for resistance against *A. foveicollis* were screened during Kharif 2004 and summer 2005. Pooled analysis for the two seasons revealed that significantly the lowest (3.72) number of beetles was found on APKL-7, followed by APKL-2 (4.04 beetles per plant) and APKL-4 (4.33 beetles per plant). APKL-6 exhibited higher (5.19) beetle population but it was at par with Local cultivar (4.97). Pooled data over the two seasons on fruit yield of pumpkin showed that APKL-7 produced higher yield (373.52 q/ha) than all the genotypes/cultivars, except for APKL-2 (359.6 q/ha). APKL-4 and APKL-00-06 were found at par and produced 333.72-340.41 q fruits/ha. APKL-6 had poor yield (263.35 q/ha) potential and it was statistically at par with Local cultivar (267.02 q/ha).

CHAPTER-III

MATERIAL AND METHODS

The present chapter deals with the materials used and methods employed to fulfill the objective of the investigation on the topic “Studies on insect pest complex and screening of improved varieties of bottle gourd (*Lagenaria siceraria*).” Field investigations on population dynamics of red pumpkin beetle, *Aulacophora foveicollis* (Lucas) and incidence of insect pest complex on different varieties of bottle gourd were carried out during the rabi season of the year 2011 at Main Vegetable Research Station, College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (MP). The data obtained from field trials were analyzed statistically by using suitable transformation. The detailed methodology adopted for various aspects are presented here as under.

3.1 Climatic Condition

Jabalpur is situated between 22⁰49' and 24⁰8' North latitude and 78⁰2' and 80⁰58' East longitude, at an altitude of 411.78 m above the mean sea level. The climate of the region is typically semi-humid and sub tropical. Jabalpur comes under the agro climatic region of Kymore plateau and Satapura hills and lies in rice-wheat crop zone of the state. The mean annual rainfall is nearly 1423 mm which is received mostly between mid-June to mid-September. The mean maximum temperature during the hottest month of May and June varies from 45.5⁰C to 46.4⁰C. January is the coldest month with mean maximum and minimum temperatures of 24.4⁰C and 7.3⁰C, respectively. The meteorological data during the course of study *i.e.* from October 2011 to April 2012 is given in Appendix - I.

3.2 Nature of damage

The feeding behaviour and nature of damage caused by *A. foveicollis* on bottle gourd crops was observed critically in the field at seedling stage as well as later stage.

3.3 To study the population dynamics of red pumpkin beetle (*Aulacophora foveicollis*) on bottle gourd.

Observations on population dynamics of *A. foveicollis* on bottle gourd variety Jabalpur local (Long) were carried out during rabi season of the year 2011. The crop was sown in 2nd week of October. The observations were recorded by counting the numbers of adult beetles per plant on three selected leaves (top, middle and bottom) at weekly interval starting from one week of germination till end of crop. Data thus, obtained were correlated with abiotic factors to determine its effect on the population of *A. foveicollis*. The various stages of the pest were collected and reared in laboratory to know the activity of natural enemies. But the natural enemies were not found during the study period; hence no correlation was made with pest activity.

3.4 Incidence of insect pest complex on different varieties of bottle gourd.

To ascertain relative resistance as well as to locate the source of resistance, twenty five (Table 1) promising varieties of bottle gourd were screened against red pumpkin beetle (*A. foveicollis*) in field condition.

Experimental details :

Number of treatments	:	25
Design	:	RBD
Replications	:	03
Plot size	:	6.0 x 2.5 m
Number of rows/ plot	:	02
Row length	:	5.0 m
Spacing	:	
Row to row	:	1.0 m
Plant to plant	:	1.0 m
No. of plant/plot	:	10
Date of sowing	:	12/10/2011

Table1: Treatment (varieties) evaluated in the experiment.

Tr.code	Variety	Tr.code	Variety
T ₁	Pusa Naveen	T ₁₄	Narendra Madhuri
T ₂	Punjab Komal	T ₁₅	NDBG-613-4
T ₃	Narendra Madhuri Selection	T ₁₆	Kashi Ganga-10
T ₄	Pusa Santusti	T ₁₇	Arka Bahar
T ₅	Narendra Shishir	T ₁₈	Dharwad
T ₆	Kashi Ganga	T ₁₉	Narendra Dharidar
T ₇	NS-421	T ₂₀	Wardan
T ₈	Dharwad Selection	T ₂₁	Pusa Samrat
T ₉	Narendra Rashmi	T ₂₂	Warad
T ₁₀	NDBGH-4	T ₂₃	Narendra Shiwani
T ₁₁	Jabalpur Local (Long)	T ₂₄	Pusa Samrudhi (OP)
T ₁₂	Ketan	T ₂₅	Sankar
T ₁₃	Narendra Shiwani Selection		-

The experiment was laid out in randomized block design with three replications. The seeds were sown by dibbling method and 2-3 seeds were sown at 1m. apart from one plant to another on both sides of 1m. wide irrigation channel made in the middle of the plots measuring 6 × 2.5 m. recommended cultivation practices were followed to raise a good and healthy crop.

Method of observation :

Three plants of each variety from each replication were selected randomly and tagged for recording the observations. The observations were recorded at weekly intervals by counting the adults beetles. The adult beetles were counted in each plant on three selected leaves (top, middle and bottom) and averaged. Data, so obtained were subjected to appropriate transformation and statistically analyzed for interpretation.

3.5 Yield, and Avoidable Losses

3.5.1 Yield

The yield is an important criterion for comparing the efficacy of different treatments. The treatment wise yield of bottle gourd was recorded during each picking from net plot area.

3.5.2 Avoidable losses

On the basis of yield of various treatments under study, the avoidable losses due to *A. foveicollis* infestation was calculated by applying the formula given by Poul (1976).

$$\text{Loss (\% due to pest)} = \frac{\text{Yield in treatment which gave the highest yield} - \text{Yield in any other treatment}}{\text{Yield in treatment which gave the highest yield}} \times 100$$

Statistical Analysis:

For testing the significance of simple correlation coefficient 't' test was applied which is expressed as.

$$t = \{ r / (1-r^2)^{1/2} \} \times (n-2)^{1/2}$$

where,

r = simple correlation coefficient.

n = total no of observations.

Analysis of variance

Following analysis of variance table was used :

Skeleton of analysis of variance (ANOVA)

Source of variation	d.f.	SS	MS	F cal.	F tab.
Replication	(r-1)				
Treatment	(t-1)				
Period	(p-1)				
T x P	(t-1) (p-1)				
Error	(r-1) (tp-1)				
Total	rtp-1				

The significance among different treatment means was judged by critical difference (C.D) at 5% level of significance for comparison among the treatments, for which the marginal means of each treatment was considered. The following formulae were used for various estimations:

Standard error for observation mean:

1) $SE_{m\pm}$ for Treatment = $\sqrt{\frac{EMS}{rp}}$

2) $SE_{m\pm}$ for Period = $\sqrt{\frac{EMS}{rt}}$

3) $SE_{m\pm}$ for Treatment x Period = $\sqrt{\frac{EMS}{r}}$

Critical difference (CD) :

1) CD between treatment = $\sqrt{2}$ x SE_m (Treatment) x t (5%) at error df.

2) CD between periods of observation = $\sqrt{2}$ x SE_m (Period) x t (5%) at error df.

3) CD between treatment x periods of observation = $\sqrt{2}$ x SE_m (Treatment x Period) x t (5%) at error df.

Where,

EMS = Error mean sum of square.

r = Number of replications.

t = Number of treatment.

p = Number of periods.

t = 't' Table value at 0.5% and 0.1% probability level.

$SE_{m\pm}$ = Standard error of mean.

CD = Critical difference.

CHAPTER – IV

RESULTS

The data generated on various aspects of *Aulacophora foveicollis* infesting bottle gourd by conducting the experiment in field were compiled and statistically analyzed. The results obtained are presented separately for each experiment under this chapter.

4.1 Nature of damage and behaviour.

Damage is caused by grubs as well as Adults. Adult beetles remained inactive during winter and hide under dry half rotten cucurbit vines, weeds left behind in the farm, bushes, standing crops as well as cracks and crevices in the soil. These inactive or hibernating beetles become active and start shifting to the growing cucurbits. Most serious damage caused by adults and found especially to the young and germinating cucurbits. Young seedlings is always preferred by the beetles and grubs due to its attractiveness and palatability. At young seedling stage, the beetles injured the cotyledons by biting holes into them as a result cotyledonary leaves withered and finally whole seedlings dried up. The grubs damage the plants by boring into the roots and underground stem. Sometimes, young seedlings of cucurbits damage severely that they have to be resown. At the time of flowering, male flowers is always preferred by the adults due to the pollens on which they survive. They feed on petals but do not destroy the sexual part of the flowers. The beetles made irregular holes into the leaves and eat away the interveinal space of the leaf. At the time of fruiting stage, the grubs bore into the fruits touching the soil. The affected under ground parts start rotting due to secondary invasion by fungi, bacteria etc., while the infested fruits became unfit for human consumption.

4.2 To study the population dynamics of red pumpkin beetle (*Aulacophora foveicollis*) on bottle gourd.

To know the effect of different abiotic factors on the population of *A. foveicollis* on bottle gourd crop, observations on activity of *A. foveicollis* on bottle gourd were recorded during rabi season of 2011 (Plate-II). The data obtained are presented in Table 2 and depicted in Fig.2

Bottle gourd [*Lagenaria siceraria* (Molina) Stand.]

The data (Table 2) on population of *A. foveicollis* adult beetles recorded during the rabi season 2011. indicated that the pest first appeared (1.33 beetles/plant) at 45th standard week (2nd week of November). The pest activity slightly increased from 47th standard week (4th week of November) and reached to peak (8.67 beetles/plant) on 14th standard week (1st week of April). The maximum and minimum temperature, morning and evening relative humidity, rainfall and number of rainy days during peak activity period were 37.8 °C & 20.2°C, 49 % & 17 %, 000.0 mm, 00 days respectively. Higher activity of the pest was noticed in the month of March and April.

Table No. 2: Population of *A. foveicollis* on bottle gourd variety Jabalpur Local (Long) during rabi 2011.

Sr. No.	Months	Standard weeks	Mean population of adult beetle/ 3 leaves/plant
1	November	44	0.00
		45	1.33
		46	1.67
		47	3.34
2	December	48	2.00
		49	1.34
		50	1.00
		51	3.00
		52	2.67
3	January	1	1.33
		2	2.34
		3	1.00
		4	2.33
4	February	5	4.34
		6	3.33
		7	3.00
		8	4.00
5	March	9	4.67
		10	5.00
		11	2.33
		12	4.00
		13	5.33
6	April	14	8.67

4.2.1 Correlation co-efficient between *A. foveicollis* population and weather parameters.

The correlation coefficient results of beetles population and abiotic factors during rabi season (Table 3) showed that the maximum and minimum temperature had significantly positive correlation with population dynamics of *A. foveicollis* beetles on bottle gourd crop is ($r = 0.48^*$) and ($r = 0.55^{**}$). Similarly, highly significant negative relationship was established between morning and evening relative humidity and *A. foveicollis* incidence is ($r = -0.71^{**}$) and ($r = -0.44^*$) respectively. The rainfall as well as number of rainy days had negatively correlated with beetle population but it was found non significant.

Table No. 3: Correlation co-efficient between abiotic factors and (*A. foveicollis*) activity on bottle gourd crop.

Sr. No.	Name of pest	Meteorological parameters					
		Max. Temp.	Min. Temp.	Morning humidity	Evening humidity	Rainfall	No. of Rainy days
		Correlation coefficient values					
1.	Red Pumpkin Beetle	+0.48*	+0.55**	-0.71**	-0.44*	-0.16	-0.07

* Significant at 5% level of significance

** Significant at 1% level of significance

The correlation coefficient studies between *A. foveicollis* population and weather parameters during rabi season 2011 indicated that the pest activity was increased with hot period of summer. The pest population was found higher when humidity

decreased in environment during monsoon season, but reverse trend was noticed in summer season.

4.3 Incidence of insect pest complex on different varieties of bottle gourd.

Considering the economic importance of *A. foveicollis* infesting bottle gourd, twenty five promising varieties were screened against this pest in field condition (Plate-I). The incidence of *A. foveicollis* was recorded at an interval of 7 days starting from one week after germination to crop maturity during rabi season. The mean data thus obtained were presented in Table 4 and depicted in Fig.3.

Bottle gourd [*Lagenaria siceraria* (Molina) Stand.]

Beetle population recorded on different varieties of bottle gourd (Table 4) revealed significant difference. Among the varieties screened, significantly least (1.20 beetle/plant) population were registered in Arka Bahar, followed by all the tested bottle gourd varieties, except Dharwad (1.21 beetles/plant), Narendra Rashmi (1.40 beetles/plant), Wardan (1.59 beetles/plant), NDBGH-4 (1.61 beetles/plant) and Narendra Madhuri (1.62 beetles/plant). The variety Dharwad Selection, Kashi Ganga-10, NS- 421, Warad, Punjab Komal, and Kashi Ganga. Was found at par to each other irrespect of beetle population/plant but significantly lower than remaining variety.

Table No. 4: Incidence of red pumpkin beetle (*A. foveicollis*) on different varieties of bottle gourd during rabi 2011-12.

Varities	Beetle Population /week/ Plant/3 leaves																		
	Periods Of Observation																		
	03/11/ 2011	10/11/ 2011	17/11/ 2011	24/11/ 2011	01/12/ 2011	08/12/ 2011	15/12/ 2011	22/12/ 2011	29/12/ 2011	05/01/ 2012	12/01/ 2012	19/01/ 2012	26/01/ 2012	02/02/ 2012	09/02/ 2012	16/02/ 2012	23/02/ 2012	01/03/ 2012	Mean
Pusa Naveen	1.12 (1.22)	1.00 (1.17)	2.11 (1.60)	1.38 (1.36)	2.11 (1.59)	1.65 (1.45)	1.75 (1.49)	1.71 (1.48)	2.82 (1.80)	2.37 (1.69)	0.71 (1.07)	2.82 (1.80)	1.67 (1.44)	1.67 (1.32)	1.67 (1.46)	1.41 (1.34)	3.33 (1.95)	3.33 (1.95)	3.85 (3.02)
Punjab Komal	0.33 (0.88)	0.00 (0.71)	0.71 (1.01)	1.38 (1.23)	1.08 (1.20)	1.16 (1.22)	0.38 (0.90)	0.38 (0.90)	2.18 (1.61)	2.08 (1.59)	1.42 (1.37)	1.85 (1.53)	1.71 (1.40)	0.41 (0.91)	0.71 (1.01)	0.11 (0.38)	1.89 (1.53)	0.96 (1.17)	2.08 (2.33)
N. Madhuri Selection	0.74 (1.05)	1.67 (1.46)	2.74 (1.79)	1.19 (1.64)	2.33 (1.68)	1.33 (1.34)	2.71 (1.78)	3.48 (1.98)	3.41 (1.96)	2.00 (1.52)	2.67 (1.77)	3.67 (2.02)	2.33 (1.66)	3.00 (1.81)	4.00 (2.08)	4.33 (2.18)	4.00 (2.08)	4.33 (2.20)	5.55 (3.56)
Pusa santusti	1.04 (1.20)	0.67 (1.05)	1.05 (1.19)	2.33 (1.20)	1.67 (1.44)	1.33 (1.34)	1.38 (1.36)	1.75 (1.49)	3.15 (1.90)	2.00 (1.56)	1.81 (1.50)	2.38 (1.67)	1.38 (1.36)	2.92 (1.84)	2.11 (1.60)	2.04 (1.51)	1.67 (1.44)	2.67 (1.76)	3.70 (2.93)
Narendra Shishir	0.37 (0.91)	1.33 (1.34)	0.78 (1.05)	1.04 (1.17)	1.04 (1.20)	1.33 (1.34)	1.41 (1.37)	2.16 (1.61)	0.38 (0.90)	0.00 (0.71)	1.77 (1.50)	2.41 (1.70)	2.37 (1.69)	2.33 (1.66)	2.67 (1.76)	2.16 (1.62)	2.00 (1.56)	2.89 (1.82)	3.16 (2.77)
Kashi Ganga	0.00 (0.71)	0.33 (0.88)	1.37 (1.29)	1.00 (0.88)	0.70 (1.02)	1.37 (1.29)	1.00 (1.17)	0.33 (0.88)	1.74 (1.46)	1.00 (1.17)	1.67 (1.44)	1.76 (1.47)	2.00 (1.52)	0.71 (1.01)	1.38 (1.36)	0.67 (1.05)	2.15 (1.61)	2.00 (1.56)	2.35 (2.42)
NS-421	0.00 (0.71)	0.04 (0.73)	0.38 (0.90)	0.33 (1.02)	0.67 (1.05)	1.00 (1.17)	1.41 (1.37)	0.71 (1.07)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	2.85 (1.82)	2.12 (1.60)	1.04 (1.10)	0.00 (0.71)	1.22 (1.15)	2.34 (1.68)	1.97 (1.57)	1.79 (2.20)
Dharwad Selection	0.37 (0.91)	0.00 (0.71)	0.00 (0.71)	0.70 (0.71)	0.04 (0.73)	0.04 (0.73)	0.00 (0.71)	0.00 (0.71)	1.22 (0.15)	0.00 (0.71)	1.83 (1.53)	2.30 (1.65)	2.42 (1.68)	2.44 (1.69)	2.84 (1.83)	1.85 (1.52)	1.63 (1.45)	2.22 (1.64)	2.21 (2.31)
N. Rashmi	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.04 (0.73)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	2.69 (1.78)	0.38 (0.90)	2.44 (1.70)	0.38 (0.90)	2.41 (1.70)	2.37 (1.69)	1.89 (1.54)	1.40 (2.00)
NDBGH-4	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	3.33 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	2.53 (1.70)	0.00 (0.71)	1.59 (1.37)	0.38 (0.90)	2.20 (1.62)	1.04 (1.18)	1.12 (1.13)	1.19 (1.24)	1.08 (1.26)	1.61 (1.94)
JabalpurLocal (Long)	0.37 (0.91)	2.52 (1.73)	1.79 (1.50)	0.00 (1.93)	3.33 (1.94)	4.59 (2.18)	5.55 (2.45)	3.75 (1.99)	4.23 (2.14)	4.33 (2.19)	4.46 (2.18)	3.46 (1.97)	5.00 (2.30)	2.33 (1.68)	4.67 (2.26)	3.33 (1.94)	3.00 (1.81)	4.00 (2.09)	6.75 (3.91)
Ketan	1.37 (1.32)	1.52 (1.33)	1.45 (1.39)	0.00 (1.68)	2.00 (1.56)	2.79 (1.79)	1.41 (1.37)	3.44 (1.98)	2.82 (1.82)	3.00 (1.82)	2.48 (1.72)	3.67 (2.02)	4.67 (2.26)	3.33 (1.93)	2.33 (1.68)	5.00 (2.32)	4.33 (2.16)	3.67 (2.04)	5.48 (3.58)
N. Shiwani Selection	0.37 (0.91)	0.44 (0.93)	0.70 (1.02)	2.33 (1.29)	1.00 (1.17)	1.41 (1.37)	1.82 (1.52)	1.75 (1.47)	1.71 (1.47)	2.00 (1.52)	1.67 (1.46)	1.71 (1.46)	1.67 (1.44)	2.33 (1.68)	2.67 (1.74)	2.33 (1.64)	3.00 (1.86)	2.00 (1.56)	3.44 (2.84)

Varities	Beetle Population /week/ Plant/3 leaves																		
	Periods Of Observation																		
	03/11/ 2011	10/11/ 2011	17/11/ 2011	24/11/ 2011	01/12/ 2011	08/12/ 2011	15/12/ 2011	22/12/ 2011	29/12/ 2011	05/01/ 2012	12/01/ 2012	19/01/ 2012	26/01/ 2012	02/02/ 2012	09/02/ 2012	16/02/ 2012	23/02/ 2012	01/03/ 2012	Mean
N. Madhuri	0.00 (0.71)	0.00 (0.71)	1.15 (1.22)	1.37 (0.73)	0.08 (0.76)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.70 (1.01)	1.75 (1.49)	0.38 (0.90)	0.38 (0.90)	1.19 (1.23)	1.72 (1.48)	3.59 (2.01)	2.24 (1.65)	1.62 (2.04)
NDBG-613-4	1.04 (1.20)	0.00 (0.71)	0.78 (1.06)	0.04 (1.34)	1.04 (1.12)	2.41 (1.67)	2.11 (1.59)	0.00 (0.71)	1.41 (1.20)	2.38 (1.67)	1.43 (1.38)	2.33 (1.64)	2.37 (1.69)	2.37 (1.67)	2.67 (1.76)	2.33 (1.68)	3.00 (1.86)	2.00 (1.56)	3.30 (2.83)
Kashi Ganga -10	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	1.33 (0.71)	0.08 (0.76)	0.00 (0.71)	0.00 (0.71)	1.16 (1.22)	0.38 (0.90)	0.37 (0.90)	0.76 (1.03)	2.77 (1.80)	0.41 (0.91)	2.46 (1.72)	3.36 (1.95)	1.52 (1.33)	1.08 (1.20)	2.43 (1.70)	2.01 (2.18)
Arka Bahar	0.00 (0.71)	0.00 (0.71)	1.04 (1.10)	0.00 (0.73)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	1.09 (1.20)	0.70 (1.01)	1.11 (1.12)	1.41 (1.29)	0.04 (0.73)	1.22 (1.25)	2.00 (1.48)	2.23 (1.63)	1.20 (1.91)
Dharwad	0.00 (0.71)	0.48 (0.94)	0.04 (0.73)	0.04 (0.71)	0.04 (0.73)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	2.85 (1.68)	1.37 (1.28)	1.04 (1.11)	0.42 (0.92)	1.70 (1.48)	2.08 (1.60)	0.86 (1.13)	1.21 (1.92)
N. Dharidar	0.37 (0.91)	0.67 (1.05)	1.33 (1.34)	0.00 (1.41)	2.33 (1.68)	2.56 (1.74)	2.44 (1.71)	2.15 (1.56)	2.48 (1.72)	1.78 (1.42)	3.33 (1.95)	3.33 (1.88)	2.67 (1.77)	3.00 (1.81)	3.67 (2.00)	4.67 (2.26)	3.67 (2.04)	3.67 (2.03)	4.90 (3.36)
Wardan	0.00 (0.71)	0.78 (1.03)	0.00 (0.71)	1.70 (0.71)	0.04 (0.73)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	1.04 (1.10)	0.38 (0.90)	1.90 (1.54)	1.14 (1.22)	1.56 (1.35)	0.08 (0.76)	1.45 (1.31)	2.45 (1.71)	1.78 (1.50)	1.59 (2.01)
Pusa Samrat	1.04 (1.02)	0.33 (0.88)	0.70 (1.02)	0.00 (1.44)	0.74 (1.05)	2.53 (1.73)	1.38 (1.36)	1.78 (1.49)	1.67 (1.46)	2.15 (1.58)	2.33 (1.66)	3.67 (2.04)	3.67 (2.03)	3.37 (1.89)	3.33 (1.93)	4.67 (2.27)	5.00 (2.32)	3.67 (2.03)	4.67 (3.26)
Warad	0.00 (0.71)	0.00 (0.71)	0.42 (0.92)	1.67 (0.73)	0.08 (0.76)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.71 (1.01)	1.74 (1.41)	1.04 (1.10)	1.85 (1.53)	1.33 (1.29)	0.96 (1.20)	3.45 (1.98)	3.63 (2.03)	2.26 (1.64)	2.13 (2.21)
N. Shiwani	0.74 (1.10)	0.33 (0.88)	0.71 (1.07)	0.04 (1.02)	1.08 (1.22)	0.67 (1.00)	2.04 (1.57)	1.00 (1.10)	1.33 (1.34)	2.74 (1.79)	1.71 (1.46)	3.00 (1.81)	2.33 (1.64)	2.67 (1.72)	4.33 (2.20)	3.00 (1.81)	1.37 (1.33)	2.85 (1.79)	3.55 (2.87)
Pusa Samrudhi (OP)	0.74 (1.05)	0.71 (1.07)	0.90 (1.11)	0.70 (1.22)	0.45 (0.95)	1.55 (1.43)	1.41 (1.31)	2.74 (1.79)	3.03 (1.88)	2.33 (1.68)	0.33 (0.88)	2.33 (1.68)	2.33 (1.68)	3.00 (1.86)	3.33 (1.95)	3.33 (1.94)	2.00 (1.58)	3.22 (1.88)	3.83 (2.99)
Sankar	0.40 (0.93)	1.74 (1.49)	1.44 (1.32)	1.07 (1.29)	1.00 (1.10)	1.48 (1.33)	1.74 (1.47)	1.38 (1.36)	2.00 (1.52)	1.74 (1.38)	1.67 (1.39)	1.67 (1.44)	1.67 (1.46)	3.00 (1.81)	4.67 (2.23)	3.33 (1.93)	2.63 (1.76)	3.56 (2.00)	4.02 (3.02)

Difference between Treatment

CD (P = 0.05) = 0.1306

Difference between Periods of Observation

CD (P = 0.05) = 0.1109

Difference between Treatment X Periods of Observation

CD (P = 0.05) = 0.5543

Figures in parenthesis are square root transformed value

The variety Narendra Shiwani registered (3.55 beetles/plant) and it was at par with Narendra Shishir (3.16 beetles/plant), NDBG-613-4 (3.30 beetles/plant) Narendra Shiwani Selection (3.44 beetles/plant), Pusa Santusti (3.70 beetles/plant) and Pusa Samrudhi (OP) (3.83 beetles/plant), on the other side, significantly highest (6.75 beetles/plant) was noted in cultivar Jabalpur Local (Long) than all the evaluated varieties. remaining six varieties (Pusa Naveen, Sankar, Pusa Samrat, Narendra Dharidar, Ketan, Narendra Madhuri Selection) were found more or less (3.85 to 5.55 beetles/plant) susceptible to *A. foveicollis*.

Considering the beetle population, the varieties under screening can be placed in increasing order of susceptibility as : Arka Bahar < Dharwad < Narendra Rashmi < Wardan < NDBGH-4 < Narendra Maduri < NS-421 < Kashi Ganga-10 < Punjab Komal < Warad < Dharwad Selection < Kashi Ganga < Narendra Shishir < NDBG-613-4 < Narendra Shiwani Selection < Narendra Shiwani < Pusa Santusti < Pusa Samrudhi (OP) < Pusa Naveen < Sankar < Pusa Samrat < Narendra Dharidar < Ketan < Narendra Madhuri Selection < Jabalpur Local (Long). (Fig.3)

4.3.1 Yield and Avoidable loss

The data revealed that fruit yield was found to be maximum (32.350 kg/plot) with the variety Arka Bahar and avoidable loss due to pest is (0%). Whereas it was minimum (8.250 kg/plot) with Jabalpur Local (Long) and avoidable loss due to *A. foveicollis* is (74.49%). (Table-5., Fig 4)

**Table No.5: Yield and avoidable loss due to red pumpkin beetle
(*A. foveicollis*) on bottle gourd.**

Sr. No	Treatment/ Var.	Yield/ plot in (Kg)	Loss (%) over the variety Arka Bahar
1	Pusa Naveen	14.200	56.10
2	Punjab Komal	19.750	38.94
3	N. Madhuri Selection	8.450	73.87
4	Pusa santusti	15.550	51.93
5	Narendra Shishir	18.00	44.35
6	Kashi Ganga	18.850	41.73
7	NS-421	21.800	32.61
8	Dharwad Selection	19.450	39.87
9	N.Rashmi	26.850	17.00
10	NDBGH-4	24.900	23.02
11	Jabalpur Local (Long)	8.250	74.49
12	Ketan	8.850	72.64
13	N.Shiwani Selection	16.950	47.60
14	N.Madhuri	24.650	23.80
15	NDBG-613-4	18.00	44.35
16	Kashi Ganga -10	21.100	34.77
17	Arka Bahar	32.350	0.00
18	Dharwad	29.750	8.03
19	N.Dharidar	11.750	63.67
20	Wardan	26.300	18.70
21	Pusa Samrat	12.00	62.90
22	Warad	19.750	38.94
23	N.Shiwani	15.900	50.85
24	Pusa Samrudhi (OP)	14.700	54.55
25	Sankar	13.00	59.81
	Total	461.100	1074.52
	Mean	18.444	42.98

CHAPTER – V

DISCUSSION

The results obtained from various aspects on population dynamics of red pumpkin beetle, *Aulacophora foveicollis* (Lucas) and its incidence on different varieties of bottle gourd are discussed in this chapter.

5.1 Nature of damage and behaviour

Damage was caused by grubs as well as beetles. Adult beetles remained inactive during winter and hide under dry half rotten cucurbit vines, weeds left uncared in the farm, bushes, standing crops as well as cracks and crevices in the soil. Adults led isolated life which is quite an advantage for the survival of the species. Adults caused most serious damage to the young and germinating cucurbits. The beetles injured the cotyledons by biting holes into them as a result cotyledonary leaves withered and finally seedlings dried up. The grubs damaged the plants by boring into the roots and underground stem. Sometimes, young seedlings of cucurbits were so severely damaged that they have to be resown. Similar damage symptoms were also noted by Nath (1963) and Atwal and Dhaliwal (2002). At the time of flowering, male flowers preferred by the adults due to the pollens on which they survive. As per the report of Sandhu and Bhalla (1974), *A. foveicollis* beetles feed on petals but do not destroy the sexual parts of the flowers. This report is in agreement with the present findings. The beetles made irregular holes into the leaves and they eat away the interveinal space of the leaf. Such types of symptoms have been also reported by earlier workers Kadam and Patel, (1957), Lucchese, (1945), Vishwanath and Agarwal, (1982) and Atwal and Dhaliwal, (2002) in past. At the time of fruiting stage, the grubs bore into the fruits touching the soil.

It was confirmed with the report of Kadam and Patel (1957). The affected under ground parts started rotting due to infection by fungi and bacteria, while the infested fruits became unfit for human consumption. Mathur *et al.*, (1987) observed similar symptoms caused by the pest incidence. These reports tally with the present damage symptoms on bottle gourd.

5.2 To study the population dynamics of red pumpkin beetle (*Aulacophora foveicollis*) on bottle gourd.

Population dynamics of *A. foveicollis* infesting bottle gourd crop showed that the pest incidence started from 45th standard week (2nd week of November) as per the report of Dutt and Dalpati (1977) from West Bengal, the beetles remained active during winter. This result tally with the present finding. The higher activity of the pest was found during February to April on bottle gourd. This result was in agreement with the finding of Kumar and Kumar (2002) and Pallavi *et al.*, (2002) they reported that the red pumpkin beetle activity was started during February on mogekai and aster plant. The higher incidence of red pumpkin beetle on bottle gourd during March-April was observed by Shinde and Purohit (1978), Butani (1979), Johri and Johri (2003b), Ghathala and Bajpai (2007) and Rathod and Borad (2010). Similarly, higher activity of this pest on muskmelon was reported by Rajak (2000) in April month. These reports are in agreement with the present conclusion.

Correlation Coefficient

During rabi season, the maximum and minimum temperature had significantly positive association while morning and evening relative humidity had negative relationship with beetle population on bottle gourd. The present findings supported by the reports of the Rajak (2000), who reported that the temperature was positively and relative humidity negatively correlated with red pumpkin beetle

population on muskmelon. Dangi (2006) from Rajasthan reported that beetle population was positively correlated with temperature and negatively with relative humidity. As per the report of Ghathala and Bajpai (2007) the beetle population showed a positive correlation with mean temperature but significant negative correlation with mean relative humidity on summer squash, pumpkin and ridge gourd. These reports are in agreement with the present findings.

The rainfall and number of rainy days had negative correlation but non significant. This result was in agreement with the finding of Roy and Pande (1991) from Tripura reported that the populations of *A. foveicollis* on red pumpkin was negatively correlated with rainfall.

5.3 Incidence of insect pest complex on different varieties of bottle gourd.

Twenty five promising varieties of bottle gourd were screened against *A. foveicollis* in field condition. Among these varieties Arka Bahar, Dharwad, Narendra Rashmi, Wardan, NDBGH-4 and Narendra Madhuri were found less susceptible to this pest. Besides the resistance mechanism, these varieties also registered high potential in producing the fruit yield and less avoidable loss due to red pumpkin beetle.

The varieties/cultivars Dharwad Selection, Kashi Ganga-10, NS-421, Warad, Punjab Komal, Kashi Ganga, Narendra Shiwani, Narendra Shishir, NDBG-613-4, Narendra Shiwani Selection, Pusa Santusti and Pusa Samrudhi (OP) are found to be moderately susceptible. The six varieties Pusa Naveen, Sankar, Pusa Samrat, Narendra Dharidar, Ketan, Narendra Madhuri Selection are more or less susceptible to *A. foveicollis* and on the other side variety Jabalpur Local (Long) were found highly susceptible to red pumpkin beetle. Saljoqi and Shahbaz Khan (2007) three gourd (*Lagenaria*

siceraria) cultivars, DIK round green, SW sweet yellow and bottle gourd long cultivars were found moderately susceptible to the attack of red pumpkin beetle. This report are disagreement with the present finding. And they were poor in yield potential and more avoidable loss.

CHAPTER – VI

**SUMMARY, CONCLUSIONS AND SUGGESTIONS FOR
FURTHER WORK**

6.1 Summary

The present investigation entitled, “Studies on insect pest complex and screening of improved varieties of bottle gourd (*Lagenaria siceraria*).” was carried out during the rabi season of the year 2011-2012 at Main Vegetable Research Station, College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (MP). The experiment were conducted with the following objectives:

1. To study the population dynamics of red pumpkin beetle (*Aulacophora foveicollis*) on bottle gourd.
2. Incidence of insect pest complex on different varieties of bottle gourd.

6.1.1 To study the population dynamics of red pumpkin beetle (*Aulacophora foveicollis*) on bottle gourd.

The red pumpkin beetle *A. foveicollis* appeared (1.33 beetles/plant) on bottle gourd from 45th standard week (2nd week of November) at 23 days crop stage. and continued at maximum level (8.67 beetles/plant) 14th standard week in the first week of April. During first week of April the maximum and minimum temperature were 37.8 °C and 20.2 °C , morning and evening relative humidity 49% and 17% while rainfall and number of rainy days were 000.0 mm and 0 days respectively.

6.1.2 Incidence of insect pest complex on different varieties of bottle gourd.

Screening of improved varieties of bottle gourd against *A. foveicollis* on the basis of total number of Adults found are. Arka Bahar, Dharwad, Narendra Rashmi, Wardan, NDBGH-4 and Narendra Madhuri had (1.20 to 1.62 beetles/plant). The variety Dharwad Selection, Kashi Ganga-10, NS- 421, Warad, Punjab Komal and Kashi Ganga. showed equal population of beetle (2.35 beetles/plant). The cultivars Narendra Shishir, NDBG-613-4, Narendra Shiwani Selection, Narendra Shiwani, Pusa Santusti, and Pusa Samrudhi (OP) (3.16 to 3.83 beetles/plant). Highest number of beetles was noted in cultivar Jabalpur Local (Long) (6.75 beetles/plant). Remaining six varieties Pusa Naveen, Sankar, Pusa Samrat, Narendra Dharidar, Ketan, Narendra Madhuri Selection were found more or less (3.85 to 5.55 beetles/plant).

6.2 Conclusion:

The important conclusions accrued from the research studies are. During rabi season, temperature and relative humidity had significantly positive and negative relationship with population fluctuation of *A. foveicollis* beetle on bottle gourd. However, the rainfall and number of rainy days were negatively correlated but it was found non significant.

Twenty five promising varieties of bottle gourd were screened against *A. foveicollis* in field condition are categories as.

Least susceptible.

Arka Bahar, Dharwad, Narendra Rashmi, Wardan, NDBGH-4 and Narendra Madhuri.

Moderately susceptible.

Dharwad Selection, Kashi Ganga-10, NS- 421, Warad, Punjab Komal, Kashi Ganga, Narendra Shishir, NDBG-613-4, Narendra Shiwani Selection, Narendra Shiwani, Pusa Santusti, and Pusa Samrudhi (OP).

Susceptible.

Pusa Naveen, Sankar, Pusa Samrat, Narendra Dharidar, Ketan, Narendra Madhuri Selection.

Highly susceptible.

Jabalpur Local (Long).

Suggestions for further work:

1. The trial should be repeated to confirm these results.
2. Studies on population dynamics of red pumpkin beetle in bottle gourd should be studied continuously for three years in order to establish status of the pest.
3. The varieties showing poor performance by *A. foveicollis* may be further tested and their Antixenotic non prefronee characteristics may be identified.

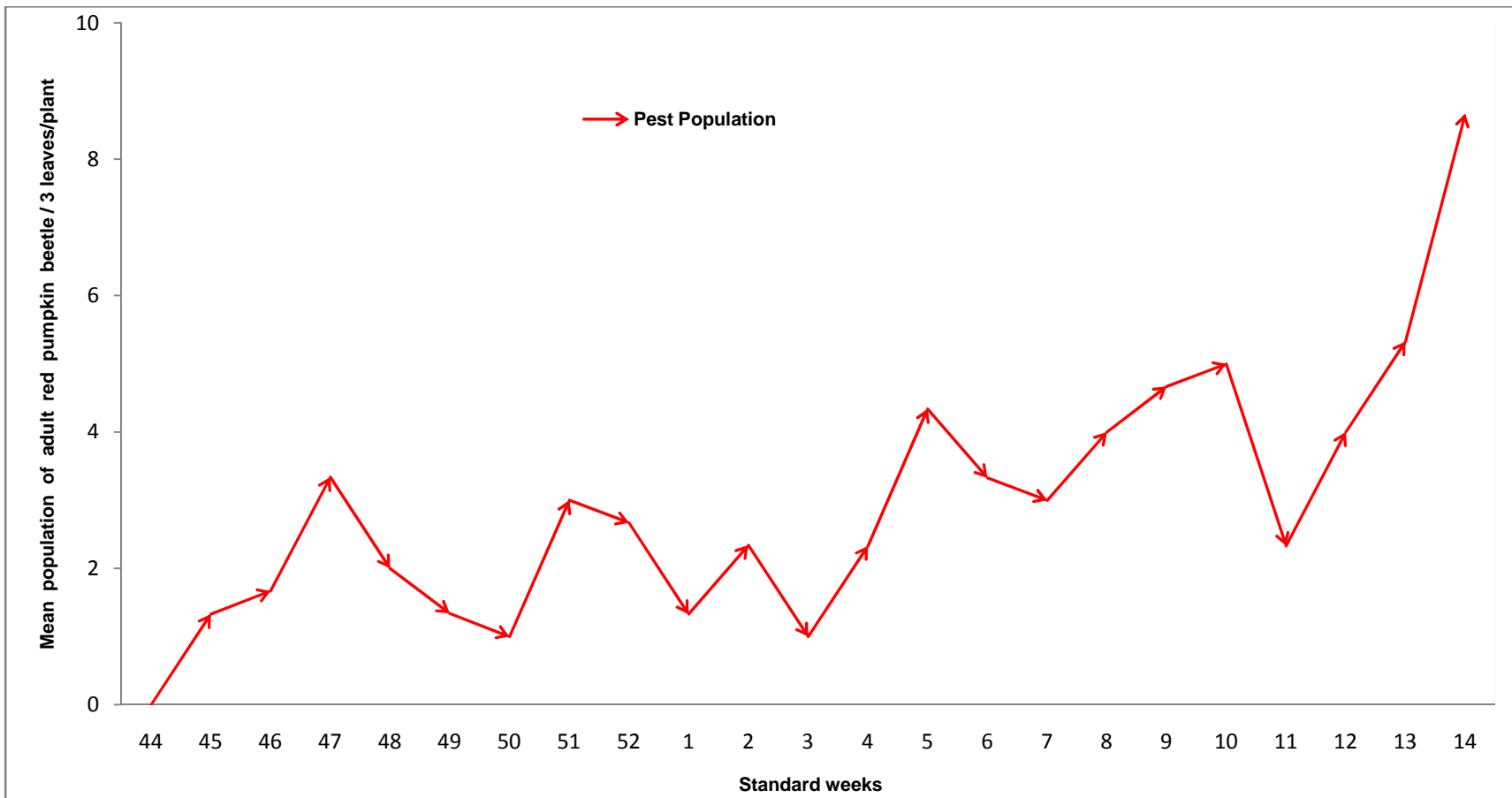
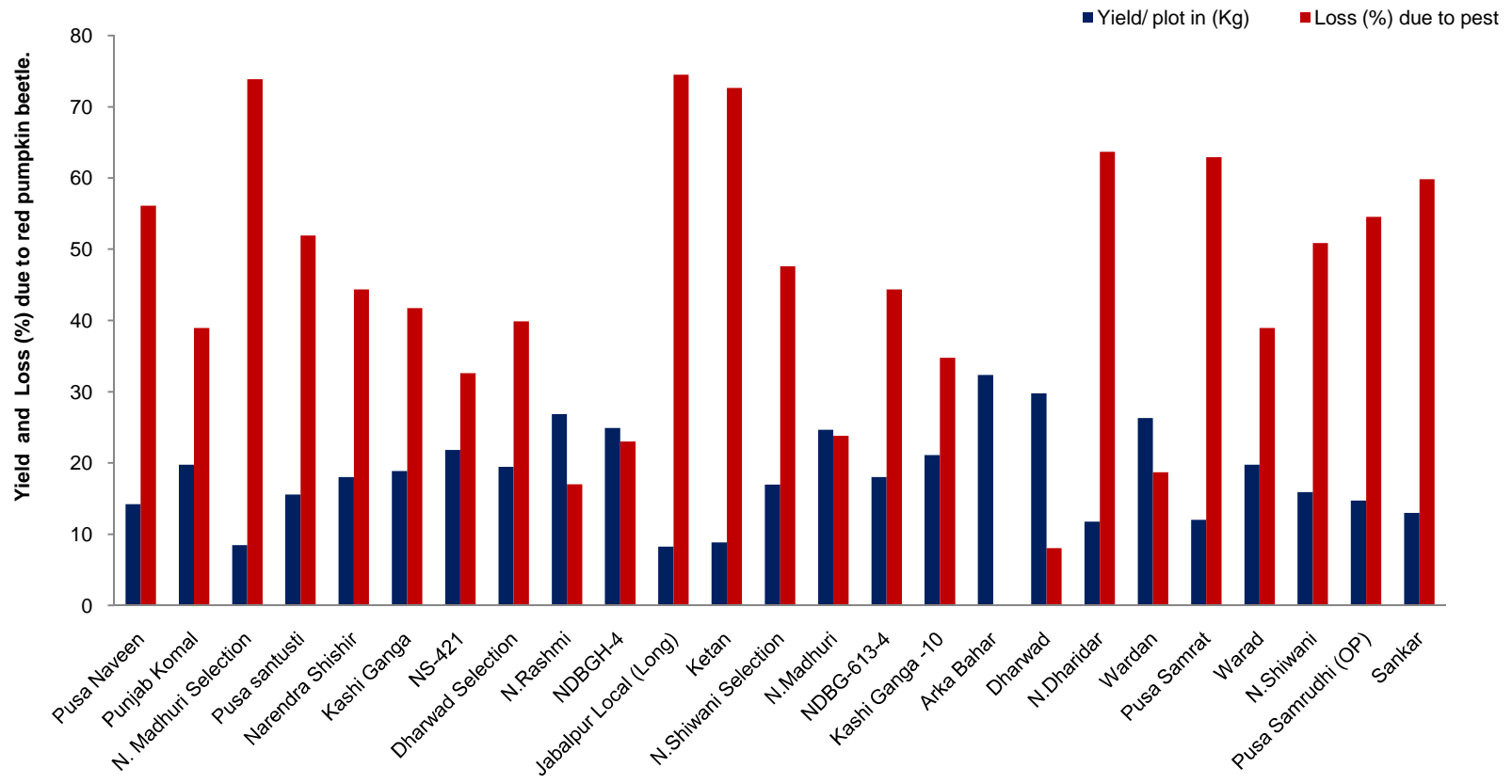


Fig. No. 2 : Seasonal activity of red pumpkin beetle on bottle gourd during rabi 2011-12.



Different varieties of bottle gourd (*Lagenria siceraria*)

Fig. No. 4: Yield and avoidable losses due to red pumpkin beetle on different varieties of bottle gourd.

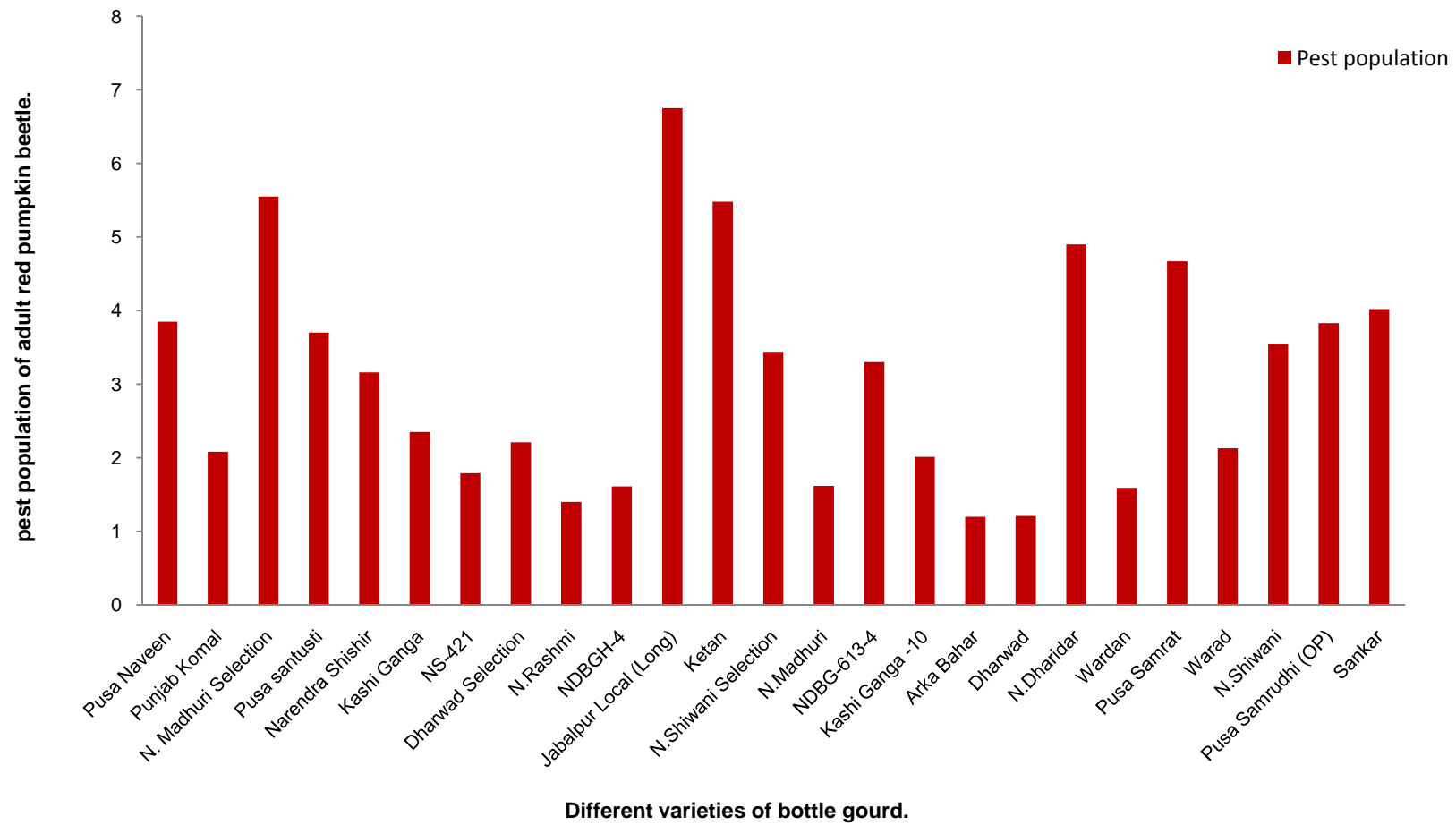
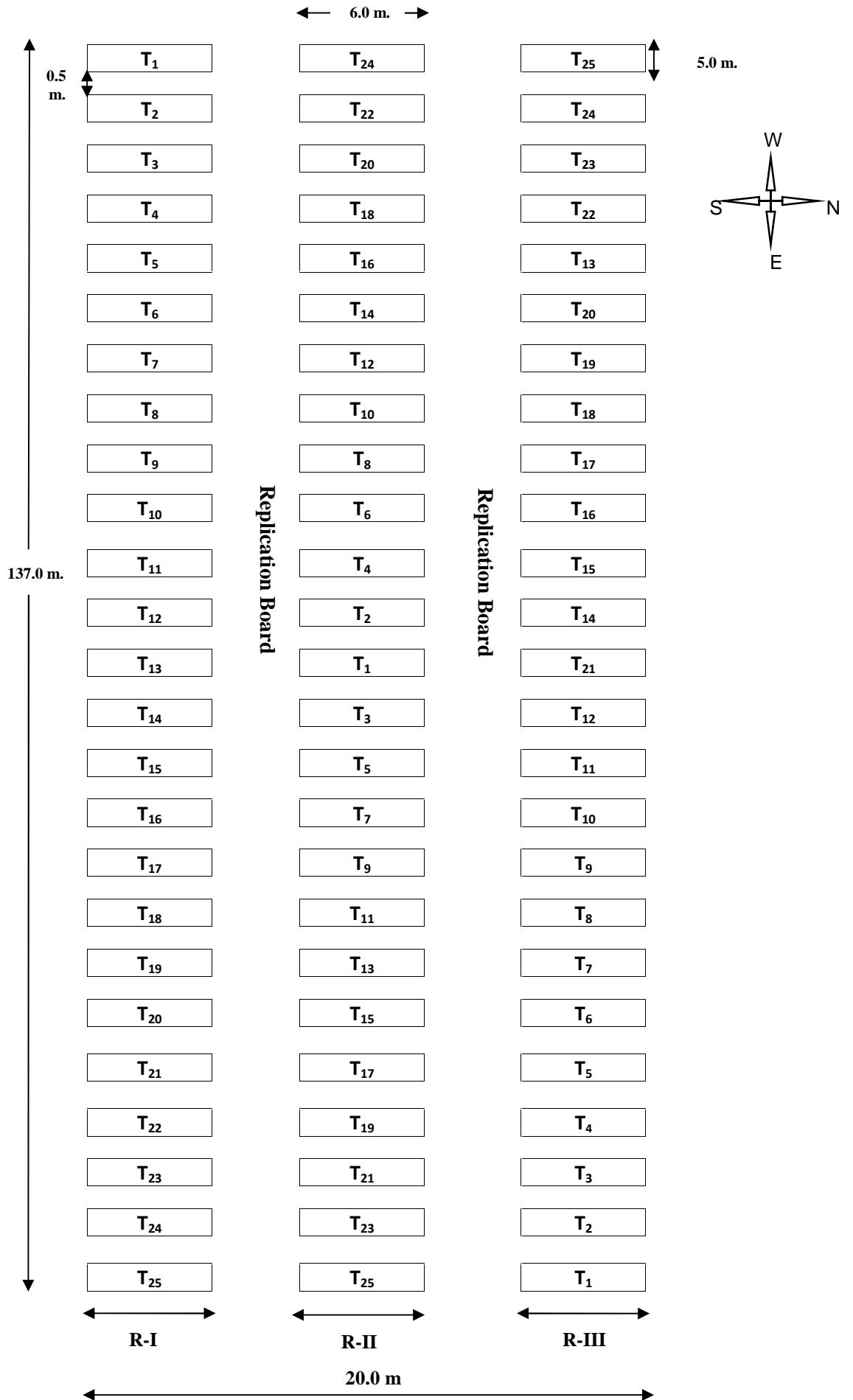


Fig. No. 3: Incidence of red pumpkin beetle on different varieties of bottle gourd during rabi 2011-12.

Fig. No. 1 : Layout plan of experimental trial.





**Plate No. 1- Layout experiment of bottle gourd
(*Lagenaria siceraria*).**



**Plate No.2 - Leaf damage by red pumpkin beetle
(*Aulacophora foveicollis*).**



**Plate No. 2 - Flower damage by red pumpkin beetle
(*Aulacophora foveicollis*).**

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Appendix - I

Weekly meteorological data of main vegetable research station, Department of Horticulture, Maharajpur, J.N.K.V.V., Jabalpur (M.P.) 2011-2012

SW	Date		Temperature (°C)		Sunshine (hrs)	Rainfall (mm)	Relative humidity (%)		Wind speed (km/hr)	Rainy days
	From	To	Max.	Min.			Morn.	Even.		
41	08-10-2011	14-10-2011	32.4	19.1	08.3	000.0	92	43	02.3	00
42	15-10-2011	21-10-2011	32.6	15.8	09.3	000.0	89	31	02.5	00
43	22-10-2011	28-10-2011	31.8	13.9	08.9	000.0	87	30	02.5	00
44	29-10-2011	04-11-2011	31.0	11.0	09.0	000.0	86	24	02.4	00
45	05-11-2011	11-11-2011	31.8	12.1	08.3	000.0	89	29	02.5	00
46	12-11-2011	18-11-2011	30.9	12.4	08.0	000.0	89	28	02.4	00
47	19-11-2011	25-11-2011	29.4	11.3	08.7	000.0	92	33	02.3	00
48	26-11-2011	02-12-2011	27.2	9.6	07.3	000.0	89	36	02.2	00
49	03-12-2011	09-12-2011	28.8	11.1	08.1	000.0	90	34	02.5	00
50	10-12-2011	16-12-2011	25.3	7.2	08.2	000.0	89	35	02.7	00
51	17-12-2011	23-12-2011	24.8	5.3	08.6	000.0	90	24	02.3	00
52	24-12-2011	31-12-2011	24.9	7.4	07.4	000.0	89	32	02.6	00
01	01-01-2012	07-01-2012	23.0	12.0	05.8	028.6	95	69	03.3	01
02	08-01-2012	14-01-2012	20.2	6.3	07.1	000.0	93	41	04.0	00
03	15-01-2012	21-01-2012	23.7	7.1	08.6	000.0	90	36	03.4	00
04	22-01-2012	28-01-2012	21.5	9.0	06.8	013.2	89	57	03.5	02
05	29-01-2012	04-02-2012	20.8	8.0	04.5	007.6	91	46	03.5	01
06	05-02-2012	11-02-2012	26.4	8.8	08.6	000.0	89	30	04.0	00
07	12-02-2012	18-02-2012	27.6	10.4	08.3	000.0	90	42	03.8	00
08	19-02-2012	25-02-2012	30.5	9.8	09.6	000.0	86	28	03.1	00
09	26-02-2012	04-03-2012	30.1	10.4	09.1	000.0	86	24	02.8	00
10	05-03-2012	11-03-2012	30.8	11.6	08.3	000.0	76	18	04.9	00
11	12-03-2012	18-03-2012	31.8	13.2	07.8	000.0	69	23	04.4	00
12	19-03-2012	25-03-2012	35.1	13.0	08.7	000.0	66	14	03.4	00
13	26-03-2012	01-04-2012	37.3	15.3	08.5	000.0	68	14	02.8	00
14	02-04-2012	08-04-2012	37.8	20.2	07.1	000.0	49	17	04.5	00

APPENDIX- II

Incidence of insect pest complex on different varieties of bottle gourd.

ANOVA

SV	DF	SS	MSS	Fcal	Ftab 5%
Replication	2	3.25	1.62	13.91	-
Treatment	24	114.1	4.75	40.71	1.71
Period	17	84.2	4.95	42.44	2.21
T x P	408	75.6	0.19	1.5873	1.00
Error	898	104.8	0.12	-	-
Total	1349	381.9	0.283	-	-

SEm (T) = \pm (0.0471)
SEm (P) = \pm (0.04)
SEm (TxP) = \pm (0.20)

CD at 5% = 0.1306
CD at 5% = 0.1109
CD at 5% = 0.5543

ABSTRACT

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ABSTRACT

The present investigation entitled, “Studies on insect pest complex and screening of improved varieties of bottle gourd (*Lagenaria siceraria*).” was carried out during the rabi season of the year 2011-2012 at Main Vegetable Research Station, College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (MP). The experiment were conducted with the following objectives:

1. To study the population dynamics of red pumpkin beetle (*Aulacophora foveicollis*) on bottle gourd.
2. Incidence of insect pest complex on different varieties of bottle gourd.

The pest first appeared (1.33 beetles/plant) at 45th standard week (2nd week of November). The pest activity slightly increased from 47th standard week (4th week of November) and reached to peak (8.67 beetles/plant) on 14th standard week (1st week of April). The maximum and minimum temperature, morning and evening relative humidity, rainfall and number of rainy days during peak activity period were 37.8 °C & 20.2°C, 49 % & 17 %, 000.0 mm, 00 days respectively. Higher activity of the pest was noticed in the month of March and April.

Correlation studies between various abiotic factors and beetle population revealed that, significantly positive relationship with maximum and minimum temperature. The morning and evening relative humidity had significantly negative relationship with population fluctuation of *A. foveicollis* beetle on bottle gourd. However, the rainfall and number of rainy days were negatively correlated but it was found non significant, respectively.

Twenty five promising varieties of bottle gourd were screened against *A. foveicollis* in field condition. None of the cultivars was found free from beetle incidence. Among these varieties Arka Bahar, Dharwad, Narendra Rashmi, Wardan, NDBGH-4 and Narendra Madhuri were found less susceptible to this pest. Besides the resistance mechanism, these varieties also registered high potential in producing the fruit yield and less avoidable loss due to red pumpkin beetle.

The varieties/cultivars Dharwad Selection, Kashi Ganga-10, NS-421, Warad, Punjab Komal, Kashi Ganga, Narendra Shiwani, Narendra Shishir, NDBG-613-4, Narendra Shiwani Selection, Pusa Santusti and Pusa Samrudhi (OP) are found to be moderately susceptible. The six varieties Pusa Naveen, Sankar, Pusa Samrat, Narendra Dharidar, Ketan, Narendra Madhuri Selection are more or less susceptible to *A. foveicollis* and on the other side variety Jabalpur Local (Long) were found highly susceptible to red pumpkin beetle. And they were poor in yield potential and more avoidable loss.

VITA

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