SEASONAL INCIDENCE, EFFECT OF SOWING DATES AND MANAGEMENT OFPESTSINFESTING DOLICHOS BEAN (*Lablab purpureus* (L.) Sweet)

A thesis submitted to the

FACULTY OF AGRICULTURE
DR. BALASAHEB SAWANT KONKAN KRISHI VIDYAPEETH, DAPOLI
(Agricultural University)
Dist. Ratnagiri (MS)

In partial fulfilment of the requirements for the degree of

MASTER OF SCIENCE(AGRICULTURE)

In

AGRICULTURAL ENTOMOLOGY

By

KENGARE MADHURI NAMDEV
B.Sc. (Ag.)

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DEPARTMENT OF AGRICULTURAL ENTOMOLOGY,

FACULTY OF AGRICULTURE,

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Title of thesis	:	Seasonal incidence, effect of sowing dates and management of pests infesting dolichos bean, (*Lablab purpureus* (L.) Sweet)
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Registration Number	:	ADPM/18/2604
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ABSTRACT

The present investigation "Seasonal incidence, effect of sowing dates and management of pest sinfesting dolichosbean,*Lablab purpureus* (L.)Sweet"was carried out during *rabi* season of 2018-19 at Central Experiment Station, Wakavali, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth Dapoli, Dist. Ratnagiri.

During present investigation, the study on seasonal incidence revealed that there was marked difference in aphidpopulation as regard standard Meteorological weeks. Minimum aphid population (2.8±76.81) was noticed in the 48thSMW (26thNovember-2ndDecember), while maximum (239.6±76.81) population was recorded during 8th SMW (19th-25th February). The infestation of pod borersstarted in the 4th week of December (52th SMW). Minimum(3.9±10.35) per cent

infestation of pod borers was recorded in 2nd SMW (8th-14th January). While, maximum (28.10±10.35) per cent infestation was recorded during 6th SMW (5th - 11th February).

The data on correlation between mean population of pests infesting dolichos bean and different weather parameters revealed that maximum temperature recorded positive non-significant correlation while, minimum temperature, morning relative humidity and evening relative humidity showed negative non-significant correlation with mean population of aphids. The pod borers exhibited non-significant positive correlation with maximum temperature and minimum temperature while, morning relative humidity and evening relative humidity were found to be negatively non-significant.

The study on the effect of sowing dates against pests infesting dolichos bean revealed marked difference in the population of aphids and pod borers infestation. The minimum (6.36) aphid populationwas recorded in first date of sowing (2-11-2018) and maximum (38.24) aphid population was recorded in third date of sowing (12-12-2018).The minimum (33.41%) damage of pod borers was recorded in first date of sowing (2-11-2018) and maximum (55.67%) observed in third date of sowing (12-12-2018). It was evident from the results that in dolichosbean pest incidence increased gradually with the advancement of cropping season.

The studies on efficacy of insecticides against pests infesting dolichos bean indicated that treatment chlorpyriphos 20EC @ 0.06 per cent was most effective which recorded 16.5 mean aphid population and was at par with *Lecanicilliumlecanii*which recorded 20.57 mean aphid population and Azadirachtin 1000 ppm @ 0.003 per cent recorded 22.53

mean aphid population per three leaves per plant. The treatment chlorpyriphos 20EC @ 0.06 per cent was the best treatment which recorded minimum (12.74%) mean pod infestation and was at par with *Bacillus thuringiensis* (14.03%).

CHAPTER I
INTRODUCTION

The grain legumes occupy a unique position in the world of agriculture by virtue of their high protein content and capacity of fixing atmospheric nitrogen. *Lablab purpureus* (L.) Sweet usually called as Dolichos bean, Hyacinth bean or Field bean is one of the most ancient crops among the cultivated plants. It is a bushy, semi-erect, perennial herb, showing no tendency to climb. It is mainly cultivated either as a pure crop or mixed with finger millet, groundnut, castor, corn and pearl millet or sorghum in Asia and Africa. It is a multipurpose crop grown for pulse, vegetable and forage. It is one of the major sources of protein in diets in southern states of India. It is also grown as an ornamental plant, mostly in USA for its beautiful dark-green, purple-veined foliage with large spikes clustered with deep-violet and white pea-like blossoms. The crop is grown for its green pods, while dry seeds are used in various vegetable food preparations. The pole types are grown in homestead by trailing to bower for its tender fruits which are used as cooked vegetable. It is a nutritive vegetable grown for the consumption of green pods; green seeds and dry seeds pulse also. Green pods contain 6.7 gm carbohydrates, 3.8 gm protein, and 1.8 gm fiber, 210 mg Ca, 68.0 mg phosphorous, 1.7 mg iron per 100 g edible portion (Anon., 2018a). It is also used as feed for animals and green manure. In India, the total area under beans is 228 thousand hectare with an annual production of 2277 thousand MT while in Maharashtra the total area under beans is 5.50 thousand

hectare with an annual production of 55.48 thousand MT (Anon., 2018b).

The phytochemical analysis of dolichos bean reveals that it contains sugar, alcohol, phenols, steroids, essential oils, alkaloids, tannins, flavonoids, saponins, coumarins, terpenoids pigments, glycosides, wide range of minerals and many other metabolites. The preliminary pharmacological studies revealed that dolichos bean possesses antidiabetic, antiinflamatory, analgesic, antioxidant, cytotoxic, hypolipidemic, antimicrobial, insecticidal, hepatoprotective properties and is also used for the treatment of iron deficiency anemia (Anon., 2018c).

The crop is attacked by a number of insect pests during its life span. Govindan (1974) recorded as many as 55 species of insects and one species of mite feeding on the crop from seedling stage till the harvest of the crop in Karnataka. However, only a few of them such as pod borers were considered to be most destructive and they appeared regularly causing economic loss, whereas others were considered as minor pests. Among the sucking pests lablab bug, *Coptosoma cribraria* (Fabricius*), Riptortus pedestris* (Fabricius) and *Nezara viridula* (Linnaeus) occurred commonly and found in large number throughout the cropping period (Govindan, 1974 and Thippeswamy, 1990). Aphids are one of the most serious pests of crops worldwide, causing major yield and economic losses. While, the larvae of pod borer are known to cause considerable damage to lablab bean attacking various parts *viz.*, buds, flowers, pods and seeds. Its nature of damage is exhibited by weaving unopened buds and flowers. The larva further damages the reproductive parts of flower leading to poor pod setting and pod formation. In the later period of crop growth, it behaves as a pod borer and completes

its larval and pupal development inside the pod. This leads to poor pod formation, reduction in grain yield as well as adverse effect on market value of green pods.

The management of these noxious pests is primarily based on synthetic insecticides due to their ease of availability and applicability. But their indiscriminate use has resulted in the development of insecticidal resistance in the pest, environmental pollution, and resurgence of minor pests, pollution hazards and disruption on balance of eco-system.

Though the crop is economically important, the information on the pest status, crop loss estimation in Konkan region is very much lacking. As the pods are consumed as vegetable, the pest management and especially the pod borer control has to be on organic basis. Considering the importance of dolichos bean and seriousness of the pests, the present investigation was planned and conducted at the Central Experiment Station, Wakavali, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri, Maharashtra with the following objectives

1) To study the seasonal incidence of pests infesting dolichos bean, *Lablab purpureus* (L.) Sweet
2) To study the effect of sowing dates against pests infesting dolichos bean, *Lablab purpureus* (L.) Sweet
3) To study the efficacy of insecticides against pests infesting dolichos bean, *Lablab purpureus* (L.) Sweet

CHAPTER II
REVIEW OF LITERATURE

The literature pertaining to the present study entitled "Seasonal incidence, effect of sowing dates and management of pests infesting dolichos bean, *Lablab purpureus* (L.) Sweet" was reviewed and presented in this chapter under following sub headings

2.1 To study the seasonal incidence of pests infesting dolichos bean, *Lablab purpureus* (L.) Sweet

2.2. To study the effect of sowing dates against pests infesting dolichos bean *Lablab purpureus* (L.) Sweet

2.3. To study the efficacy of insecticides against pests infesting dolichos bean *Lablab purpureus* (L.) Sweet

1. To study the seasonal incidence of pests infesting dolichos bean, *Lablab purpureus* (L.) Sweet

Gupta and Singh (1993) studied the population dynamics of insect pests associated with green gram and reported that in summer, thrips and stem fly appeared first followed by galerucid beetle *Madurasia obscurella* (Jacoby) and whitefly while, in rainy season (*kharif*) thrips, stem fly and other insect pests were noticed. The populations of all the insect pests except thrips continued to build up till vegetative growth *i.e.* 7 or 8 weeks after sowing the crop. Most of the insect pests attained their peaks by 7th or 8th weeks after sowing. Correlations between population of insect pests and various abiotic factors revealed that for thrips and whitefly, dry conditions were found to be more favourable than rainy conditions. For galerucid beetle, jassids, leaf-miner

and leaf-eating caterpillars, the rainy conditions were observed more favourable.

El-Defrawi *et al.* (2000) reported that the pest had two main periods of activity, with highest counts during the 3rd week of December and February in 1995-96, and during the 4th week of December and 3rd week of March in 1996-97.

Sharma *et al.* (2000) conducted the research on seasonal incidence of pod borers on dolichos lablab, *Lablab purpureus* (L.) Sweet in Jabalpur, Madhya Pradesh, India, from July 1991 to March 1992. The peak population of *Helicoverpa armigera* (Hubner), *Lampoides boeticus* (Linnaeus), *Sphenarches caffer,* (Zeller), *Anarsiae phippias* (Meyrick), *Spodoptera litura* (Fabricius) and *Maruca vitrata* (Fabricius) was observed from the 3rd week of November to the 2nd week of December and from the last week of February to the 2nd week of March.

Abou-Elhagag and Salman (2001) noticed that the population of aphid attained peak between the 2nd and 3rd week of March. While the population of leaf hoppers (*Empoasca* spp.) was observed during 1st week of February 2000 and 2nd week of January 2001, reaching its highest level between 2nd and 3rd week of March.

Akhauri and Yadav (2002) conducted experiment in Bihar, India during 1990-91 and 1991-92 to determine the population trend and damage potential of the spotted pod borer, *Maruca testulalis* (Geyer) on early pigeon pea. The larval population of spotted pod borer fluctuated widely in relation to seasonal changes beginning from the 2nd week of October until the end of December. The period of maximum activity was between 2nd and last week of November, when the mean population fluctuated

around 12.67 - 15.17 larvae per plant, while the flower damage was minimum (0.65%) in the second week of October and increased to maximum level (18.66%) in the last week of November. The mean level of pod damage gradually increased from (10.46 to 26.50%) the third week of October to the last week of December.

Dalwadi *et al.* (2007) studied the population dynamics of pests of Indian bean, *Lablab purpureus* (L.) and revealed that *Aphis craccivora* (Koch) remained active from mid-November to the end of March with two distinct peaks. The pod borer, *Helicoverpa armigera* (Hubner) incidence on pods started from 3rd week of December and continued more or less throughout the crop period. It's maximum (2.40 larvae per plant) population was noticed during 3rd week of February.

Rekha and Mallapur (2007) reported that incidence of aphid, *Aphis craccivora* (Koch) was noticed in large number from September to first week of October with a population of 30.5 to 50.0 and 8.4 to 11.2 aphids per 3 leaves on crop sown during 3rd week of August and first week of September, respectively. The coreid bug, *Anoplocnemi sphasiana* (Fabricius) was noticed from September to December, the adults of which were found feeding on the sap from tender twigs. *Clavigralla gibbosa* (Spinola) and *C. horrenshar* bored the crop from October to January. The nymphs and adults of *Riptortus pedestris* (Fabricius) were observed at later stages of crop growth.

Thejaswi *et al.* (2008) conducted research on population dynamics of pests of field bean at Shimoga during 2006-07 and revealed that 22 species of insect pests were found to infest field bean. Population build-up of pod borers was noticed from May second fortnight to first fortnight of February with peak during

second fortnight of November. Among sucking pests, *Aphis craccivora* Koch, *Riptortus pedestris* F., *R. strennus*, *Coptosoma cribraria* F., *Anopolcnemi sphasiana* F. and *Nezara viridula* L. were more predominant. The natural enemies were also recorded *viz.*, *Campoletis chloridae* Uchida, *Bracon* sp., *Herpector costalis*, (Stal.) ladybird beetles, mirids, syrphids and carabid predators. Among them *C. chlorideae*, Bracon sp. were predominant. The parasitoids were more active during rainy and winter seasons and the activity of parasitoids was noticed from June to October. Lady beetles activity was quite high (3.50 to 5.00 beetles per 5 plant) from 30 - 60 days after germination. While the activity of syrphids, mirids, carabids and *Hypsopygia costalis* (Fabricius) was very less from 15 to 50 days crop.

Ganapathy (2010) revealed that the peak incidence of spotted pod borer in Indian bean and pigeon pea started from 40th (October) to 47th standard week (November) at Tamil Nadu Agricultural University, Coimbatore.

Godwal (2010) revealed that minimum temperature had negative significant correlation with aphid on Indian bean.

Prasad *et al.* (2011) studied the incidence of different insect pests and predators on new variety, HA-4 of dolichos bean. The sucking pest population was found throughout the year. The peak population of aphids (49.00 per 3 leaves) was observed on 60 days after sowing (DAS). Among the pod borer, higher pod damage due to *M. vitrata* was 16.66 per cent on 80 DAS.

Mallikarjuna *et al.* (2012) observed eight pod borers on field bean from Bengaluru and among them, *H. armigera* was the predominant and its incidence was as high as 80.50 larvae per 10 plants during 3rd week of November. The life cycle of

Adisura atkinsoni (Moore) was synchronous with those local photosensitive lablab cultivars. *A. atkinsoni* appeared to have changed its life cycle and was observed only during late pod maturing stage *i.e.* 1st week of November and reached peak during last week of December with a mean of 42 larvae per 10 plants. The seasonal incidence of plume moths *viz.*, *E. atomosa* and *S. caffer* was observed right from the budding stage and peak incidence was observed during 3rd week and 2nd week of November, respectively.

Shalaby *et al.* (2012) carried out field experiment at Kafr El-Sheikh governorate during two successive seasons 2008/2009 and 2009/2010 to study the population fluctuations of some insect pests infesting broad bean plantations namely *Liriomyza trifolii* (Burgess); *Aphis craccivora* (Koch) and *Empoasca discipiens* Poali infesting broad bean plantations. In addition, the effect of certain weather factors (daily mean temperatures and daily mean R.H.) and plant age were studied on the population fluctuations of the previously mentioned pests. The weather factors and plant age had significant effect on the population fluctuations of *L. trifolii, A. craccivora* and *E. discipiens*. Also, the relative humidity had shown no significant effect on population fluctuations of the three insect pests during the two seasons 2008/2009 and 2009/2010. The percentage of explained variance was 83.5 per cent and 81.9 per cent during the two seasons, respectively.

Duraimurugan and Tyagi (2013) carried out experiments to explore the change in pest spectra, their status, succession and yield loss in mungbean and urdbean under changing climatic scenario. The broad mite *Polyphago tarsonemuslatus* (Banks), blister beetle *Mylabris pustulata* (Fabricius) and spotted pod

borer *Maruca vitrata* (Fabricius) assumed the status of major pests during *kharif* season as compared to earlier report at Kanpur location. Bean flower thrips *Megalurothrips usitatus* (Bagnall), a major pest during spring/summer seasons became major pest in *kharif* season also.

Kshama Patel (2014) reported that aphid (*Aphis craccivora* Koch.) population on Indian bean started from 1st week of November with 0.2 aphid index, increased continuously, reached a peak of 4.2 aphid index in 3rd week of December; jassid (*Empoasca kerri* Pruthi) population also started from 1st week of November (0.3 jassid per leaf) and reached a peak level (4.4 jassids per leaf) in 3rd week of December whereas, whitefly (*Bemisia tabaci* Genn.) population started from 1st week of November (0.2 whitefly per leaf) and reached to a peak level of 4.4 whiteflies per leaf in last week of December. The incidence of gram pod borer (*H. armigera)* started in 1st week of November reached to a peak level (4.2 larvae per plant) in 3rd week of December and thereafter decreased gradually. The population of spotted pod borer (*M. vitrata*) started from 2nd week of November (0.4 larva per plant) coinciding with the flower initiation and reached to a peak of 4.6 larvae per plant in 3rd week of December.

Malik *et al.* (2015) studied the seasonal dynamics of *Helicoverpa armigera* (Hubner) and relative abundance of its larval parasitoid, *Campoletis chlorideae* (Uchida) in chickpea ecosystem. The highest mean larval population of *H. armigera* (22.33 larvae per meter length) was observed during 13th standard week. When the maximum and minimum temperature, 27.88ºC and 16.17ºC, respectively, and relative humidity 67.58 per cent and rainfall were 2.4 mm. Population growth of

H. armigera was positively correlated to temperature while non-significant negative correlation was recorded with relative humidity. However, *C. chlorideae* population build up showed significant positive correlation with *H. armigera* population.

Naik and Mallapur (2015) found that the incidence of spotted pod borer in black gram commenced after second week of August at Dharwad conditions and it gradually increased to attain peak during last week of August. Similarly, the pod damage due to spotted pod borer peaked (24.80%) during last week of September.

Sampathkumar and Durairaj (2015) noticed relative abundance of *M. vitrata* in pigeonpea variety, CORG 7 during *Kharif* and *Rabi* seasons of 2011 and 2012 at Department of Pulses, TNAU, Coimbatore and revealed that in 2011, the first peak incidence was during 34th SMW (4th week of August) and 36th (1st week of September) SMW as 4.44 and 3.68 webbings per plant, respectively followed by the second peak during 50 (2nd week of December) and 52nd (4th week of December) SMWs as 9.38 and 5.72 webbings per plant, respectively. In 2012, on 50th and 52nd SMWs (2nd and 4th weeks of December) the peak incidence of 6.21 and 5.10 webbings per plant were recorded, respectively.

Jhansi Rani and Hanumantharaya (2016) carried out research on population dynamics of French bean. During the study period a total of 11 insect taxa and one non-insect taxa belonging to 7 orders and 9 families were recorded throughout the cropping period for two seasons. The peak incidence of thrips, *Megaleurothrips* sp. was noticed during the 2nd week of November and 3rd week of February. The peak incidence of *H. armigera* was noticed during the 3rd week of November and

last week of March whereas, *Maruca testulalis* (Geyer) was noticed during the last week of December and last week of March. Further, the peak incidence of aphids, whitefly and leaf hopper were recorded in 3rd week of November and 2nd week of February; 3rdweek of November and last week of February; 3rd week of November and March, respectively.

Manoj Kumar and Singh (2016) conducted the experiment during the *kharif* season of 2014 on population dynamics of major insect pests of blackgram. The results revealed that the highest population of whiteflies 8.07 adult per cage per plant and jassids 1.43 nymphs and adult per cage per plant was recorded during 37th standard week. The population of whitefly and jassid showed non-significant negative correlation with maximum and minimum temperature and sunshine hours while significant positive correlation with maximum humidity whereas non-significant positive correlation showed with total rainfall and minimum humidity. The highest population of spotted pod borer 2.13 larvae per plant was record during 38th standard week and flower thrips 3.47 nymph and adult per 10 flowers was recorded during 37th standard week and spotted pod borer population showed significant positive correlation with sunshine hours while flower thrips and spotted pod borer population showed non-significant positive correlation with maximum and minimum relative humidity and non-significant negative correlation with maximum and minimum temperature whereas population of spotted pod borer showed non-significant negative correlation with total rainfall, while population of thrips showed non-significant positive correlation with total rainfall while sunshine hours showed non-significant negative correlation.

Mollah *et al.* (2016) carried out field experiment at Entomology Department, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, Bangladesh during March to July 2009 in order to know the insect pest complex in heat tolerant year round country bean (IPSA Seem 2) field during summer season. During the study period, the insect pests *viz*; aphid (*Aphis* spp.), pod borer (*Maruca testularis* G.) were found year round on country bean field. Among the insect pests; aphids (*Aphis* spp.) were found at the vegetative stage; while pod borer (*Maruca testularis* G.) and aphid (Aphis spp.) were found at flowering stage.

Ojha *et al.* (2016) conducted the experiment on chickpea during winter 2010-11 and 2011-12 to determine the impact of abiotic factors and parasitization by *Campoletis chloridae* (Uchida) on population dynamics of *H. armigera*, It was observed that during February month, the larval population had the highest peaks as 8.93 and 7.93 larvae per meter row alongwith the highest multiplication rate as 0.44 and 0.33 larvae per day. The natural parasitization was maximum during December month as 51.67 and 56.67 per cent. Simple correlation coefficient (r) of temperature (maximum and minimum), wind speed, and evaporation rate had reflected positive values when relative humidity (morning and evening), rainfall and larval parasitization played a negative role on the pest population.

Chopkar (2017) noticed that the appearance of lablab bean aphid started from week 1 (1st week of January) and was prevalent up to week 12 (3rd week of March). Overall mean aphid population per leaf per plant was in the range of 11.70 to 30.17. The leaf eating caterpillar, *S. litura* was recorded from week 1 (1st week of January) to week 12 (3rd week 15 of March). Overall

mean number of holes made by leaf eating caterpillar per leaf per plant in twelve weeks was in the range of 0.60 to 2.17. The infestation of pod borer, *M. vitrata* was noticed from week 7 (2nd week of February) and persisted till the harvest of crop. Overall per cent infestation of pod borer in six weeks was in the range of 9.93 to 19.81. The natural enemies like black ants, spiders, lady beetles and chrysopids were noticed throughout the cropping period starting from week first (1st week of January) till harvest of the crop i.e. week 12 (3rd week of March).

Jakhar *et al.* (2017) conducetd trial on seasonal incidence of major sucking pests and their natural enemies on Indian bean crop, *Lablab purpureus* (L.) and revealed that three sucking pests *viz.*, aphid, *Aphis craccivora* Koch (Hemiptera: Aphididae), jassid, *Empoasca fabae* Harris (Hemiptera: Cicadellidae), whitefly, *Bemisia tabaci* Gennadius (Hemiptera: Aleyrodidae) appeared as major pests due to their high population under semi-arid region of Rajasthan. The incidence of aphid and whitefly commenced in the 1st week of September, which gradually increased and reached to its peak in 2nd week of October. Jassid population first appeared in 1st week of September which gradually increased and reached at their peak in 3rd week of October. Predatory lady bird beetle, *Menochilus sexmaculatus* Fabricius was also recorded during the crop season. The incidence of the lady bird beetle started in 3rd week of September, which gradually increased and reached peak in 2nd week of October. The weather factors *viz.*, maximum and minimum temperatures and rainfall showed a non-significant correlation with aphid, jassid and white fly population. The correlation coefficient of relative humidity worked out with aphid and jassids population showed a non-significant correlation while such correlation was

significantly positive with white fly population. The correlation matrix of predatory population depicted a non-significant correlation with maximum and minimum temperatures, relative humidity and rainfall. However, its population showed a significant effect on the pest species.

Mantesh *et al.* (2017) studied the population dynamics of major pests of cow pea during 2016 - 2017 in the agricultural fields of Bangalore, India. The pest population was showing positive correlation with high temperature and the population of predators and other associated insect was showing negative correlation with minimum temperature, relative humidity and rainfall. The activity of jassids was observed from 1st week of September, 2016 with 0.85 nymphs per 3 leaves (36th MW), during this period maximum and minimum temperature was average, morning and evening relative humidity and rainfall recorded were 27.20°C, 18.50°C, 91 per cent, 55 per cent and 12.8 mm respectively. The population of jassids decreased steadily and was at its lowest level on second week of October. The incidence of thrips was observed from first week of September, 2016 with 1.20 thrips per 3 leaves (36th MW), during this period average maximum and minimum temperature. Then after population started increasing up to 3rd week of September. The activity of pod sucking bugs started after the flowering stage of the crop *i.e.* third week of October, 2016 (42nd MW) with 0.53 bugs per plant. At the time of first observation in 2nd week of August, 2016 (35th MW) population of coccinellid grubs were increased, population started declining up to second week of October.

Srinivasa *et al.* (2017) carried out research to find the correlation between seasonal incidence of lablab bug,

Coptosoma cribraria (Fabricius) with weather variables during *kharif* 2015-16 and *kharif* 2016-17, respectively. The results on the seasonal incidence of major insect pests revealed that the incidence of lablab bug, *Coptosoma cribraria* (Fabricius) was observed from second week of October during 41st standard week to 4th standard week in *kharif* 2015–16. The highest incidence of *C. cribraria* population was recorded with two peaks *i.e.* at 47th standard week (3rd week of November) and 49th standard week (1st week of December) with 5.3 and 5.1 bugs per plant, respectively while, the population of *Coptosoma cribraria* increased gradually from third week of October during 42nd standard week to 4th standard week in *kharif* 2016-17 and the highest incidence of *Coptosoma cribraria* population were recorded during 47th, 50th and 1st standard weeks with 4.9, 4.4 and 4.4 bugs per plant, respectively. The relationship between the *C. cribraria* bug population with preceding one week (one week lag) weather parameters during kharif 2015-16 revealed that there was a significant negative correlation with maximum temperature (-0.590*) and sunshine hours (-0.546*) at 5 per cent level of significance while, positive significant correlation with evening relative humidity (0.576*) at 5 per cent level of significance and wind speed (0.645**) at 1 per cent level of significance were recorded. During *kharif* 2016-17, maximum temperature (-0.554*) and minimum temperature (-0.578*) were negatively significant with *C. cribraria* population at 5 per cent level of significance whereas mean temperature (-0.645**) was negatively correlated at 1 per cent level of significance.

Kishor *et al.* (2019) noticed that the incidence of aphid on lentil, started from 4th meteorological standard week (23.80 aphid per 10 cm apical twigs). The aphid population gradually

increased and reached to its peak (35.4 aphid per 10 cm apical twigs) on 7th meteorological standard week (12th -18th February) and thereafter its population gradually decreased from 8th SMW (19th – 25th February) (31.30 aphid per 10 cm apical twigs) to 12th SMW (19th March- 25th March) (9.0 aphid per 10 cm apical twigs).

Golvankar (2019) studied the seasonal incidence, screening and management of pests infesting lablab bean (*Lablab purpureus* (L.) Sweet). The results revealed the maximum population (2.50 and 12.38) of aphids three leaves per plant was recorded in 12th Standard Meteorological Week i.e. SMW (19- 25 March, 2018) and 11th SMW (12-18 March, 2019), respectively.

Kishor *et al.* (2019) conducted a series of field experiments at Research Farm of Tirhut College of Agriculture, Dholi, Muzaffarpur, to determine the seasonal incidence and explore the possibilities of management of aphid and pod borer on lentil. The incidence of aphid (*A. craccivora*), started from 4th meteorological standard week (MSW) (23.80 aphids per 10 cm apical twigs). The aphid population gradually increased and reached to its peak (35.4 aphid per 10 cm apical twigs) on 7th MSW (22nd of February) and thereafter its population gradually decreased from 8th MSW 4th week of February (31.30 aphid per 10 cm apical twigs) to 12th MSW(4th week of March) (9.0 aphid per 10cm apical twigs). The incidence of pod borer moth *Etiella zinckenella* (Treitschke), was observed from 7th MSW (3rdweek of February) (4.00%) and the per cent pod damage gradually increased and reached to its peak (14.30%) on 9th MSW (1stweek of March). Its infestation was found to decrease gradually 10th MSW (12.10%). Initially *Coccinella septempunctata* (Linnaeus) population was very low in 4th MSW of January, 2018 (0.90 per

plant) and after that the population gradually increased. The maximum population of *C. septempunctata* (4.50 per plant) was recorded in 8th MSW of February, 2018. Spider population was very low (1.10 spider per plant) in 4th MSW of January, 2018 and the maximum population (2.00 spider per plant) of spider was recorded in 6th SMW of February.

2.2 To study the effect of sowing dates against pests infesting dolichos bean, *Lablab purpureus* (L.) Sweet

Yadav *et al.* (1983) observed that early sowing of chickpea or the use of early maturing varieties could significantly reduce the damage caused by *H. armigera*, because pod setting and maturation were completed during the period when larval population was low.

Dhurve and Borle (1986) cited that the pod damage in gram (*Cicer arietinum* L.) by *H. armigera* was the lowest when the crop was sown between 30th October and 4th December. The yield was significantly higher in 30th October and 27th November sowings.

Talekar *et al.* (1991) found that early November sowing of gram (*Cicer arietinum*) had the lowest number of eggs and larvae of *H. armigera* as compared with the sowing made 2 and 4 weeks later.

Begum *et al.* (1992) reported significant influence of sowing dates on *H. armigera* in chickpea in Bangladesh. They observed that chickpea sown on 15 November and 1 December suffered significantly less pod damage than those sown on 15 and 31 December.

Ekesi (1996) investigated the relationship between planting dates and damage by the pyralid, *M. testulalis* (pod borer) on *V.*

unguiculata (cowpea) in Nigeria during July to August 1993 and 1994. The population tended to build up in the course of the sowing period in both years. The number of flower and pods infested were greater in cowpea planted in August than in July in both years. Grain yield also decreased significantly in late planted crops than in early planted cowpea within the 1st and 2nd week of July would reduce damage by the pest.

Singh *et al.* (2002) carried out trial in Gurdaspur, Punjab, India, during 1999 and 2000 on chickpea cultivars PBG-1 and GL-769 to determine the effect of sowing dates (10th October, 20th October, 30th October, 10th November and 20th November) on incidence of *H. armigera*. Significant differences in the infestation of *H. armigera* on plots of different sowing dates were observed. The first three dates of sowing of both cultivars suffered significantly less pod damage than the others. There was higher incidence of *H.armigera* in the crop of 10th November and later date, maximum being recorded on 20th November. Both the cultivars showed similar pattern of infestation across all the sowing dates during both the years.

Patnaik (2004) conducted a field trial on the effects of sowing date (30th October, 15th November, 30th November or 15th December) and row spacing (30 or 45 cm) on the incidence of *H. armigera* on chickpea in Keonjhar, Orissa, India. The sowing date had greater effects on pod damage and grain yield than the genotype. Crops sown on 30th October and 30th November had high grain yields (11.8-15.2 and 15.6-20.7 quintal per ha) despite the high levels of pod damage (4.6-11.1 and 14.5-16.7%) caused by *H. armigera* However, based on yield and pod damage, sowing on 30th October was considered optimum. Closer spacing (30 cm) resulted in a higher mean number of eggs (5.0) and

larvae (8.2) per plant irrespective of sowing date and cultivar. Pod damage and grain yield did not significantly vary with the row spacing and cultivar.

Altaf *et al.* (2006) conducted an experiment at Pulses Research Center, Ishurdi, Pabna, Bangladesh during *kharif* to find out the insect pests attacking mung bean crop sown at different dates to determine the optimum date(s) of sowing. It was seen that the incidence and population fluctuation of various insect pests was very much dependent on the prevailed climatic conditions of the cropping season. The early (February 14 to March 6) and late sown (mid-April to onward) crops received higher pest infestation than mid sown (March 13 to April 10) crops. The highest yield (1548 kg per ha) was obtained from March 27 sown crop. The second highest yield (1279 kg per ha) was obtained from March 13 sown crop which was statistically identical to March 20, April 03 and April 10 sown crop. Again, the delayed sowings after mid-April to onward provided yield of 717 kg per ha to 178 kg per ha which were very poor. Hence, for ensuring higher yield and less insect pests infestation, mungbean should be sown within the period of March 13 to April 10 and the best date of sowing should be March 27.

Helalia *et al.* (2011) conducted the field trials during 2005 and 2006 seasons at Minofia governorate to evaluate the effect of planting date of three cowpea cultivars on their infestation rate with cowpea pod borer, *E. zinckenella*. For each cowpea cultivar planted at each tested date, the number of bores and larvae were counted in green and dry pods as well as in dry seeds and the means were obtained to estimate the degree of insect infestations. The results indicated that, regardless the planting

date in both seasons, Kream 7 was the highest resistant cultivar to insect infestation followed by Kaha1 and then Kafr El Shikh 1. On the other hand, regardless the cowpea cultivar, the rate of insect infestation was greatly reduced at the early plantation. Thus, selection of Kream7 cultivar and early plantation could be involved in reducing *E. zinckenella* infestation and subsequently increase the cowpea yield. These studies clearly demonstrated that several non-insecticidal approaches have great potential for cowpea pod borer *E. zinckenella* management.

Islam *et al.* (2013) conducted field experiment to study the sowing times and varieties on incidence of pod borer in lentil at the Farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, Bangladesh during the period from October 2008 to sowing on 6th November, sowing on 26thNovember and four varieties *viz.*, V1, BARI, BARI Masur-5 and V4 were evaluated in the experiment. The result indicated that the pod damaged by pod borer varied significantly due to sowing times and crops sowing in November 16 had the lowest level of pod borer infestation (11.33%) compared to early (14.71%) and late season (15.84%) sowing crops.

Akter (2014) evaluated the effect of sowing dates and different micronutrients on incidence of insect pests of mung bean (*Vigna radiata* (L.) Wilezek) during *kharif* season (August to December) of 2013. Considering the sowing times, the lowest number of whitefly (1.13), jassid (1.40) and pod infestation (24.10%) of pod borer was observed in S2 (Sowing on 23th September, 2013) and the highest population of those was found in S1 (Sowing on 24th August, 2013). The lowest (3.93) and highest (5.36) number of thrips was observed in S1 and S2.

Akhtar *et al.* (2014) studied the impact of different sowing dates of chickpea crop on the incidence of gram pod borer *H. armigera* and its grain yield at farm area of Entomological Research Institute, Faisalabad during 2012-13 and 2013-14. The Chick pea variety, NOOR-2009 was sown on 20th October, 30th October, 9th November and 19th November with 10 days interval. Initially, pod borer larval population was recorded by observing 1 meter row length from each plot. After pod formation, pod damage percentage was calculated by observing total number of pods and number of damaged pods. Average pod borer larval population ranged from 0.20 to 3.10 and 0.10 to 2.55 per 1 meter row length during 2012-13 and 2013-14, respectively with maximum in 20th October sown plots. Maximum yield (3072.43 and 3163.3 kg per ha) was observed at 20th October *i.e.* 1.51 and 1.48 times higher than the yield from the plot sown on 19th November during the seasons 2012-13 and 2013-14, respectively. Gram pod borer larval population was found to be positively and significantly correlated with temperature but negatively correlated with relative humidity during both the years.

Dialoke *et al.* (2014) studied three short duration cultivars of pigeon pea namely, ICPL 84023, ICPL 87, ICPL 151 which were planted during first week in April, June, and August in 2008 and 2009. ICPL 87 was most vulnerable to insect pests as it suffered more damage by the pod borer (*Helicoverpa armigera* Hubner), pod sucking bugs (*Clavigralla tomentosicollis* Stal.) and pod fly (*Melanagromyza obtusa* Malloch) than ICPL 151 and ICPL 84023. The pod borer caused the greatest pod/seed damage in April planted crop while the least damage was observed in June planted crop. Pod/seed damage by *C. tomentosicollis* was highest

in the crop planted in August and least in crop planted in June, while *M. obtusa* damage was highest in April and least in August planting. ICPL 87 recorded the poorest seed yields and ICPL 151 gave higher seed yields 604.83 kg per ha in 2008, but got reduced to 579.59 kg per ha in 2009 compared with ICPL 84023. With respect to planting dates, the highest seed yields of 809.93 kg ha^{-1} in 2008 and 840.84 kg per ha in 2009 were recorded in June planted crop followed by the crop planted in April with seed yields of 656.24 kg ha-1 in 2008, and 716.70 kg per ha in 2009. August plantings had the least seed yield of 19.63 kg per ha in 2008 and 25.50 kg per ha in 2009 compared with yields from April and June planting seasons.

Parmar *et al.* (2015) conducted experimental trial to confirm the optimum sowing date of chickpea to determine the infestation of *H. armigera* and grain yield. It was observed that the incidence and population fluctuation of the pest was much dependent on the prevailed weather parameters during the cropping season of all seven different dates of sowing. The overall minimum mean eggs population (3.04 per 10 plants) was recorded on early sown crop on November 07 which was significantly superior over the other sowing dates. Correlation analysis revealed that morning relative humidity (%) exhibited significantly positive correlation with eggs population on November 07 (r= 0.60), December 27 (r= 0.64) and maximum temperature on December 17 (r= 0.57) while, significantly negative correlation (r= -0.61) was found with evening relative humidity (%) on December 17 sown crop, respectively. Minimum larval population (1.74/mrl) was observed on November 07 sown crop which was significantly superior over other six sowing dates. Correlation coefficient of larval population with sunshine

hours exhibited significantly positive correlation (r= 0.55) on November 07 sown crop. Whereas, maximum temperature (r= 0.66) showed positively significant association with mean larval population while, both morning and evening relative humidity exhibited negative correlation (r= -0.54 and -0.55) on November 27 sown crop. On December 07 sown crop, the correlation of mean larval population with maximum and minimum temperature was also exhibited significantly positive (r= 0.70 and 0.62). Maximum grain yield 1855 kg per ha was recorded from early sown crop on November 07, whereas minimum yield 612 kg per ha was obtained from late sown crop of chickpea.

Kalyan and Ameta (2017) conducted an experiment to study the effect of sowing time and varieties on incidence of insect pests of soybean. The crop sown during 1st week (timely sown) of July had significantly higher incidence of *Bemisia tabaci* (Gennadius) and *Obereopsis brevis* (Swedenboard) as compare to crop sown in the 3rdweek (late sown) of July. The incidence of *Chrysodeix isacuta*, (Walker), *H. armigera* and *S. litura* significantly lower in timely sown as compared to late sown. In case of yield, the significantly highest yield with mean of 1564 and 1650 kg per ha was recorded in timely sown crop.

Patel *et al.* (2017) carried out field experiments at the College Farm, N. M. College of Agriculture, Navsari Agricultural University, Navsari during *Kharif* 2015-16 to study the effect of sowing period on incidence of pod borers of pigeonpea. The study revealed that the pigeonpea pod borers and grain yield were significantly influenced by sowing period and cultivars. Early sowing recorded lower incidence of pod borers *viz.*, *H. armigera* and Plume moth, *E. atomosa* while, late sowing caused lower incidence of pod fly, *Melanagromyza obtusa* (Malloch) Further,

study revealed that pod borers damage was low in determinate variety Vaishali as compare to indeterminate variety GT-1. Highest grain yield was recorded in early sowing of indeterminate variety GT-1.

Yousif and Ibrahim (2017) revealed that soybean sown in the 1st of June harbored more aphids than those sown in the 15th of April during both seasons. When soybean sowing was delayed to the beginning of June, the activity of aphids had increased and population has two peaks of abundance.

Parul *et al.* (2018) studied the impact of sowing dates on the incidence of insect pests of pigeon pea in the Tarai region of Uttarakhand during 2016 and 2017. Four different sowing dates *viz.*, 10th June, 20th June, 10th July and 10th August were selected for the study. The crop sown at 10th June showed significantly lower incidence of *Empoasca kerri* (Walsh), *Clavigralla gibbosa* (Spinola), *Helicoverpa armigera* (Hubner) and *Maruca vitrata* (Fabricius) at early stage of the as against to other three sowing dates. Hence, the crop was escaped from early infestation of insect pests. The per cent pod damage caused by *H. armigera* (1.85%) and *M. vitrata* (12.80%) was also found to be lowest on the crop sown at 10th June, while the pod damage by *M. obtusa* was lowest (21.05%) on the late sown crop (10th August). The yield data indicated that the crop sown on 10th June recorded significantly higher yield (1219 kg per ha) as compared to subsequent sowing, while the lowest yield (747 kg per ha) was noticed in crop sown on 10thAugust. Thus, the study showed that the first flush of the pigeon pea crop was escaped from peak activity of the *M. vitrata*, *H. armigera* and other sucking pests at early sowing. Therefore, it was noticed that 10th

June would be the most suitable date of sowing for pigeon pea in the Tarai region of Uttarakhand.

2.3 To study the efficacy of insecticides against pests infesting dolichos bean, *Lablab purpureus* (L.) Sweet

Kumar and Sangappa (1984) compared the efficacy of plant products for the control of gram caterpillar in bengal gram. From the results it was evident that honge oil @ 5 per cent concentration recorded least pod damage (1.05 %), however, it was on par with NSKE 5 per cent, neem oil 5 per cent, honge oil 3 per cent and endosulfan @ 0.07 per cent. Ethenolic extracts of NSKE lowered the incidence of *H. armigera*, *M. testulalis* and *M. obtusa* on pigeon pea. In general, the extracts offered less protection as compared to fenvalerate against lepidopterous borers.

Singh *et.al.* (1985) stated that ethanolic neem kernel extract reduced the incidence of *H. armigera*, *M. testulalis* and *M. obtusa.*

Karel and Schoonhoven (1986) conducted a field trial on use of chemical and microbial insecticides against pests of common beans, *Phaseolus vulgaris* L. and reported that the two applications of *Bacillus thuringiensis* (Berliner) during the post flowering growth stage of bean plants controlled the larvae of pod borer, *M. testulalis* and *H. armigera* (Hub.) as effectively as two applications of lindane 20 EC @ 2 g a.i. per lit water and carbaryl 85 WP 2.25 g a.i. per lit water over the same period.

Manjula and Padmavathanma (1996) reported that the maximum reduction in the larval population of *M. vitrata* was recorded with the treatment of *B. thuringinensis* (1×10^7 spore per ml) + monocrotophos (0.025 %).

Sharma *et al.* (1999) revealed that the pathogens such as *Bacillus thuringiensis*, *Nosema* sp. and *Aspergillus* sp. played important role in regulating *M. vitrata* population.

Chandrakar and Shrivastava (2001) compared the efficacy of dipel 8 EL @ 500 ml per ha, NSKE 2 per cent and monocrotophos 36 EC @ 750 ml per ha, sprayed singly and in combination at 30, 45 and 60 days after sowing to control pod borer complex *i.e. H. armigera, M. vitrata* of urd bean. The infestation was effectively controlled by monocrotophos followed by dipel during 30 and 45 days after sowing, respectively.

Reddy *et al.* (2001) evaluated some insecticides, biopesticides and their combinations against pod borers in pigeonpea. The studies on bio-efficacy of two synthetic pyrethroids *viz.*, deltamethrin and fenvalerate, two biopesticides *viz.*, *B. thuringiensis* (Dipel) and *B. bassiana* (Dispel) and their judicious combinations revealed that the combination of dipel with deltamethrin (0.004% or 0.002%) was most effective in reducing the damage due to pod borers. These treatments also gave highest net profit and were rated as most cost effective management strategy.

Byrappa *et al.* (2009) observed that among biopesticides, sequential application of NSKE-*HaNPV-Bt* was effective against insect pests of field bean. *HaNPV* was effective against *H. armigera* larvae, but ineffective to other pod borers. Panchagavya and clerodendron + cow urine extract were ineffective in reducing the pod borer incidence. Among biopesticides treated plots, sequential application of NSKE-*HaNPV-Bt* recorded higher grain yield (10.01 q per ha) whereas, package of practices followed treatment (inorganic plot) recorded 11.37 q per ha.

Naveena *et al.* (2010) conducted field trial to evaluate the efficacy of biopesticides and neem products to control the field infestation of bruchids in Dolichos lablab. The field bean (cultivar HA 3) seeds were sown in randomized block design with eight treatments *viz.*, two *Bt* formulations (Halt and Dipel), *Pseudomonas* sp., Neem oil, Neem seed kernel extract, malathion and spinosad. They revealed that spraying of NSKE (5%) resulted in good control of pulse beetle under field conditions. The mean per cent pod damage was significantly different between the treatments. NSKE (5%) recorded the lowest pod damage (4.64%) when compared to malathion (5.96%) and spinosad (6.30%). However, they were significantly different from the others except Dipel (4.88%). Untreated control recorded highest pod damage (10.95 %) followed by *Pseudomonas* sp. (8.88 %). Significantly high yield was obtained in case of NSKE (12.19 q per ha) followed by Dipel (9.95 q per ha). However, lowest yield was in untreated control (7.55 q per ha).

Poonam Shinde (2014) studied the efficacy of Entomopathogenic fungi against dolichos bean, the lowest aphid population was recorded in the treatments of *Verticillium lecanii* 7.5 g and *V. lecanii* 5 g with 33.70 and 35.28 aphids/3 leaves respectively, which were at par with each other and were superior over all other treatments followed by *V. lecanii* 3 g and *Metarhizium anisopliae* 7.5 g with 38.20 and 34.05 aphids/3 leaves count, respectively.

Subhasree and Mathew (2014) conducted the field experiments at College of Horticulture, Thrissur, to evaluate the efficacy of a botanical viz., azadirachtin (0.005%), bioagents viz., *Beauveria bassiana* (1%), *Metarhizium anisopliae* (1%), *Bacillus thuringiensis* (0.2%) along with their sequential

application (azadirachtin followed by *B. bassiana /M. anisopliae /B. thuringiensis),* a safer chemical viz., flubendiamide 480SC (0.008%) and a standard check (quinalphos 0.05%) against pod borer complex of cowpea. Results showed that after three consecutive sprays at fortnightly intervals starting from flowering, flubendiamide was found to be the most effective in managing the larval population of pod borers, viz., *Maruca vitrata* (Fabricius), *Lampides boeticus* (L.). Azadirachtin, *M. anisopliae* and *B. thuringiensis* recorded larval population below economic threshold level (ETL) starting from 14th day after first spraying till the end of cropping period. With respect to per cent pod damage (in terms of number and weight) flubendiamide was found to be significantly superior over control and all other treatments were on par. Though quinalphos recorded the highest total yield both in terms of weight and number, application of flubendiamide resulted in highest number of marketable pods. It also recorded the highest B: C ratio (1.69) followed by quinalphos (1.53) and *B. bassiana* (1.22).

Chaudhari *et al.* (2015) revealed that the applications of neem seed kernel extract (5%) and neem leaves extract (10%) were effective against sucking pests. While, the emamectin benzoate 5 SG @ (0.0025%) and spinosad 45 SC (0.015%) proved to be effective against pod borer infesting Indian bean. Whereas on green pod yield, the treatments of emamectin benzoate and spinosad produced significantly higher pod yield (3326 to 3477 kg per ha) in comparison to other biopesticides. Fungal based microbial insecticides produced poor yield (2119 to 2332 kg per ha). Maximum (1:44.14) incremental cost benefit ratio (ICBR) was found in the treatment of NSKE followed by NLE (1:37.20). Though, the spinosad and emamectin benzoate showed higher

(23924 to 25150 per ha) net realization over control, they exhibited relatively poor (1:11.30 to 1: 14.95) economic returns.

Mahalakshmi *et al.* (2015) evaluated the efficacy of chemical insecticides belonging to different groups against spotted pod borer was well established on different pulse crops. Neem products such as neem seed kernel extract (NSKE) or neem oil and biocides like *Bacillus thuringiensis* (*Bt*) (Berliner) showed different levels of efficacy on different crops.

Singh *et al.* (2015) tested efficacy of certain botanical insecticides against lentil aphid. The treatment were; T_1 - NSKE (5%), T_2 - nimbicidine (0.03%), T_3 - multineem (0.03%), T_4 - econeem (0.03%), T_5 - rakshak (0.5%), and T_6 -achook (2%), T_7 - dimethoate 30 EC (0.03%), respectively were applied. At 14 days after spray, dimethoate 30 EC @ 0.03 per cent treated plots showed (88.4%) reduction in aphid population and was again significantly superior over the other treatments. The remaining treatments in order of efficacy were T_6 (67.8%)> T_4 (60.0%)> T_5 (57.6%)> T_2 (52.4%)> T_3 (50.8%)> T_1 (45.4%)> T_8 (3.6%).

Venansio (2015) evaluated the potential of entomopathogenic fungi (EPF) for the management of *M. vitrata* on cowpea. Screening of EPF was done to identify the most potent isolates against *M. vitrata*. Fourteen isolates of *Metarhizium anisopliae* (Metschnikoff) Sorokin and six of *Beauveria bassiana* (Balsamo) Vuillemin were screened against first instar larvae, from which the best two isolates namely *M. anisopliae* ICIPE 18 and ICIPE 69 that caused highest mortality of 91 per cent and 81 per cent, respectively were selected for further studies. Field evaluation results showed that Karate®, the commercial formulation of *M. anisopliae* ICIPE 69 (Campaign®), and Nimbecidine®, significantly reduced pest

damage which translated into grain yield increment of up to 1254 kg per ha (387%), 747 kg per ha (231%) and 340 kg per ha (117%), respectively. Overall, the study demonstrated that *M. anisopliae* isolates ICIPE 18 and ICIPE 69 were effective against *M. vitrata*, and that isolate ICIPE 69 produced more biomass and propagules than ICIPE 18, in Jenkins-Prior and APU1 liquid media.

Yadav *et al.* (2015a) reported that thiamethoxam (25% WG), acetamiprid (20% SP) and triazophos (20%EC) were most effective in reducing the population of whitefly and leafhopper. The treatments of azadirachtin 0.03 per cent EC, jatropha oil and *B. bassiana* (5% WP) were found relatively toxic to the *coccinellid* beetles.

Yadav *et al.* (2015b) conducted field experiment to evaluate efficacy of insecticides and bio-pesticides against sucking pests in Black gram. The results revealed that thiamethoxam (25%WG), acetamiprid (20% SP) and triazophos (20% EC) were found to be the most effective in reducing the population of whitefly and leafhopper. The treatments of azadirachtin (0.03% EC), jatropha oil and *Beauveria bassiana* (5% WP) were found relatively less harmful whereas, indoxacarb (14.5% SC) was observed relatively toxic to the coccinellid beetles.

Nath *et al.* (2017) studied the effect of bio-rational approaches such as intercropping and application of bio-pesticide on the larval population, pod damage, grain damage and grain weight loss by plume moth, *Exelastis atomosa* (Wlsm.) infesting pigeon pea, *C. cajan* (L.) Millsp. The two sprays of NSKE 5 per cent (first at flowering and pod formation stage and second after 20 days) were found superior in reducing larval population, pod damage, grain damage and grain weight loss. However, the

plots devoid of any biopesticidal treatment had maximum larval population (0.68 larva per plant), pod damage (2.75%), grain damage (0.86%) and grain weight loss (0.60%) by *E. atomosa.*

Selvam (2018) conducted field experiment on black gram under rainfed conditions to study the botanicals and entomogenous fungi against pod borer complex of spotted borer, *Maruca vitrata* and gram blue butterfly, *Euchrysops cnejus*. Azadirachtin (0.03%) formulation was effective against *M. vitrata* where reduction of flower (50.63%) and pod damage (65.80%), was recorded over untreated control. Neem oil (2%) treatment was also significantly similar in activity with a reduction of flower (57.80%) and pod damage (62.22%), caused by *E. cnejus.* Based on various parameters recorded, *Metarrhizium anisopliae* Metchnikoff sorokin (1883) and *Beauveria bassiana* Vuill. (1992) were less active compared to botanicals. In terms of crop yield, the highest yield of 750 kg per ha was achieved in the treatment of azadirachtin (0.03%) over the untreated crop (433 kg per ha).

CHAPTER III

MATERIAL AND METHODS

The field experiment was conducted at Vegetable Improvement Scheme, Central Experimental Station, Wakawali, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli during the *rabi* season of 2018-19. The details of the material used and methodology adopted during the present investigation are given in this chapter.

A brief account of the methodology adopted during the present studies is given under the following sub headings

3.1. To study the seasonal incidence of pests infesting dolichos bean, *Lablab purpureus* (L.) Sweet

3.2. To study the effect of sowing dates against pests infesting dolichos bean, *Lablab purpureus* (L.) Sweet

3.3. To study the efficacy of insecticides against pests infesting dolichos bean, *Lablab purpureus* (L.) Sweet

3.1 To study the seasonal incidence of pests infesting dolichos bean

The field experiment was conducted at Vegetable Improvement Scheme, CES, Wakavali, DBSKKV, Dapoli during *rabi* season to study the seasonal incidence of sucking pests and pod borers infesting dolichos bean. The details of experiment are given below.

Size of plot	:	3m x 1.2m
Method of planting	:	On raised beds
Spacing	:	30 cm x 30 cm
Variety	:	Konkan Bhushan
Date of sowing	:	22nd November, 2018

3.1.1 Method of recording observations:

The experimental plot was kept unsprayed throughout the cropping season. The observations were recorded as soon as the infestation was noticed.

a) Sucking Pests

The population of sucking pests infesting dolichos bean was not observed throughout the cropping season except aphids. The observations regarding aphids were recorded at weekly interval during morning hours on three randomly selected plants. Population was counted on three leaves top, middle and bottom and expressed as number per three leaves.

b) Pod borers

During the cropping season three different pod borers *viz., Helicoverpa armigera* (Hubner), *Spodoptera litura* (Fabricius) and *Maruca vitrata* (Fabricius) were observed to infest dolichos bean. The observations were recorded at each picking *i.e.* on the basis of number of healthy and infested pods due to pest.

Per cent pod infestation was calculated by the following formula,

$$\text{Per cent pod infestation} = \frac{\text{Number of infested pods}}{\text{Total number of pods}} \times 100$$

In order to study the influence of abiotic factors (meteorological parameters) on pest infestation, the correlations were worked out with weekly weather data *viz.*, average maximum and minimum temperatures, morning and evening relative humidity available at the meteorological observatory, Central Experimental Station, Wakawali, Tal. Dapoli, Dist-Ratnagiri.

3.2 To study the effect of sowing dates against pests infesting dolichos bean

The field experiment was conducted at Vegetable Improvement Scheme, CES, Wakavali, DBSKKV, Dapoli during *rabi* season to study the effect of sowing dates against pests infesting dolichos bean. The details of experiment are given below**.**

Size of plot	:	6m x 1.2m
Method of planting	:	On raised beds
Spacing	:	30 cm x 30 cm
Variety	:	Konkan Bhushan
Replications	:	Eight
Treatments	:	Three
Date of sowing	:	2nd November, 2018 22nd November, 2018 12th December,2018

3.2.1 Method of recording observations

All the agronomic practices were followed as per the package of practices except the plant protection measures which were undertaken. Each treatment was replicated eight times. Observations on insect pests were recorded at weekly interval after germination till harvesting of the crop.

a) Sucking Pests

The population of sucking pests infesting dolichos bean other than aphids was not observed throughout the cropping season. The population of aphids was recorded at weekly interval during morning hours on five randomly selected plants. The

population was counted on three leaves top, middle and bottom and expressed as number per three leaves.

b) Pod borers

During the cropping season three different pod borers *viz., Helicoverpa armigera* (Hubner), *Spodoptera litura* (Fabricius) and *Maruca vitrata* (Fabricius) were observed to infest dolichos bean. The observations were recorded at each picking i.e. on the basis of number of healthy and infested pods due to pest.

Per cent pod infestation was calculated by the following formula,

$$\text{Per cent pod infestation} = \frac{\text{Number of infested pods}}{\text{Total number of pods}} \times 100$$

3.3 To evaluate the efficacy of insecticides against pests infesting dolichos bean

A field experiment was conducted during *rabi* season of 2018-19 to study the effectiveness of some insecticides against sucking pests and pod borers infesting dolichos bean

3.3.1 Experimental details

The details of experiment are given below, while the treatment details are given in Table 1. The list of insecticides used in the present study is given in Table 2.

Experimental details:

Location	:	CES, Wakawali, DBSKKV, Dapoli, Dist. Ratnagiri
Period of study	:	November 2018 to April 2019
Variety	:	Konkan Bhushan
Spacing	:	30 cm × 30 cm
Size of treatment plot	:	1.5m × 1.2m
Total plot size	:	37.8m
Date of sowing	:	22nd November, 2018
Method of planting	:	On raised beds
Design	:	Randomized Block Design (RBD)
Number of replication	:	Three
Number of treatment	:	Seven

3.3.2 Spraying

The quantity of spray suspension required for each treatment was calibrated by spraying water over three plots in the experiment prior to the application of insecticide. Spray suspension of desired strength of each insecticide was prepared against aphids and pod borers in the field.

The insecticides were sprayed thrice in case of aphids and twice in case of pod bores because the infestation of aphids was noticed in the 48th SMW while the infestation of pod borers was noticed in the 52th SMW. The First spray of each insecticide was applied when incidence was noticed, while remaining sprays were given at an interval of 15 days with manually operated knapsack sprayer. The observations were recorded in each treatment on randomly selected plants.

Table 1: Treatment details to evaluate the efficacy of insecticides against pests infesting dolichos bean

Treatment No.	Insecticide Name	Conc. (%)	Quantity per litre (ml)
T_1	*Beauveria bassiana*	-	5
T_2	*Lecanicillium lecanii*	-	5
T_3	*Bacillus thuringiensis*	-	2
T_4	Azadirachtin 1000ppm	0.003	3
T_5	*Metarrhizium anisopliae*	-	2.5
T_6	Chloropyriphos	0.06	3
T_7	Untreated control	-	-

3.3.3 Method of recording observations

a) Sucking pests:

The population of sucking pests infesting dolichos bean other than aphids was not observed throughout the cropping season. The observations on the number of aphids were recorded on five randomly selected plants per plot. Number of pests was recorded from the three leaves top, middle and bottom of the plant. The pre-treatment observations were recorded 24 hrs before each spray. Subsequently post treatment observations were recorded at third, seventh, tenth and fourteenth day after each spray in the early morning hours.

b) Pod borers

During the cropping season three different pod borers *viz., Helicoverpa armigera* (Hubner), *Spodoptera litura* (Fabricius) and *Maruca vitrata* (Fabricius) were observed to infest dolichos bean. The observations of pod borers were recorded on five randomly

selected plants per plot at each picking *i.e.* number of healthy and infested pods due to pest.

Per cent pod infestation was calculated by the following formula,

$$\text{Per cent pod infestation} = \frac{\text{Number of infested pods}}{\text{Total number of pods}} \times 100$$

Table 2: Details of insecticides used against pests infesting Dolichos bean

Sr. No.	Common name	Trade name	Formulation	Concentration Used	Source
1	*Beauveria bassiana*	Y-Bea	2×10^8 cfu/ml	-	Yashoda Biotech, Near Panchgaon Road, Village-Panchgaon, Taluka-Karveer, Dist-Kolhapur-416013
2	*Lecanicillium lecanii*	Y-Verti	2×10^8 cfu/ml	-	Yashoda Biotech, Near Panchgaon Road, Village-Panchgaon, Taluka-Karveer, Dist-Kolhapur 416013.
3	*Bacillus thuringiensis*	Dipel-8L	3.5% ES	-	Sumitomo Chemical India Pvt.Ltd. C-5/185, G.I.D.C., Vapi-396195, Dist-Valsad, Gujrat.

4	Azadirachtin	Neemazal	1% EC	0.003%	Yashoda Biotech, Near Panchgaon Road, Village-Panchgaon, Taluka-Karveer, Dist-Kolhapur-416013
5	*Metarhizium anisopliae*	Yashomet	2×10^{8} cfu/ml	-	Yashoda Biotech, Near Panchgaon Road, Village-Panchgaon, Taluka-Karveer, Dist-Kolhapur-416013
6	Chlorpyriphos	Kemtrek	20% EC	0.06%	Sumitomo Chemical India Pvt.Ltd. C-5/185, G.I.D.C., Vapi-396195, Dist-Valsad, Gujrat.
7	Untreated control	-	-	-	-

CHAPTER IV
RESULTS AND DISCUSSION

The research project entitled 'Seasonal incidence, effect of sowing dates and management of pests infesting dolichos bean, *Lablab purpureus* (L.) Sweet'was undertaken at Vegetable Improvement Scheme, CES, Wakavali during *rabi*season of 2018-19. The results of the field studies are presented and discussed under the subheads given below.

4.1 To study the seasonal incidence of pests infesting dolichos bean

4.2 To study the effect of sowing dates against pests infesting dolichos bean

4.3 To study the efficacy of insecticides against pests infesting dolichos bean

4.1 To study the seasonal incidence of pests infesting dolichos bean

4.1.1 Seasonal incidence of aphids infesting dolichos bean

The data on seasonal incidence of aphids infesting dolichos bean are presented in Table 3 and graphically shown in Fig. 1.

The population of aphids (2.8 ± 76.81) was noticed in the 48th SMW (26th November- 2nd December). During cropping season, the population was in the range of 2.8 to 239.6 aphids per three leaves per plant. Minimum aphid population (2.8± 76.81) was recorded in 48th SMW (26th November- 2nd December), while the maximum (239.67 ± 76.81) population was recorded during 8th SMW (19th February- 25th February). It was observed that aphid population gradually increased (230.1) up to the

Table 3: Mean population of aphids infesting dolichos bean in relation to weather parameters

SMW	Period	Temperature (⁰C)		Relative humidity (%)		Mean population of aphids per three leavesper plant
		Tmax	Tmin	RH-I (%)	RH-II (%)	
48	26.11-02.12	33.07	15.29	90.14	40.99	2.8
49	03.12-09.12	33.5	17.43	88.25	45.26	2.9
50	10.12-16.12	31.17	13.58	82.37	33.56	15
51	17.12-23.12	31.43	13.1	85	37.97	46.3
52	24.12-31.12	31.71	12.86	80.45	29.13	99.5
1	10.01-07.01	33.21	11.77	86.6	24.44	230.1
2	08.01-14.01	32.77	11.77	87.92	26	121.1
3	15.01-21.01	34.34	15.86	89.66	32.54	230.1
4	22.01-28.01	32.91	12.97	81.42	32.56	185.3
5	29.01-04.02	32.11	14.13	87.19	29.54	156.95
6	05.02-11.02	28.92	11.1	84.66	12.48	164.2
7	12.02-18.02	33.01	14.91	82.38	19.03	198.1
8	19.02-25.02	35.71	17.14	82.32	31.4	239.6
9	26.02-04.03	33.29	13.84	77.34	64.61	174.3
10	05.03-11.03	33.89	15.74	80.81	71.45	106.15
11	12.03-18.03	34.29	16.47	71.03	50.15	95.35
12	19.03-25.03	36.57	16.46	72.35	35.61	103.85
13	26.03-01.04	37.24	21.24	89.37	48.12	99.34
					SD±	76.81

SMW- Standard Meteorological Week

SD- Standard Deviation

3rdSMW(15th January- 21st January). Further population decreased (198.1) upto 7th SMW (12th February – 18th February). It again increased at 8th SMWupto 239.6 aphids per three leaves per plant (19th February- 25th February) and then gradually decreased till harvest.

The present findings are more or less in conformity with Kshama Patel (2014). She found that aphid population started from 1st week of November with 0.2 aphid index, increased continuously, reached a peak of 4.2 aphid indexin 3rd week of December.

Deepak *et al*. (2019) noticed that the incidence of aphid on lentil, started from 4th meteorological standard week (23.80 aphid per 10 cm apical twigs). The aphid population gradually increased and reached to its peak (35.4 aphid per 10 cm apical twigs) on 7th meteorological standard week (12th -18th February) and thereafter its population gradually decreased from 8th SMW (19th – 25th February) (31.30 aphid per 10 cm apical twigs) to 12th SMW (19th March- 25th March) (9.0 aphid per 10 cm apical twigs).

4.1.1.1 Correlation between mean population of aphids infesting dolichos bean and weather parameters

The data regarding correlation between mean population of aphids in relation to different weather parameters are given in Table 4 and illustrated in Fig. 2.

The data on correlation between mean population of aphids infesting dolichos bean and different meteorological parameters revealed that all the meteorological parameters *viz*., maximum temperature, minimum temperature, morning relative humidity and evening relative humidity were found to be non- significant.

The maximum temperature had positive correlation with mean population of aphids (r= 0.131) while, minimum temperature(r=-0.175), morning relative humidity (-0.045)and evening relative humidity(-0.315) had negative correlation with mean population of aphids.

Table 4: Correlation coefficient of mean population of aphids infesting dolichos bean in relation to different weather parameters

Climatic parameters	Correlation coefficient (r)
Maximum temperature(Tmax)	0.131
Minimum temperature (Tmin)	-0.175
Morning relative humidity	-0.045
Evening relative humidity	-0.315

*significant at 5 per cent levelr= 0.468

The results of the present investigations are more or less in accordance with the findings of Dalwadi*et.al* (2007). They reported that minimum temperature (r=-0.708), mean temperature (r= -0.550) and vapour pressure (r=0.681) showed significant negative association with aphids in Indian bean, whilerelative humidity (RH), sunshine hours and wind speed correlated positively with the aphid population.

Godwal(2010) revealed that minimum temperature had negative significant correlation with aphid on Indian bean.

In French bean, aphids (nymph and adult) exhibited negative correlation but non-significant correlation with maximum (r=-0.469) minimum temperature (r=-0.284), maximum relative humidity (r=-0.170) and rainfall (r=-0.418) and non-significant positive correlation with minimum relative humidity (r=0.340) (Jhansi Rani and Hanumanthraya,2016).

4.1.2 Seasonal incidence of pod borers infesting dolichos bean

The data on seasonal incidence of pod borers infesting dolichos bean are presented in Table 5 and graphically represented in Fig. 3.

The infestation of pod borers started in 52th SMW (24th-31stDecember). During cropping season, the infestation varied from 3.9 to 28.1 per cent on number basis. Minimum(3.9 ± 10.35) per cent infestation of pod borers was recorded in 2nd SMW (8th– 14th January) while, maximum (28.10 ± 10.35) per cent infestation was recorded during 6thSMW (5th – 11th February).

The results of the present investigation are similar with the findings of Rekha and Mallapur (2005). They recorded six pod borers on field bean which includes *M. testulalis*, *H. armigera*, *L.boeticus,C. ptychora*, *E. atomosa*and*E. zinckenella*. Among which *M. testulalis* was found quite predominant at all the stages of crop growth with 9.14 per cent pod damage on 45 days crop to 34.95 per cent pod damage on 108 days old crop. Thereafter, the per cent pod damage declined and reached 14.00 per cent at 136 days after sowing.

Table 5 :Mean per cent infestation of pod borers infesting dolichos bean in relation to weather parameters

SMW	Period	Temperature (ºC)		Relative humidity (%)		Per cent pod damage per plant
		Tmax	Tmin	RH-I (%)	RH-II (%)	Pod borer
48	26.11-02.12	33.07	15.29	90.14	40.99	0
49	03.12-09.12	33.5	17.43	88.25	45.26	0
50	10.12-16.12	31.17	13.58	82.37	33.56	0
51	17.12-23.12	31.43	13.1	85	37.97	0
52	24.12-31.12	31.71	12.86	80.45	29.13	25.7
1	10.01-07.01	33.21	11.77	86.6	24.44	28.1
2	08.01-14.01	32.77	11.77	87.92	26	3.9
3	15.01-21.01	34.34	15.86	89.66	32.54	19.2
4	22.01-28.01	32.91	12.97	81.42	32.56	19.05
5	29.01-04.02	32.11	14.13	87.19	29.54	20.05
6	05.02-11.02	28.92	11.1	84.66	12.48	22.45
7	12.02-18.02	33.01	14.91	82.38	19.03	23.05
8	19.02-25.02	35.71	17.14	82.32	31.4	20.03
9	26.02-04.03	33.29	13.84	77.34	64.61	24.64
10	05.03-11.03	33.89	15.74	80.81	71.45	22.8
11	12.03-18.03	34.29	16.47	71.03	50.15	20
12	19.03-25.03	36.57	16.46	72.35	35.61	23.9
13	26.03-01.04	37.24	21.24	89.37	48.12	24.7
					SD±	10.35

SMW- Standard Meteorological Week

SD- Standard Deviation

The population peak incidence of *Marucatestulalis* (Geyer) in French bean was noticed during the last weeks of December and last weeks of March (Jhansi Rani and Hanumantharaya, 2016).

Chopkar (2017) reported that the appearance of lablab bean pod borer, *M. vitrata* was noticed from 7th SMW (2nd week of February) and persisted till the harvest of crop. Overall per cent infestation of pod borer in six weeks was in the range of 9.93 to 19.81.

4.1.2.1 Correlation between mean per cent infestation of pod borers infesting dolichos bean and weather parameters

Data on correlation coefficient of mean infestation of pod borers in relation to different weather parameters are presented in Table 6 and illustrated in Fig. 4.

Table 6: Correlation coefficient of mean population of pod borers infesting dolichos bean in relation to different weather parameters

Climatic parameters	Correlation coefficient(r)
Maximum temperature (Tmax)	0.286
Minimum temperature (Tmin)	0.076
Morning relative humidity	-0.374
Evening relative humidity	-0.002

*significant at 5 per cent level r= 0.468

During cropping season, the data on correlation between mean per cent infestation of pod borers and different meteorological parameters revealed that all the meteorological

Parameters *viz.*, maximum temperature, minimum temperature, morning relative humidity and evening relative humidity were found to be non-significant. The maximum temperature(r=0.286)and minimum temperature (0.076) had positive correlation, while morning relative humidity (r=-0.374)and evening relative humidity(-0.002) had negative correlation with infestation of pod borers.

The present findings are strongly in accordance with Jhansi Rani and Hanumantharaya (2016) who revealed that in French bean, the pod borer, *M. testulalis*exhibited non significantpositive correlation with maximum and minimum temperature (r= 0.125 and r= 0.071), maximum and minimum relative humidity (r= 0.205 and r= 0.153) and rainfall (r= 0.307).

4.2 Effect of sowing dates against pests infesting dolichos bean

The results of the field experiment conducted during *rabi*season of 2018-19 at Vegetable Improvement Scheme, CES, Wakawali to study the effect of different dates of sowing against pests infesting dolichos bean are presented here under

4.2.1 Effect of sowing dates against aphids infesting dolichos bean

During the studies, three different dates of sowing were evaluated against aphids infesting dolichos bean. The study revealedmarked difference in aphid infestation as regardsdates of sowing. The data regarding effect of sowing dates against aphids infesting dolichos bean are given in Table 7 and depicted in Fig. 5.

The mean population of aphids per three leaves per plant at first week after sowing (WAS) ranged from 1.71 to 18.64.The

first date of sowing(2-11-2018)recorded lowest (1.71)aphid population, while second date of sowing(22-11-2018) recorded 3.51 mean aphid population. The third date of sowing (12-12-2018) recorded highest (18.64) mean aphid population per three leaves per plant.

At 2nd WAS,the first sowing date (2-11-2018) recorded minimum 1.45 mean aphid population. The second date of sowing (22-11-2018) recorded 6.38 aphidpopulation. While, maximum (25.7) aphid population was recorded in third date of sowing (12-12-2018).

At the 3rd WAS, the lowest (3.51) aphid population was recorded in first date of sowing (2-11-2018),followed by second sowing date (22-11-2018) which recorded 5.99 mean aphid population. The highest (28.1) mean aphid population was observed in third date of sowing(12-12-2018).

The observations recorded at 4th WAS indicated that minimum (3.59) aphid population was noticed in first date of sowing(2-11-2018) which was found to be the effective sowing date over remaining dates of sowing. The second sowing date (22-11-2018) recorded 6.45 mean aphid population. The maximum (20.96) aphid population observed in third date of sowing(12-12-2018).

At 5th WAS, the lowest (7.05) mean aphid population was observed in firstsowing date (2-11-2018). The first date of sowing (2-11-2018) was at par with second sowing date 22-11-2018 which recorded 8.27 mean aphid population. While thehighest (29.04) mean aphid population was noticed in third date of sowing (12-12-2018).

Table 7: Effect of sowing dates against aphids infestingdolichos bean

Mean population of aphids per three leavesper plant																	
Date of sowing	**1 WAS**	**2 WAS**	**3 WAS**	**4 WAS**	**5 WAS**	**6 WAS**	**7 WAS**	**8 WAS**	**9 WAS**	**10 WAS**	**11 WAS**	**12 WAS**	**13 WAS**	**14 WAS**	**15 WAS**	**16 WAS**	**Overall Mean**
02-11-2018	1.71 (1.64)*	1.45 (1.56)	3.51 (2.07)	3.59 (2.13)	7.05 (2.84)	6.59 (2.75)	7.55 (2.92)	7.36 (2.89)	7.25 (2.87)	7.90 (2.98)	7.66 (2.94)	7.90 (2.98)	8.31 (3.05)	8.09 (3.01)	8.08 (3.01)	7.86 (2.98)	6.36 (2.66)
22-11-2018	3.51 (2.12)	6.38 (2.71)	5.99 (2.64)	6.45 (2.73)	8.27 (3.02)	18.36 (4.37)	23.11 (4.91)	22.96 (4.89)	30.44 (5.61)	22.08 (4.73)	25.28 (5.08)	28.25 (5.28)	32.35 (5.76)	39.63 (6.35)	42.39 (6.56)	50.96 (7.17)	22.89 (4.62)
12-12-2018	18.64 (4.42)	25.7 (5.15)	28.1 (5.37)	20.96 (4.66)	29.04 (5.44)	27.35 (5.32)	34.17 (5.80)	31.32 (5.60)	41.32 (6.50)	40.26 (6.42)	41.05 (6.48)	40.42 (6.43)	53.25 (7.35)	54.46 (9.43)	60.84 (7.84)	65.07 (8.09)	38.24 (6.14)
S.Em. ±	0.08	0.11	0.16	0.11	0.16	0.11	0.27	0.22	0.04	0.18	0.15	0.23	0.13	0.17	0.16	0.28	0.16
CD (p = 0.05)	0.24	0.33	0.47	0.47	0.48	0.34	0.82	0.65	0.11	0.54	0.44	0.69	0.39	0.53	0.48	0.85	0.48

*Figures in parentheses are $\sqrt{x+1}$ values WAS : Week After Sowing

Observationsrecorded at the 6th WAS revealed that first date of sowing(2-11-2018) recorded minimum (6.59)mean aphid population. While, the second sowing date(22-11-2018)recorded 18.36 aphid population. Third date of sowing(12-12-2018) recorded maximum (27.35) mean aphid population per three leaves per plant.

At 7th WAS,first date of sowing (2-11-2018)recorded lowest (7.55)aphid population. The second sowing date (22-11-2018)recorded 23.11 mean aphid population. The maximum (34.17) aphid population was recorded in third date ofsowing (12-12-2018).

Observations recorded at the 8th WAS indicated thatminimum(7.36)mean aphid population was observed in first date of sowing(2-11-2018). The second sowing date (22-11-2018)recorded 22.96 mean aphid population, while the maximum (31.32) aphid population was observed in third date of sowing(12-12-2018).

At 9th WAS, the lowest (7.25)aphid population was recorded in firstsowing date (2-11-2018). The second sowing date (22-11-2018) recorded 30.44 mean aphid population. While, the maximum (41.32) aphid population was noticed in third date of sowing(12-12-2018).

Observations recorded at the 10th WAS indicated that the first date of sowing (2-11-2018)recorded minimum (7.90) mean aphid population per three leaves per plant. The second sowing date (22-11-2018) recorded 22.08 aphid population.The maximum (40.26) mean aphid population was recorded in third date of sowing(12-12-2018).

At the 11th WAS, the lowest (7.66) aphid population was observed in first date of sowing(2-11-2018). The second sowing date (22-11-2018) recorded 25.28 mean aphid population. While, the highest (41.05) mean aphid population was observed in thirddate of sowing (12-12-2018).

Observations recorded at the 12th WASindicated that the first dateof sowing (2-11-2018)recorded minimum (7.90) mean aphid population. The second sowing date (22-11-2018) recorded 28.25 mean aphid population. The maximum (40.42) mean aphid population per three leaves per plant was observed in third date ofsowing(12-12-2018).

At the 13th WAS, the lowest (8.31) aphid population recordedin first date of sowing(2-11-2018). The second sowing date (22-11-2018)recorded 32.35 mean aphid population. While, the maximum (53.25) mean aphid population per three leaves per plant was observed in third date of sowing(12-12-2018).

The observations recorded at the 14th WAS indicated that the first date of sowing (2-11-2018) recorded minimum (8.09) mean aphid population. The second sowing date (22-11-2018) recorded 39.63 mean aphid population. The maximum (54.46) mean aphid population per three leaves per plant was noticed in third date of sowing(12-12-2018).

Observations recorded at the 15th WAS revealed that the first date of sowing(2-11-2018)recordedlowest (8.08) mean aphid population. The second sowing date (22-11-2018) recorded 42.39 mean aphid population. Whereas, the highest (60.84) mean aphid population per three leaves per plant was recorded in third date of sowing(12-12-2018).

Observations recorded at the 16th WAS indicated that the first date of sowing(2-11-2018) recorded minimum (7.86) mean aphid population. The second sowing date (22-11-2018) recorded 50.96 mean aphid population. The maximum (65.07) mean aphid population per three leaves per plant was observed in third date of sowing(12-12-2018).

During the cropping season, the mean population of aphids per three leaves per plant varied from 6.36 to 38.24. The minimum mean (6.36) population of aphids was recorded in early sown crop*i.e.* 2nd November, 2018 while, the maximum (38.24) aphid population was noticed on late sown crop, *i.e.* 12th December, 2018. It was evident from the results that in dolichos bean, aphid infestation increased gradually with the advancement of cropping season.

The present findings are more or less confirmative with Yousif and Ibrahim (2017). They revealed that soybean sown in the 1st of June harbored more aphids than those sown in the 15th of April during both seasons. When soybean sowing was delayed to the beginning of June, the activity of aphids had increased and population has two peaks of abundance.

4.2.2 Effect of sowing dates against pod borers infesting Dolichos bean

The effect of three different dates of sowing was evaluated against pod borersinfesting dolichos bean. The study revealed the marked difference in the infestation of pod borersas regard dates of sowing.The data aregiven in Table 8and depicted in Fig. 6.The infestation of pod borers was started eight weeks after sowing.

At the 8th WAS, the minimum (21.90%) infestation of pod borers was recorded in first date ofsowing (2-11-2018). The secondsowing date (22-11-2018) recorded 40.46 per cent pod damage. The maximum (60%) infestation of pod borers was observed in third date of sowing (12-12-2018).

Observationrecorded at the 9thWAS indicated that the first date of sowing (2-11-2018) recorded the lowest (30.97%) pod borers in festation. The second sowing date (22-11-2018) recorded 41.55 per cent infestation of pod borers. The third date of sowing (12-12-2018) recorded the highest (60.46%) infestation of pod borers.

At the 10th WAS,first date of sowing(2-11-2018) recorded the minimum (31.94%) pod infestation while, second sowing date (22-11-2018) recorded 42.13 per cent pod infestation. The maximum (57.50%) pod infestation recorded in third date ofsowing (12-12-2018).

At the 11th WAS,data indicated that the minimum (32.69%) pod infestation was observed in first date of sowing (2-11-2018). The second sowing date(22-11-2018) recorded 39.06 per cent pod infestation. While, the maximum (57.18%) pod infestation was observed in third date of sowing (12-12-2018).

Observations recorded at the 12th WAS revealed that the first date of sowing (2-11-2018) recorded minimum (34.99%) pod infestation and it was at par with the second sowing date (22-11-2018)which recorded 39.45 per cent pod infestation. Themaximum (56.28%) pod infestation was observed in third date of sowing (12-12-2018).

Table 8: Effect of sowing dates against pod borers infesting dolichos bean

Per cent pod infestation per five plants								
Date of sowing	**8WAS**	**9WAS**	**10WAS**	**11WAS**	**12WAS**	**13WAS**	**14WAS**	**Overall Mean**
02-11-2018	21.90 (27.83)*	30.97 (33.76)	31.94 (34.36)	32.69 (34.82)	34.99 (36.23)	40.34 (39.41)	41.05 (39.84)	33.41 (35.17)
22-11-2018	40.46 (39.49)	41.55 (40.13)	42.13 (40.47)	39.06 (38.68)	39.45 (38.90)	41.69 (40.21)	41.43 (40.06)	40.82 (39.70)
12-12-2018	60.00 (50.80)	60.46 (51.20)	57.50 (49.32)	57.18 (49.14)	56.28 (48.75)	48.55 (41.26)	49.73 (44.84)	55.67 (47.90)
S.Em. ±	0.91	1.27	0.82	0.83	1.19	0.82	0.95	0.97
CD (p = 0.05)	2.75	3.84	2.48	2.53	3.60	2.50	2.88	2.94

*Figures in parentheses are arcsine transformed values WAS : Week After Sowing

At the 13th WAS,data indicated that the first date of sowing (2-11-2018) and second date of sowing (22-11-2018) were at par with each other which recorded 40.34 per cent and 41.69 per cent mean pod infestation, respectively. The third date of sowing (12-12-2018)recorded 48.55 per cent infestation of pod borers.

Observationsrecorded at the 14th WAS revealed that the minimum 41.05 and 41.43 per cent infestation of pod borers was observed in the sowing dates 2-11-2018 and 22-11-2018, respectively. Both the sowing dates were at par with each other. The maximum (49.73%) pod infestation was recorded in third date ofsowing (12-12-2018).

During the cropping season, the pod damage varied from 33.41 to 55.67 per cent on number basis. The minimum (33.41%) pod damage was recorded in early sown crop *i.e.* 2nd November, 2018. while, maximum (55.67%) pod damage was recorded on late sown crop *i.e.* 12th December, 2018. The results indicated that, pod borer incidence increased gradually with the advancement of cropping season.

The present findings are supported by the results of Yadav*et al.* (1983). They observed that early sowing of chickpea or the use of early maturing varieties could significantly reduce the damage caused by *H. armigera*, because pod setting and maturation were completed during the period when larval population was low.

Similarly, Talekar*et al.* (1991) found that early November sowing of gram had the lowest number of eggs and larvae of pod borer as compared with the sowing made 2nd and 4th weeks later.

Begum *et al.* (1992) also noticed significant influence of sowing dates on*H. armigera*in chickpea. They observed that

chickpea sown on 15th November and 1st December suffered significantly less pod damage than those on 15th and 31st December.

4.3 To study the efficacy of insecticides against pests infesting dolichos bean

4.3.1. Efficacy of insecticides against aphids infesting dolichos bean

4.3.1.1 Efficacy of insecticides against aphids infesting dolichos bean recorded at different intervals after first spray

The data pertaining to the efficacy of different insecticides against aphids infesting dolichos bean at 3rd, 7th, 10th and 14th days after first spray are represented in Table 9 and graphically represented in Fig. 7.

The data on mean population of aphids per three leaves per plant prior to insecticide application ranged from 80.2 to 82.46. There was no significant difference among the different treatments since uniform distribution of aphids population was noticed in different treatments.

At third day after first spraying of insecticides, mean population of aphids per three leaves per plant ranged from 72.2 to 102.46. The treatment chlorpyriphos 20EC @ 0.06 per cent was found more effective which recorded minimum (50.33) aphid population. The next effective treatment wasAzadirachtin 1000ppm @ 0.003 per cent which recorded 61.48 aphid population and was at par with *Lecanicilliumlecanii*with 70.97aphid population per three leaves per plant. The treatment *Beauveriabassiana*recorded 72.2 aphid population and it was at par with *Metarrhiziumanisopliae* (75.18) and *Bacillus*

thuringiensis (78.84). The maximum (102.46) aphid population was found in untreated control.

At the seventh day after first spray of insecticide application data indicated that minimum (40.33) aphid population was recorded in the treatment chlorpyriphos 20EC @ 0.06 per cent which was significantly superior over the rest of treatments. The next effective treatments were Azadirachtin 1000ppm @ 0.003 per cent (52.48), *Lecanicilliumlecanii* (62.97), *Beauveriabassiana* (68.20), *Metarrhiziumanisopliae* (71.18) and *Bacillus thuringiensis* (75.84). The maximum (122.46) aphid population was found in untreated control.

The observations recorded at 10th day after first spray revealed that the minimum (31.83) aphid population wasobserved in the treatment chlorpyriphos 20EC @ 0.06 per cent which was at par with *Lecanicilliumlecanii* (37.97). The next effective treatment was Azadirachtin 1000ppm @ 0.003 per cent which recorded 45.48 aphid population per three leaves per plant. Whereas the treatment viz.,*Beauveriabassiana* with 60.2 aphid population was at par with *Metarrhiziumanisopliae* (63.18). The next treatment,*Bacillus thuringiensis*recorded 72.34 aphid population. The maximum (162.46) aphid population was recorded in untreated plot.

Table9: Efficacy of different insecticides against aphids infesting dolichos bean after first spray

Sr. No.	Treatment	Conc. (%)	Mean population of aphids per three leaves per plant					
			Pre count	3 DAS	7 DAS	10 DAS	14 DAS	Overall Mean
1	*Beauveriabassiana*	-	80.2 (9.01)*	72.2 (8.56)	68.2 (8.32)	60.2 (7.82)	52.2 (7.29)	63.2 (7.99)
2	*Lecanicilliumlecanii*	-	80.97 (9.05)	70.97 (8.48)	62.97 (8)	37.97 (6.24)	12.97 (3.73)	46.22 (6.61)
3	*Bacillus thuringiensis*	-	80.84 (9.04)	78.84 (8.93)	75.84 (8.76)	72.34 (8.56)	68.84 (8.35)	73.96 (8.65)
4	*Azadirachtin 1000 ppm*	0.003	81.48 (9.08)	61.48 (7.9)	52.48 (7.31)	45.48 (6.81)	38.48 (6.28)	49.48 (7.07)
5	*Metarrhiziumanisopliae*	-	81.18 (9.06)	75.18 (8.72)	71.18 (8.49)	63.18 (8.01)	55.18 (7.49)	66.18 (8.17)
6	*Chlorpyriphos*	0.06	80.33 (9.01)	50.33 (7.15)	40.33 (6.41)	31.83 (5.7)	23.33 (4.89)	36.45 (6.03)
7	Untreated control	-	82.46 (9.13)	102.46 (10.17)	122.46 (11.11)	162.46 (12.78)	122.46 (11.11)	127.46 (11.29)
	S.Em. ±		0.18	0.19	0.19	0.21	0.24	0.2
	CD (P= 0.05)		NS	0.58	0.6	0.63	0.73	0.63

*Figures in parentheses are arcsine transformed values DAS :Days After Spraying

At the 14th day after first spraying, the minimum aphid population was recorded in *Lecanicilliumlecanii* (12.97) which was significantly superior over the rest of the treatments. The next effective treatments were found to be chlorpyriphos 20EC @ 0.06 per cent and Azadirachtin 1000ppm @ 0.003 per cent which recorded 23.33 and 38.48 aphids per three leaves per plant, respectively. The treatment *Beauveriabassiana*was found to be at par with *Metarrhiziumanisopliae*which recorded 52.20 and 55.18 aphid population, respectively.The next treatment, *Bacillus thuringiensis*recorded 68.84 aphid population. While, the maximum (122.46) aphid population was found in untreated plot.

The data on mean population of aphids per three leaves per plant after first spray revealed that the treatment Chlorpyriphos 20EC @ 0.06 per cent was found to be the best treatment which recorded minimum (36.45) mean aphid population per three leaves per plant and was at par with *Lecanicilliumlecanii* (46.22). The next treatment Azadirachtin 1000ppm @ 0.003 per cent recorded 49.48 mean population of aphid per three leaves per plant which was independently significant. The treatment *Beauveriabassiana*recorded 63.20 mean population of aphids per three leaves per plant and was at par with *Metarrhiziumanisopliae* (66.18). The treatment *Bacillus thuringiensis*recorded 73.96 aphid population. All the above treatments were found to be superior over untreated control which recorded maximum (127.46) aphids per three leaves per plant.

4.3.1.2 Efficacy of insecticides against aphids recorded at different intervals after second spray

The results regarding efficacy of some insecticides against aphids recorded at different intervals after second spray are presented in Table 10 and graphically depicted in Fig. 7.

The observations recorded at third day after second spray indicated that minimum (17.48) aphid population was noticed in the treatment Azadirachtin 1000ppm @ 0.003 per cent which was at par with chlorpyriphos 20EC @ 0.06 per cent (19.33) and *Lecanicilliumlecanii*(23.47).The next effective treatment *Beauveriabassiana* was at par with *Metarrhiziumanisopliae*which recorded 49.20 and 51.18 aphid population, respectively. The treatment *Bacillus thuringiensis* recorded 65.84 mean aphid population. The maximum (127.46) mean aphid population per three leaves per plant was noticed in untreated control.

At 7th day after second spray, the minimum (15.88) aphid population was recorded in the treatment chlorpyriphos 20EC @ 0.06 per cent which was at par with Azadirachtin 1000ppm @ 0.003 per cent (17.22). The next best treatment was found to be *Lecanicilliumlecanii* which recorded 22.72 mean aphid population per three leaves per plant. The treatment *Beauveriabassiana*recorded 45.20 mean aphid population and was at parwith*Metarrhiziumanisopliae* (47.18). The next treatment,*Bacillus thuringiensis*recorded 62.84 mean aphid population per three leaves per plant. The maximum (134.46) mean aphid population perthree leaves per plant was noticed in untreated control.

Table 10:Efficacy of different insecticides against aphids infesting dolichos bean after second spray

Sr. No.	Treatment	Conc.	Mean population of aphids per three leaves per plant					
		(%)	Pre count	3 DAS	7 DAS	10 DAS	14 DAS	Overall Mean
1	*Beauveriabassiana*	-	52.20 (7.29)	49.20 (7.08)	45.20 (6.80)	37.20 (6.18)	29.20 (5.49)	40.2 (6.38)
2	*Lecanicilliumlecanii*	-	12.97 (3.73)	23.47 (4.95)	22.72 (4.87)	11.72 (3.56)	2.39 (1.84)	15.07 (3.80)
3	*Bacillus thuringiensis*	-	68.84 (8.35)	65.84 (8.17)	62.84 (7.99)	59.34 (7.76)	55.84 (7.53)	60.96 (7.80)
4	*Azadirachtin 1000 ppm*	0.003	38.48 (6.28)	17.48 (4.29)	17.22 (4.26)	14.72 (3.95)	11.72 (3.55)	15.28 (4.01)
5	*Metarrhiziumanisopliae*	-	55.18 (7.49)	51.18 (7.22)	47.18 (6.93)	39.18 (6.33)	31.18 (5.66)	42.18 (6.53)
6	*Chlorpyriphos*	0.06	23.33 (4.89)	19.33 (4.45)	15.88 (4.03)	8.05 (2.97)	6.38 (2.71)	12.41 (3.54)
7	Untreated control	-	122.46 (11.11)	127.46 (11.33)	134.46 (11.64)	74.46 (8.68)	59.46 (7.76)	98.96 (9.85)
	S.Em. ±		0.24	0.25	0.27	0.24	0.23	0.24
	CD (P= 0.05)		0.73	0.77	0.82	0.72	0.70	0.75

*Figures in parentheses are arcsine transformed valuesDAS : Days After Spraying

The observations recorded at 10th day after second spray revealed that the treatment,chlorpyriphos 20EC @ 0.06 per cent was the most effective treatment which recorded 8.05 mean aphid population. It was at par with *Lecanicilliumlecanii*which recorded 11.72 mean aphid population per three leaves per plant. The next effective treatment was Azadirachtin 1000ppm @ 0.003 per cent which recorded 14.72 mean aphid population. The treatment *Beauveriabassiana*was at par with *Metarrhiziumanisopliae*which recorded 37.20 and 39.18 mean aphid population, respectively. The treatment *Bacillus thuringiensis* recorded 59.34 mean aphid population. In untreated plot, the maximum (74.46) aphid population was recorded.

At 14th day of second spraying, it was revealed that the minimum (2.39) aphid population was recorded in *Lecanicilliumlecanii.* The next effective treatment was found to be chlorpyriphos 20EC @ 0.06 per cent (6.38) and Azadirachtin 1000ppm @ 0.003 per cent (11.72). The treatment *Beauveriabassiana*was at par with *Metarrhiziumanisopliae* which recorded 29.20 and 31.18 mean aphid population per three leaves per plant, respectively. The treatment *Bacillus thuringiensis* recorded 55.84 mean aphid population. The maximum (59.46) aphid population was observed in untreated control.

The data on mean population of aphids per three leaves per plant after second spray revealed that the treatment Chlorpyriphos 20 EC @ 0.06 per cent was the best treatment which recorded minimum (12.41) mean aphid population per three leaves per plant and was at par with *Lecanicilliumlecanii* (15.07) and Azadirachtin 1000ppm @ 0.003 per cent (15.28). The

treatment *Beauveriabassiana* recorded 40.2 mean aphid population per three leaves per plant and was at par with *Metarrhiziumanisopliae* (42.18). The treatment *Bacillusthuringiensis* recorded 60.96 mean aphid population per three leaves per plant. All the above treatments were found to be superior over untreated control which recorded maximum (98.96) aphid population.

4.3.1.3 Efficacy of insecticides against aphids recorded at different intervals after third spray

The results regarding efficacy of some insecticides against aphids recorded at different intervals after third spray are presented in Table 11 and graphically represented in Fig. 7.

After 3 days of third spray, the treatment *Lecanicilliumlecanii*was found the most effectivetreatment which recorded (0.89) mean aphid population per three leaves per plant. It was at par with treatment chlorpyriphos 20EC @ 0.06 per cent (1.38). The next effective treatment was found to be Azadirachtin 1000ppm @ 0.003 per cent which recorded 6.72 mean aphid population per three leaves per plant. The treatment *Beauveriabassiana* was at par with *Metarrhiziumanisopliae*which recorded 21.20and 23.18 mean aphid population, respectively. The treatment *Bacillus thuringiensis* recorded 45.34 mean aphid population per three leaves per plant. The maximum (58.46) aphid population was noticed in untreated control.

The data at 7th day of third spray indicated that the treatment *Lecanicilliumlecanii* recorded 0.64 aphid population which was at par with chlorpyriphos 20EC @ 0.06 per cent (0.88) and Azadirachtin 1000 ppm @ 0.003 per cent (3.22). The

Table11: Efficacy of different insecticides against aphids infesting dolichos bean after third spray

Sr. No.	Treatment	Conc. (%)	Mean population of aphids per three leaves per plant					
			Pre count	3 DAS	7 DAS	10 DAS	14 DAS	Overall Mean
1	*Beauveriabassiana*	-	29.20 (5.49)	21.20 (4.71)	13.20 (3.76)	5.20 (2.47)	2.70 (1.89)	10.57 (3.20)
2	*Lecanicilliumlecanii*	-	2.39 (1.84)	0.89 (1.36)	0.64 (1.27)	0.17 (1.07)	0.00 (1.00)	0.42 (1.17)
3	*Bacillus thuringiensis*	-	55.84 (7.53)	45.34 (6.80)	29.84 (5.54)	14.34 (3.88)	7.84 (2.90)	24.34 (4.78)
4	*Azadirachtin 1000 ppm*	0.003	11.72 (3.55)	6.72 (2.74)	3.22 (1.95)	1.03 (1.38)	0.42 (1.17)	2.84 (1.81)
5	*Metarrhiziumanisopliae*	-	31.18 (5.66)	23.18 (4.89)	15.18 (3.97)	5.57 (2.55)	3.07 (2.00)	11.75 (3.35)
6	*Chlorpyriphos*	0.06	6.38 (2.71)	1.38 (1.51)	0.88 (1.32)	0.23 (1.11)	0.07 (1.03)	0.64 (1.24)
7	Untreated control	-	59.46 (7.76)	58.46 (7.70)	44.46 (6.70)	30.46 (5.40)	25.46 (4.85)	39.71 (6.16)
	S.Em. ±		0.23	0.27	0.34	0.43	0.49	0.38
	CD (P= 0.05)		0.70	0.84	1.05	1.33	0.51	1.18

*Figures in parentheses are arcsine transformed values DAS : Days After Spraying

Treatment*Beauveriabassiana* was at par with *Metarrhiziumanisopliae* which recorded 13.20 and 15.18 mean aphid population, respectively. The treatment *Bacillusthuringiensis*recorded 29.84 mean aphid population per three leaves per plant. The maximum (44.46) aphid population was recorded in untreated control.

The observations recorded at 10th day after third spray revealed that the treatment *Lecanicilliumlecanii* recorded 0.17 mean aphid population which was at par with chlorpyriphos 20EC @ 0.06 per cent (0.23) and Azadirachtin 1000 ppm @ 0.003 per cent (1.03). The next effective treatment was *Beauveriabassiana*and was at par with *Metarrhiziumanisolpliae*which recorded 5.20 and 5.57 aphid population, respectively. The treatment *Bacillus thuringiensis* recorded 14.34 mean aphid population. Whereas, the untreated plot recorded 30.46 mean aphid population per three leaves per plant.

At 14th day of observation, no aphid population was observed in treatment *Lecanicilliumlecanii* which was at par with chlorpyriphos 20EC @ 0.06 per cent (0.07) and Azadirachtin 1000ppm @ 0.003 per cent (0.42). The next effective treatment was *Beauveriabassiana*and it was at par with *Metarrhiziumanisopliae*which recorded 2.70 and 3.07 mean aphid population, respectively. The treatment *Bacillusthuringiensis*recorded 7.84 mean aphid population per three leaves per plant. The untreated plot recorded 25.46 mean aphid population.

The data regarding overall mean population of aphids per three leaves after third spray revealed that the treatment *Lecanicilliumlecanii* was the best treatment which recorded

minimum (0.42) mean aphid population per three leaves per plant and was at par with chlorpyrihos 20EC @ 0.06 per cent (0.64) and Azadirachtin 1000 ppm @ 0.003 per cent (2.84). The treatment *Beauveriabassiana* recorded 10.57 mean aphid population per three leaves and was at par with *Metarrhiziumanisopliae*whichrecorded 11.75 mean aphid population. The next treatment *Bacillus thuringiensis*recorded 24.34 mean aphid population. All the above treatments were found to be superior over untreated control which recorded maximum (39.71) aphid population per three leaves per plant.

4.3.1.4 Cumulative efficacy of different insecticides against aphids infesting dolichos bean

The data pertaining to the cumulative efficacy of different insecticides against aphids infesting dolichos bean are presented in Table 12 and graphically depicted in Fig. 7.

The results regarding overall mean of all three sprays against aphids revealed that treatment chlorpyriphos 20EC @ 0.06 per cent was the most effective which recorded 16.50 mean aphid population and was at par with *Lecanicilliumlecanii* whichrecorded 20.57 mean aphid population and Azadirachtin 1000 ppm @ 0.003 per cent (22.53). The next effective treatment was *Beauveriabassiana*(37.99) and it was at par with *Metarrhiziumanisopliae*which recorded 40.03 mean aphid population. The next treatment *Bacillusthuringiensis*recorded 53.08 mean aphid population. All the above treatments were found to be superior over untreated control which recorded maximum (88.71) mean aphid population.

Table12: Cumulative efficacy of different insecticides against aphids infesting dolichos bean

Sr. No.	Treatment	Conc. %	Mean population of aphids per three leaves per plant			Cumulative Mean Population
			First spray	Second spray	Third spray	
1	*Beauveriabassiana*	-	63.2 (7.99)*	40.2 (6.38)	10.57 (3.20)	37.99 (5.85)
2	*Lecanicilliumlecanii*	-	46.22 (6.61)	15.07 (3.80)	0.42 (1.17)	20.57 (3.86)
3	*Bacillus thuringiensis*	-	73.96 (8.65)	60.96 (7.80)	24.34 (4.78)	53.08 (7.07)
4	Azadirachtin 1000ppm	0.003	49.48 (7.07)	15.28 (4.01)	2.84 (1.81)	22.53 (4.29)
5	*Metarrhiziumanisopliae*	-	66.18 (8.17)	42.18 (6.53)	11.75 (3.35)	40.03 (6.01)
6	Chlorpyriphos	0.06	36.45 (6.03)	12.41 (3.54)	0.64 (1.24)	16.5 (3.60)
7	Untreated control	-	127.46 (11.29)	98.96 (9.85)	39.71 (6.16)	88.71 (9.1)
S.Em. ±			0.2	0.24	0.38	0.27
CD (P=0.05)			0.63	0.75	1.18	0.85

*Figures in parentheses are $\sqrt{x+1}$ values

The present findings are corroborative with the results of PoonamShinde (2014). She revealed that the lowest aphid population was recorded in the treatments of *Verticilliumlecanii*7.5 g and *V. lecanii* 5 g with 33.70 and 35.28 aphids/3 leaves respectively, which were at par with each other and were superior over all other treatments. Whereas, use of insecticides for management of aphids on dolichos bean, 0.01 per cent acephate 75 SP and 0.075 per cent novaluron 10 EC recorded with 25.66 and 28.20 aphids/3 leaves, respectively, observed to be most effective treatments.

4.3.2. Efficacy of insecticides against pod borers infesting dolichos bean

4.3.2.1 Efficacy of insecticides against pod borers infesting dolichos bean recorded at different intervals after first spray

Data on per cent pod infestation of pod borer recorded at 3rd, 7th, 10th and 14th days after first spray are presented in Table13 and depicted in Fig. 8.

The infestation of the pod borers prior to application of insecticides ranged from 30.50 to 32.65 per cent. The differences among the treatments and replications were non-significant indicating uniform distribution of pest in both treatments and replications.

The observations recorded on third day after first spray indicated that the treatment chlorpyriphos 20EC @ 0.06 per cent was found most effective treatment which recorded minimum (26.81%) pod infestation and was at par with *Bacillusthuringiensis* (29.10%) and Azadirachtin 1000ppm @ 0.003 per cent (29.17%). The next effective treatment was

Beauveriabassiana (31.73%) and it was at par with *Metarrhiziumanisopliae*(31.85%) and *Lecanicilliumlecanii* (32.65%). The maximum (42.93%) pod infestation was noticed in untreated control.

On the seventh day after first spraying, the minimum (22.81%) pod infestation was observed in treatment chlorpyriphos 20EC @ 0.06 per cent and was at par with *Bacillus thuringiensis* (26.10%) and Azadirachtin 1000ppm @ 0.003 per cent (27.17%). The next best treatment *Beauveriabassiana*recorded 28.73 per cent pod infestation and was at par with *Metarrhiziumanisopliae* (28.85%) and *Lecanicilliumlecanii* (29.85%). The maximum (47.43%) pod infestation was found in untreated plot.

On 10th day after first spray, the treatment chlorpyriphos20EC @ 0.06 per cent recorded the minimum (18.56%) pod infestation and was at par with *Bacillus thuringiensis* (21.60%) and Azadirachtin 1000ppm @ 0.003 per cent (22.50%). The next best treatment *Beauveriabassiana*(25.23%) was at par with *Metarrhiziumanisopliae* and *Lecanicilliumlecanii*which recorded 25.69 and 29.35 per cent pod infestation, respectively. The maximum (52.93%) pod infestation was observed in untreated control.

At 14th day after first spraying, the minimum (14.31%) pod infestation was recorded in chlorpyriphos 20EC @ 0.06 per cent and it was at par with *Bacillus thuringiensis*and Azadirachtin 1000ppm @ 0.003 per cent which recorded 17.10 and 18.50 per cent pod infestation, respectively. While, the treatment *Beauveriabassiana*(21.73%) was at par with *Metarrhizium*

Table13: Efficacy of diffeerent insecticides against pod borers infesting dolichos bean after first spray

Sr. No.	Treatment	Conc. (%)	Per cent pod damage per five plants					
			Pre count	3 DAS	7 DAS	10 DAS	14 DAS	Overall Mean
1	*Beauveriabassiana*	-	31.29 (33.99)	31.73 (34.28)	28.73 (32.41)	25.23 (30.15)	21.73 (27.78)	26.85 (31.15)
2	*Lecanicilliumlecanii*	-	32.65 (34.83)	32.65 (34.84)	29.85 (33.11)	29.35 (32.80)	27.85 (31.84)	29.92 (33.14)
3	*Bacillus thuringiensis*	-	32.10 (34.51)	29.10 (32.64)	26.10 (30.72)	21.60 (27.69)	17.10 (24.42)	23.47 (28.86)
4	*Azadirachtin 1000 ppm*	0.003	30.50 (33.52)	29.17 (32.69)	27.17 (31.41)	22.50 (28.31)	18.50 (25.47)	24.33 (29.47)
5	*Metarrhiziumanisopliae*	-	32.32 (34.62)	31.85 (34.35)	28.85 (32.47)	25.69 (30.43)	22.52 (28.29)	27.22 (31.38)
6	*Chlorpyriphos*	0.06	32.14 (34.44)	26.81 (31.08)	22.81 (28.39)	18.56 (25.31)	14.31 (21.89)	20.62 (26.66)
7	Untreated control	-	32.43 (34.68)	42.93 (40.93)	47.43 (43.52)	52.93 (46.68)	58.43 (49.86)	50.43 (45.24)
	S.Em. ±		1.50	0.98	1.03	1.16	1.30	1.11
	CD (P= 0.05)		NS	3.02	3.17	3.57	4.01	3.44

*Figures in parentheses are arcsine transformed values DAS : Days After Spraying

anisopliae and *Lecanicilliumlecanii* which recorded 22.52 and 27.85 per cent pod infestation, respectively. The maximum (58.43%) pod infestation was observed in untreated control.

The results of overall mean per cent pod infestation revealed that the treatment chlorpyriphos 20EC @ 0.06 per cent was found to be most effective treatment which recorded 20.62 per cent pod infestation and it was at par with *Bacillus thuringiensis* (23.47%) and Azadirachtin 1000 ppm @ 0.003 per cent (24.33%). The next best treatment was *Beauveriabassiana* (26.85%) and it was at par with *Metarrhiziumanisopliae* and *Lecanicilliumlecanii* recorded 27.22 and 29.92 mean per cent pod infestation, respectively. While, the maximum (50.43%) pod infestation was observed in untreated control.

4.3.2.2 Efficacy of insecticides against pod borers infesting dolichos bean recorded at different intervals after second spray

Data on per cent pod infestation of pod borers recorded at 3rd, 7th, 10th, and 14th, days after second spray are presented in Table 14 and depicted in Fig. 8.

The observations recorded on third day after second spray revealed that the per cent pod infestation in the treatment chlorpyriphos 20EC @ 0.06 per cent was minimum (10.06%) and was at par with *Bacillus thuringiensis*and Azadirachtin 1000 ppm @ 0.003 per cent which recorded 11.60 and 14.50 per cent pod damage, respectively. The next effective treatment was *Beauveriabassiana*which recorded 18.23 per cent pod damage. It was at par with *Metarrhiziumanisopliae* which recorded 19.35 per cent pod damage. The treatment *Lecanicilliumlecanii*

recorded 26.35 per cent pod damage. While, the maximum (60.93%) pod damage was recorded in untreated plot.

At seventh day after second spraying, the minimum (6.10%) pod damage was recorded in *Bacillus thuringiensis*and it was at par with chlorpyriphos 20EC @ 0.06 per cent which recorded 7.81 per cent pod damage. Azadirachtin 1000 ppm @ 0.003 per cent was found to be next best treatment which recorded 10.50 per cent pod damage. The treatment *Beauveriabassiana* recorded 14.73 per cent pod damage and was at par with*Metarrhiziumanisopliae* (16.19%). The treatment *Lecanicilliumlecanii* recorded 24.85 per cent pod damage. The untreated plot recorded maximum (63.43%) pod damage.

The observations recorded on 10th day after second spray revealed that the treatment *Bacillus thuringiensis* recorded 0.60 per cent pod damage and was at par with chlorpyriphos 20EC @ 0.06 per cent (1.19%). The next effective treatment Azadirachtin 1000 ppm @ 0.003 per cent recorded 5.50 per cent pod damage. The treatment *Beauveriabassiana* was at par with *Metarrhiziumanisopliae* which recorded 10.23 and 10.29 per cent pod damage, respectively. The treatment *Lecanicilliumlecanii* recorded22.35 per cent pod damage. While, the maximum (60.93%) pod damage was recorded in untreated plot.

At 14th day after second spraying, data indicated that the treatment *Bacillus thuringiensis* was found to be most effective which recorded 0.12 per cent pod damage and it was at par with chlorpyriphos 20EC @ 0.06 per cent (0.45%). The next effective treatment Azadirachtin 1000 ppm @ 0.003 per cent recorded 2.00 per cent pod damage. The treatment *Beauveriabassiana* recorded 5.73 per cent pod damage and was at par with

Table14: Efficacy of different insecticides against pod borers infesting dolichos bean after second spray

Sr. No.	Treatment	Conc. (%)	Per cent pod damage per five plants					
			Pre count	3 DAS	7 DAS	10 DAS	14 DAS	Overall Mean
1	*Beauveriabassiana*	-	21.73 (27.78)	18.23 (25.26)	14.73 (22.55)	10.23 (18.62)	5.73 (13.76)	12.23 (20.04)
2	*Lecanicilliumlecanii*	-	27.85 (31.84)	26.35 (30.88)	24.85 (29.89)	22.35 (28.20)	18.85 (25.71)	23.10 (28.67)
3	*Bacillus thuringiensis*	-	17.10 (24.42)	11.60 (19.91)	6.10 (14.29)	0.60 (4.42)	0.12 (1.92)	4.60 (10.13)
4	*Azadirachtin 1000 ppm*	0.003	18.50 (25.47)	14.50 (22.39)	10.50 (18.89)	5.50 (13.53)	2.00 (7.94)	8.12 (15.68)
5	*Metarrhiziumanisopliae*	-	22.52 (28.29)	19.35 (26.04)	16.19 (23.64)	10.29 (18.67)	5.79 (13.82)	12.90 (20.54)
6	*Chlorpyriphos*	0.06	14.31 (21.89)	10.06 (17.81)	7.81 (16.09)	1.19 (6.11)	0.45 (3.60)	4.87 (10.90)
7	Untreated control	-	58.43 (49.86)	60.93 (51.32)	63.43 (52.80)	60.93 (51.32)	52.43 (46.39)	59.43 (50.45)
	S.Em. ±		1.30	1.56	1.01	0.87	1.04	1.12
	CD (P= 0.05)		4.01	4.82	3.12	2.70	3.22	3.46

*Figures in parentheses are arcsine transformed values DAS : Days After Spraying

Metarrhiziumanisopliae(5.79%). The treatment *Lecanicilliumlecanii* was recorded 18.85 per cent pod damage. The maximum (52.43%) pod damage was recorded in untreated plot.

The data on overall mean per cent pod damage after second spray indicated that among the all treatments, *Bacillus thuringiensis* recorded minimum (4.60%) pod damage and was at par with chlorpyriphos 20EC @ 0.06 per cent (4.87%). The next effective treatment Azadirachtin 1000ppm @ 0.003 per cent recorded 8.12 per cent pod damage. The treatment *Beauveriabassiana*(12.23%) was at par with *Metarrhiziumanisopliae* which recorded 12.90 per cent pod damage. The treatment *Lecanicilliumlecanii* recorded 23.10 per cent pod damage. The maximum (59.43%) mean per cent pod damage was recorded in untreated plot.

4.3.2.3 Cumulative efficacy of different insecticides against pod borers infesting dolichos bean

The data pertaining to the cumulative efficacy of different insecticides against pod borers infesting dolichos bean are presented in Table 15 and illustrated in Fig. 8.

Based on overall mean of two sprays, it was revealed that chlorpyriphos 20 EC @ 0.06 per cent was the best treatment whichrecorded minimum (12.74%) mean pod infestation and was at par with *Bacillusthuringiensis* (14.03%). The next effective treatment,Azadirachtin 1000 ppm @ 0.003 per cent (16.22%) was at par with *Beauveriabassiana*which recorded 19.54 per cent pod damage. The treatment *Metarrhiziumanisopliae* recorded 20.06 per cent pod damage. The treatment *Lecanicilliumlecanii*recorded 26.51 per cent pod damage. All the

above treatments were found to be superior over untreated control which recorded maximum (54.93%) pod damage.

The present findings are supported by the results of Karel and Schoonhoven (1986). They reported that two applications of *Bacillus thuringiensis* (Berliner) during the post flowering growth stage of bean plants controlled the larvae of pod borer, *M. testulalis* and *H. armigera*. as effectively as two applications of lindane 20 EC @ 2 g a.i. per lit water and carbaryl 85 WP 2.25 g a.i. per lit water over the same period.

Manjula and Padmavathanma (1996) also reported maximum reduction in the larval population of *M. vitrata*with the treatment of *B. thuringinensis*(1×107 spore per ml)+monocrotophos (0.025 %).

Chandrakar and Shrivastava (2001) compared the efficacy of dipel 8 EL @ 500 ml per ha, NSKE 2 per cent and monocrotophos 36 EC @ 750 ml per ha, sprayed singly and in combination at 30, 45 and 60 days after sowing to control pod borer complex i.e. *H. armigera,M. vitrata* of urd bean. The infestation was effectively controlled by monocrotophos followed by dipel during 30 and 45 days after sowing, respectively.

Reddy*et al.* (2001) studied the bio-efficacy of two synthetic pyrethroids*viz.*, deltamethrin and fenvalerate, two biopesticides*viz.*, *Bacillus thuringiensis* (Dipel) and *Beauveriabassiana* (Dispel) and their judicious combination, revealed that the combination of dipel with deltamethrin (0.004% or 0.002%) was most effective in reducing the damage due to pod borers.

Byrappa*et al.* (2009) observed that among biopesticides, sequential application of NSKE-*HaNPV-Bt* was effective against

insect pests of field bean.*HaNPV* was effective against*H. armigera* larvae, but ineffective to other pod borers.Panchagavya and clerodendron + cow urine extract were ineffective in reducing the pod borer incidence. Among biopesticides treated plots, sequential application of NSKE-*HaNPV-Bt* recorded higher grain yield (10.01 q per ha) whereas, package of practices followed treatment (inorganic plot) recorded 11.37 q per ha.

PoonamShinde (2014) studied the efficacy of Entomopathogenic fungi against dolichos bean, the lowest aphid population was recorded in the treatments of *Verticilliumlecanii* 7.5 g and *V. lecanii* 5 g with 33.70 and 35.28 aphids/3 leaves respectively, which were at par with each other and were superior over all other treatments followed by *V. lecanii* 3 g and *Metarhizium anisopliae* 7.5 g with 38.20 and 34.05 aphids/3 leaves count, respectively.

Mahalakshmi*et al.* (2015) evaluated the efficacy of chemical insecticides belonging to different groups against spotted pod borer was well established on different pulse crops. Neem products such as neem seed kernel extract (NSKE) or neem oil and biocides like *Bacillus thuringiensis*(*Bt*) (Berliner) showed different levels of efficacy on different crops.

Nath*et al.* (2017) studied the effect of bio-rational approaches such as intercropping and application of bio-pesticide on the larval population, pod damage, grain damage and grain weight loss by plume moth, *Exelastisatomosa* (Wlsm.) infesting pigeonpea,*C. cajan* (L.) Millsp. The two sprays of NSKE 5 percent (first at flowering and pod formation stage and second after 20 days) were found superior in reducing larval population, pod damage, grain damage and grain weight loss. However, the

Table15: Cumulative efficacy of different insecticides against pod borers infesting dolichos bean

Sr. No.	Treatment	Conc. (%)	Mean per cent pod damage		Cumulative per cent infestation
			First spray	Second spray	
1	*Beauveriabassiana*	-	26.85 (31.15)*	12.23 (20.04)	19.54 (25.59)
2	*Lecanicilliumlecanii*	-	29.92 (33.14)	23.10 (28.67)	26.51 (30.90)
3	*Bacillus thuringiensis*	-	23.47 (28.86)	4.60 (10.13)	14.03 (19.49)
4	Azadirachtin 1000ppm	0.003	24.33 (29.47)	8.12 (15.68)	16.22 (22.57)
5	*Metarrhiziumanisopliae*	-	27.22 (31.38)	12.90 (20.54)	20.06 (25.96)
6	Chlorpyriphos	0.06	20.62 (26.66)	4.87 (10.90)	12.74 (18.78)
7	Untreated control	-	50.43 (45.24)	59.43 (50.45)	109.86 (47.84)
S.Em. ±			1.11	1.12	1.11
CD (p= 0.05)			3.44	3.46	3.45

*Figures in parentheses are arcsine transformed values

plotsdevoid of any biopesticidal treatment had maximum larval population (0.68larva per plant), pod damage (2.75%), grain damage (0.86%) and grain weight loss (0.60%) by *E. atomosa.*

Selvam (2018) revealed that the treatment Azadirachtin (0.03%) was effective against pod borer which reduce flower (50.63%) and pod damage (65.80%).

CHAPTER V
SUMMARY AND CONCLUSION

Dolichos bean an important vegetable crop grown in India. This crop is attacked by number of pests, amongst which aphids, whiteflies and pod borerare a major constraint in production. Considering the importance of crop and seriousness of the pests, the present investigation "Seasonal incidence, effect of sowing dates and management of pests infesting dolichos bean (*Lablab purpureus*(L) Sweet)" was carried out during *rabi* season of 2018-2019 at Central Experiment Station, Wakavali, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri. The results of experiments are summarized below.

The study on seasonal incidence revealed that there was marked difference in aphids population as regard Standard Meteorological Weeks. The population of aphids (2.8±76.81) was noticed in the 48thSMW (26thNovember- 2nd December). During cropping season, the population was in the range of 2.8 to 239.6 aphids per three leaves per plant. Minimum(2.8 ± 76.81) aphid population was recorded in 48th SMW (26th November- 2nd December), while maximum (239.6±76.81) population was recorded during 8th SMW (19th February- 25th February).

The correlation data between mean aphid population and weather parameters indicated that the maximum temperature (r=0.131) recorded positive non-significant correlation with mean population of aphids. The minimum temperature(r=-0.175), morning relative humidity (r=0.045) and evening relative humidity(r=-0.315) showed negative non-significant correlation with mean population of aphids.

The infestation of pod borers was started in the 4th week of December (52th SMW). During cropping season, the infestation varied

from 3.9 to 28.1 per cent on number basis. The minimum(3.9±10.35) per cent infestation of pod borerswas recorded in 2nd SMW (8th-14th January) While, maximum (28.10±10.35) per cent infestation was recorded during 6th SMW (5th -11th February).

During cropping season, the data on correlation between mean per cent infestation of pod borers exhibited non-significant positive correlation (r=0.286, 0.076) with maximum temperature and minimum temperature respectively. While, morning relative humidity(r=-0.374) and evening relative humidity (-0.002) were found to be negatively non-significant.

A field experiment were conducted to study the effect of sowing dates against pests infesting dolichos bean. Based on overall results of field experiment, it was revealed that minimum (6.36%) aphid infestation was recorded in early sown crop i.e. 2nd November. The minimum (33.41%) pod borers damage was recorded in early sown crop i.e. 2nd November while, maximum (55.67%) pod borer damage was recorded on late sown crop i.e. 12th December.It was evident from the result that in dolichos bean, pest infestation increased gradually with the advancement of cropping season.

Another field experiment was conducted during *Rabi* season to study the efficacy of some insecticides against pests infesting dolichos bean.The results regarding overall mean of all sprays against aphids revealed that treatment chlorpyriphos 20EC @ 0.06 per cent was most effective which recorded 16.5 mean aphid population and was at par with *Lecanicillium lecanii*which recorded 20.57 mean aphid population and Azadirachtin 1000 ppm @ 0.003 per cent (22.53). The next effective treatment was *Beauveria bassiana*which recorded 37.99 mean aphid population and was at par with *Metarrhizium anisopliae* (40.03). The next effective treatment was *Bacillus thuringiensis*which recorded 53.08 mean aphid population. All the above treatments were

found to be superior over untreated control which recorded maximum (88.71) aphid population.

Based on overall mean of two sprays revealed that chlorpyriphos 20EC @ 0.06 per cent was the best treatment which recorded minimum (12.74%) mean pod infestation and was at par with *Bacillus thuringiensis* (14.03%). The next effective treatment was Azadirachtin 1000 ppm @ 0.003 per cent which recorded 16.22 per cent pod damage and was at par with *Beauveria bassiana* which recorded 19.54 per cent pod damage. The treatment *Metarrhizium anisopliae* recorded 20.06 per cent pod damage. *Lecanicillium lecanii* recorded 26.51 per cent pod damage. All the above treatments were found to be superior over untreated control which recorded maximum (54.93%) pod damage.

The present investigations are based on one season and one location data. Therefore, in order to arrive at a sound conclusion, it is necessary to continue the studies with long duration trials at different locations including improved pest management practices to keep the pest infestation at low level and to get higher returns from dolichos bean.

SYNOPSIS OF RESEARCH WORK

Seasonal incidence, effect of sowing dates and management of pests infesting dolichos bean*Lablab purpureus* (L.) Sweet

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10. Introduction:

The grain legumes occupy a unique position in the world of agriculture by virtue of their high protein content and capacity of fixing atmospheric nitrogen. *Lablab purpureus* (L.) Sweet usually called asDolichos bean, Hyacinth bean or Field bean is one of the most ancient crops among the cultivated plants. It is a bushy, semi-erect, perennial herb, showing no tendency to climb. It is mainly cultivated either as a pure crop or mixed with finger millet, groundnut, castor, corn and bajara or sorghum in Asiaand Africa. It is a multipurpose crop grown for pulse, vegetable and forage. It is one of the major sources of protein in diets in southern states of India. It is also grown as an ornamental plant, mostly in USA for its beautiful dark-green, purple-veined foliage with large spikes clustered with deep-violet and white pea-like blossoms.The crop is grown for its green pods, while dry

seeds are used in various vegetable food preparations. The pole types are grown in homestead by trailing to bower for its tender fruits which are used as cooked vegetable. It is a nutritive vegetable grown for the consumption of green pods; green seeds and dry seeds pulse also. Green pods contain 6.7 gm carbohydrates, 3.8 gm protein, and 1.8 gm fiber, 210 mg Ca, 68.0 mg phosphorous, 1.7 mg iron per 100 g edible portion (Anon., 2018a). It is also used as feed for animals and green manure. In India, the total area under beans is 228 thousand hectare with an annual production of 2277 thousand MT while in Maharashtra the total area under beans is 5.50 thousand hectare with an annual production of 55.48 thousand MT (Anon., 2018b).

The phytochemical analysis of dolichos bean showed that it contained sugar, alcohol, phenols, steroids, essential oils, alkaloids, tannins, flavonoids, saponins, coumarins, terpenoids pigments, glycosides, wide range of minerals and many other metabolites. The preliminary pharmacological studies revealed that dolichos bean possessesantidiabetic, antiinflamatory, analgesic, antioxidant, cytotoxic, hypolipidemic, antimicrobial, insecticidal, hepatoprotective properties and also used for the treatment of iron deficiency anemia (Anon., 2018c).

The crop is attacked by a number of insect pests during its life span. Govindan (1974) recorded as many as 55 species of insects and one species of mite feeding on the crop from seedling stage till the harvest of the crop in Karnataka. However, only a few of them such as pod borers were considered to be most destructive and they appeared regularly causing economic loss, whereas others were considered as minor pests. Among the sucking pests lablab bug, *Coptosomacribraria* (Fabricius*), Riptortuspedestris* (Fabricius) and *Nezaraviridula* (Linnaeus) occurred commonly and found in large number throughout

the cropping period (Govindan, 1974 and Thippeswamy, 1990). Aphids are one of the most serious pests of crops worldwide, causing major yield and economic losses. While,the larvae of pod borer are known to cause considerable damage to lablab bean attacking various parts *viz.*, buds, flowers, pods and seeds. Its nature of damage is exhibited by weaving unopened buds and flowers. The larva further damages the reproductive parts of flower leading to poor pod setting and pod formation. In the later period of crop growth, it behaves as a pod borer and completes its larval and pupal development inside the pod. This leads to poor pod formation, reduction in grain yield as well as adverse effect on market value of green pods.

The management of these noxious pests is primarily based on synthetic insecticides due to their easy availability and applicability. But their indiscriminate use has resulted in the development of insecticidal resistance in the pest, environmental pollution, and resurgence of minor pests, pollution hazards and disruption on balance of eco-system.

Though the crop is economically important, the information on the pest status, crop loss estimation in Konkan region is very much lacking. As the pods are consumed as vegetable, the pest management and especially the pod borer control has to be on organic basis. Considering the importance of dolichos bean and seriousness of the pests, the present investigation was planned and conducted at the Central Experiment Station, Wakavali, Dr. BalasahebSawantKonkanKrishiVidyapeeth, Dapoli, Dist. Ratnagiri, Maharashtra with the following objectives

4) To study the seasonal incidence of pests infesting dolichos bean, *Lablab purpureus* (L.) Sweet

5) To study the effect of sowing dates against pests infesting dolichos bean, *Lablabpurpureus*(L.) Sweet
6) To study the efficacy of insecticides against pests infesting dolichos bean, *Lablabpurpureus* (L.) Sweet

11. Material and Methods

11.1 To study the seasonal incidence of pests infesting dolichos bean

The field experiment was conducted at Vegetable Improvement Scheme, CES, Wakavali, DBSKKV, Dapoli during *rabi* season to study the seasonal incidence of sucking pests and pod borers infesting dolichos bean. The details of experiment are given below

Size of plot	:	3mx 1.2m
Method of planting	:	On raised beds
Spacing	:	30 cm x 30 cm
Variety	:	KonkanBhushan
Date of sowing	:	22nd November, 2018

11.1.1 Method of recording observations

The experimental plot was kept unsprayed throughout the cropping season. The observations were recorded as soon as the infestation was noticed.

a) Sucking pests

The population of sucking pests infesting dolichos bean was not observed throughout the cropping season except aphids. The observations regarding aphids were recorded at weekly interval during morning hours on three randomly selected plants. Population was counted on three leaves top, middle and bottom and expressed as number per three leaves.

b) Pod borers

During the cropping season three different pod borers *viz.,Helicoverpaarmigera* (Hubner), *Spodopteralitura*(Fabricius) and *Marucavitrata* (Fabricius) were observed to infest dolichos bean. The observations were recorded at each picking *i.e.* on the basis of number of healthy and infested pods due to pest.

Per cent pod infestationwas calculated by the following formula,

$$\text{Per cent pod infestation} = \frac{\text{Number of infested pods}}{\text{Total number of pods}} \times 100$$

In order to study the influence of abiotic factors (meteorological parameters) on pest incidence, the correlations were worked out with weekly weather data *viz.*, average maximum and minimum temperatures, morning and evening relative humidity available at the meteorological observatory, Central Experimental Station, Wakawali, Tal. Dapoli, Dist- Ratnagiri.

11.2 To study the effect of sowing dates against pests infesting dolichos bean

The field experiment was conducted at Vegetable Improvement Scheme, CES, Wakavali, DBSKKV, Dapoliduring *rabi*season to study the effect of sowing dates infesting dolichos bean. The details of experiment are given below

Size of plot	:	6mx 1.2m
Method of planting	:	On raised beds
Spacing	:	30 cm x 30 cm
Variety	:	KonkanBhushan
Replications	:	Eight
Treatments	:	Three
Date of sowing	:	2nd November, 2018 22nd November, 2018 12th December,2018

11.2.1 Method of recording observations:

All the agronomic practices were followed as per the package of practices. Each treatment was replicated eight times. Observations on insect pests were recorded at weekly interval after germination till harvesting of the crop.

b) Sucking Pests

The population of sucking pests infesting dolichos bean other than aphids was not observed throughout the cropping season. The population of aphids was recorded at weekly interval during morning hours on five randomly selected plants. The Population was counted on three leaves top, middle and bottom and expressed as number per three leaves.

b) Pod borers

During the cropping season three different pod borers *viz.,Helicoverpaarmigera* (Hubner), *Spodopteralitura* (Fabricius) and *Marucavitrata* (Fabricius) were observed to infest dolichos bean. The observations were recorded at each picking i.e. on the basis of number of healthy and infested pods due to pest.

Per cent pod infestedwere calculated by the following formula,

$$\text{Per cent pod infestation} = \frac{\text{Number of infested pods}}{\text{Total number of pods}} \times 100$$

11.3 To evaluate the efficacy of insecticides against pests infestingdolichos bean

A field experiment was conducted during *rabi*season of 2018-19 to study the effectiveness of some insecticides against sucking pests and pod borers infesting dolichosbean.

11.3.1 Experimental details:

Location	:	CES, Wakawali, DBSKKV, Dapoli, Dist. Ratnagiri
Period of study	:	November 2018 to April 2019
Variety	:	KonkanBhushan
Spacing	:	30 cm × 30 cm
Size of treatment plot	:	1.5m × 1.2m
Total plot size	:	37.8m
Date of sowing	:	22nd November, 2018
Method of planting	:	On raised beds
Design	:	Randomized Block Design (RBD)
Number of replication	:	Three
Number of treatment	:	Seven

11.3.2 Spraying

The quantity of spray suspension required for each treatment was calibrated by spraying water over three plots in the experiment prior to the application of insecticide. Spray suspension of desired strength of each insecticide was prepared againstaphids and pod borers in the field.

The insecticides were sprayed thrice in case of aphids and twice in case of pod bores because the infestation of aphids was noticed in the 48th SMW while the infestation of pod borers was noticed in the 52th SMW. The First spray of each insecticide was applied when

incidence was noticed while remaining sprays were given at an interval of 15 days with manually operated knapsack sprayer. The observations were recorded in each treatment on randomly selected plants.

11.3.3Treatment details

Table 1:

Treatment No.	InsecticideName	Conc. (%)	Quantity per litre(ml)
T_1	*Beauveriabassiana*	-	5
T_2	*Lecanicilliumlecanii*	-	5
T_3	*Bacillus thuringiensis*	-	2
T_4	Azadirachtin1000ppm	0.003	3
T_5	*Metarrhiziumanisopliae*	-	2.5
T_6	Chloropyriphos	0.06	3
T_7	Untreated control	-	-

11.3.4 Method of recording observations

a) Sucking pests

The population of sucking pests infesting dolichos bean other than aphids was not observed throughout the cropping season. The observations on the number of aphids were recorded on five randomly selected plants per plot. Number of pests was recorded from the three leaves top, middle and bottom of the plant. The pre-treatment observations were recorded 24 hrs before each spray. Subsequently post treatment observations were recorded at third, seventh, tenth and fourteenth day after each spray in the early morning hours.

b) Pod borers

During the cropping season three different pod borers *viz.,Helicoverpaarmigera* (Hubner), *Spodopteralitura* (Fabricius) and *Marucavitrata* (Fabricius) were observed to infest dolichos bean. The Observations of pod borers were recorded on five randomly selected plants per plot at each picking *i.e.*number of healthy and infested pods due to pest.

Per cent pod infestation was calculated by the following formula,

$$\text{Per cent pod infestation} = \frac{\text{Number of infested pods}}{\text{Total number of pods}} \times 100$$

Table 2: Mean population of aphids infesting dolichos bean in relation to weather parameters

SMW	Period	Temperature (ºC)		Relative humidity (%)		Mean population of aphids per three leaves per plant
		Tmax	Tmin	RH-I (%)	RH-II (%)	
48	26.11-02.12	33.07	15.29	90.14	40.99	2.8
49	03.12-09.12	33.5	17.43	88.25	45.26	2.9
50	10.12-16.12	31.17	13.58	82.37	33.56	15
51	17.12-23.12	31.43	13.1	85	37.97	46.3
52	24.12-31.12	31.71	12.86	80.45	29.13	99.5
1	10.01-07.01	33.21	11.77	86.6	24.44	230.1
2	08.01-14.01	32.77	11.77	87.92	26	121.1
3	15.01-21.01	34.34	15.86	89.66	32.54	230.1
4	22.01-28.01	32.91	12.97	81.42	32.56	185.3
5	29.01-04.02	32.11	14.13	87.19	29.54	156.95
6	05.02-11.02	28.92	11.1	84.66	12.48	164.2
7	12.02-18.02	33.01	14.91	82.38	19.03	198.1
8	19.02-25.02	35.71	17.14	82.32	31.4	239.6
9	26.02-04.03	33.29	13.84	77.34	64.61	174.3
10	05.03-11.03	33.89	15.74	80.81	71.45	106.15
11	12.03-18.03	34.29	16.47	71.03	50.15	95.35
12	19.03-25.03	36.57	16.46	72.35	35.61	103.85
13	26.03-01.04	37.24	21.24	89.37	48.12	99.34
					SD±	76.81

SMW- Standard Meteorological week

SD- Standard Deviation

Table 3:Mean infestation of pod borers infesting dolichos bean in relation to weather parameters

SMW	Period	Temperature (ºC)		Relative humidity (%)		Per cent pod damage per plant
		Tmax	Tmin	RH-I (%)	RH-II (%)	Pod borer
48	26.11-02.12	33.07	15.29	90.14	40.99	0
49	03.12-09.12	33.5	17.43	88.25	45.26	0
50	10.12-16.12	31.17	13.58	82.37	33.56	0
51	17.12-23.12	31.43	13.1	85	37.97	0
52	24.12-31.12	31.71	12.86	80.45	29.13	25.7
1	10.01-07.01	33.21	11.77	86.6	24.44	28.1
2	08.01-14.01	32.77	11.77	87.92	26	3.9
3	15.01-21.01	34.34	15.86	89.66	32.54	19.2
4	22.01-28.01	32.91	12.97	81.42	32.56	19.05
5	29.01-04.02	32.11	14.13	87.19	29.54	20.05
6	05.02-11.02	28.92	11.1	84.66	12.48	22.45
7	12.02-18.02	33.01	14.91	82.38	19.03	23.05
8	19.02-25.02	35.71	17.14	82.32	31.4	20.03
9	26.02-04.03	33.29	13.84	77.34	64.61	24.64
10	05.03-11.03	33.89	15.74	80.81	71.45	22.8
11	12.03-18.03	34.29	16.47	71.03	50.15	20
12	19.03-25.03	36.57	16.46	72.35	35.61	23.9
13	26.03-01.04	37.24	21.24	89.37	48.12	24.7
					SD±	10.35

SMW- Standard Meteorological Week

SD- Standard Deviation

Table 4: Correlation coefficient of mean population of aphids infesting dolichos bean in relation to different weather parameters

Climatic parameters	Correlation coefficient (r)
Maximum temperature (Tmax)	0.131
Minimum temperature (Tmin)	-0.175
Morning relative humidity	-0.045
Evening relative humidity	-0.315

*significant at 5 per cent levelr= 0.468

Table 5: Correlation coefficient of mean population of pod borer infesting dolichos bean in relation to different weather parameters

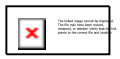
Climatic parameters	Correlation coefficient(r)
Maximum temperature (Tmax)	0.286
Minimum temperature (Tmin)	0.076
Morning relative humidity	-0.374
Evening relative humidity	-0.002

*significant at 5 per cent level r= 0.468

Table 6: Effect of sowing dates against aphids infestingdolichos bean

Mean population of aphids per three leavesper plant

Date of sowing	1WAS	2WAS	3WAS	4WAS	5WAS	6WAS	7WAS	8WAS	9WAS	10WAS	11WAS	12WAS	13WAS	14WAS	15WAS	16WAS	Overall Mean
02-11-2018	1.71 (1.64)*	1.45 (1.56)	3.51 (2.07)	3.59 (2.13)	7.05 (2.84)	6.59 (2.75)	7.55 (2.92)	7.36 (2.89)	7.25 (2.87)	7.90 (2.98)	7.66 (2.94)	7.90 (2.98)	8.31 (3.05)	8.09 (3.01)	8.08 (3.01)	7.86 (2.98)	**6.36** (2.66)
22-11-2018	3.51 (2.12)	6.38 (2.71)	5.99 (2.64)	6.45 (2.73)	8.27 (3.02)	18.36 (4.37)	23.11 (4.91)	22.96 (4.89)	30.44 (5.61)	22.08 (4.73)	25.28 (5.08)	28.25 (5.28)	32.35 (5.76)	39.63 (6.35)	42.39 (6.56)	50.96 (7.17)	22.89 (4.62)
12-12-2018	18.64 (4.42)	25.7 (5.15)	28.1 (5.37)	20.96 (4.66)	29.04 (5.44)	27.35 (5.32)	34.17 (5.80)	31.32 (5.60)	41.32 (6.50)	40.26 (6.42)	41.05 (6.48)	40.42 (6.43)	53.25 (7.35)	54.46 (9.43)	60.84 (7.84)	65.07 (8.09)	38.24 (6.14)
S.Em. ±	0.08	0.11	0.16	0.11	0.16	0.11	0.27	0.22	0.04	0.18	0.15	0.23	0.13	0.17	0.16	0.28	0.16
CD (p = 0.05)	0.24	0.33	0.47	0.47	0.48	0.34	0.82	0.65	0.11	0.54	0.44	0.69	0.39	0.53	0.48	0.85	0.48

*Figures in parenthesis are  values

WAS- Week After Sowing

Table 7: Effect of sowing dates against pod borers infesting dolichos bean

Per cent pod damage per five plants								
Date of sowing	**8WAS**	**9WAS**	**10WAS**	**11WAS**	**12WAS**	**13WAS**	**14WAS**	**Overall Mean**
02-11-2018	21.90 (27.83)*	30.97 (33.76)	31.94 (34.36)	32.69 (34.82)	34.99 (36.23)	40.34 (39.41)	41.05 (39.84)	33.41 (35.17)
22-11-2018	40.46 (39.49)	41.55 (40.13)	42.13 (40.47)	39.06 (38.68)	39.45 (38.90)	41.69 (40.21)	41.43 (40.06)	40.82 (39.70)
12-12-2018	60.00 (50.80)	60.46 (51.20)	57.50 (49.32)	57.18 (49.14)	56.28 (48.75)	48.55 (41.26)	49.73 (44.84)	55.67 (47.90)
S.Em. ±	0.91	1.27	0.82	0.83	1.19	0.82	0.95	0.97
CD (p = 0.05)	2.75	3.84	2.48	2.53	3.60	2.50	2.88	2.94

*Figures in parenthesis are arcsine transformed values

WAS- Week After Sowing

Table 8: Efficacy of different insecticides against aphids infesting dolichos bean after first spray

Sr. No.	Treatment	Conc. (%)	Mean population of aphids per three leaves per plant					
			Pre count	3 DAS	7 DAS	10 DAS	14 DAS	Overall Mean
1	*Beauveriabassiana*	-	80.2 (9.01)*	72.2 (8.56)	68.2 (8.32)	60.2 (7.82)	52.2 (7.29)	63.2 (7.99)
2	*Lecanicilliumlecanii*	-	80.97 (9.05)	70.97 (8.48)	62.97 (8)	37.97 (6.24)	12.97 (3.73)	46.22 (6.61)
3	*Bacillus thuringiensis*	-	80.84 (9.04)	78.84 (8.93)	75.84 (8.76)	72.34 (8.56)	68.84 (8.35)	73.96 (8.65)
4	*Azadirachtin 1000 ppm*	0.003	81.48 (9.08)	61.48 (7.9)	52.48 (7.31)	45.48 (6.81)	38.48 (6.28)	49.48 (7.07)
5	*Metarrhiziumanisopliae*	-	81.18 (9.06)	75.18 (8.72)	71.18 (8.49)	63.18 (8.01)	55.18 (7.49)	66.18 (8.17)
6	*Chlorpyriphos*	0.06	80.33 (9.01)	50.33 (7.15)	40.33 (6.41)	31.83 (5.7)	23.33 (4.89)	36.45 (6.03)
7	Untreated control	-	82.46 (9.13)	102.46 (10.17)	122.46 (11.11)	162.46 (12.78)	122.46 (11.11)	127.46 (11.29)
	S.Em.±		0.18	0.19	0.19	0.21	0.24	0.2
	CD (P= 0.05)		NS	0.58	0.6	0.63	0.73	0.63

Figures in parentheses are arcsine transformed values

DAS- Days After Spraying

Table 9: Efficacy of different insecticides against aphids infesting dolichos bean after second spray

Sr. No.	Treatment	Conc. (%)	Mean population of aphids per three leaves per plant					
			Pre count	3 DAS	7 DAS	10 DAS	14 DAS	Overall Mean
1	*Beauveriabassiana*	-	52.20 (7.29)	49.20 (7.08)	45.20 (6.80)	37.20 (6.18)	29.20 (5.49)	40.2 (6.38)
2	*Lecanicilliumlecanii*	-	12.97 (3.73)	23.47 (4.95)	22.72 (4.87)	11.72 (3.56)	2.39 (1.84)	15.07 (3.80)
3	*Bacillus thuringiensis*	-	68.84 (8.35)	65.84 (8.17)	62.84 (7.99)	59.34 (7.76)	55.84 (7.53)	60.96 (7.80)
4	*Azadirachtin 1000 ppm*	0.003	38.48 (6.28)	17.48 (4.29)	17.22 (4.26)	14.72 (3.95)	11.72 (3.55)	15.28 (4.01)
5	*Metarrhiziumanisopliae*	-	55.18 (7.49)	51.18 (7.22)	47.18 (6.93)	39.18 (6.33)	31.18 (5.66)	42.18 (6.53)
6	*Chlorpyriphos*	0.06	23.33 (4.89)	19.33 (4.45)	15.88 (4.03)	8.05 (2.97)	6.38 (2.71)	12.41 (3.54)
7	Untreated control	-	122.46 (11.11)	127.46 (11.33)	134.46 (11.64)	74.46 (8.68)	59.46 (7.76)	98.96 (9.85)
	S.Em. ±		0.24	0.25	0.27	0.24	0.23	0.24
	CD (P= 0.05)		0.73	0.77	0.82	0.72	0.70	0.75

Figures in parentheses are arcsine transformed values

DAS- Days After Spraying

Table10: Efficacy of different insecticides against aphids infesting dolichos bean after third spray

Sr. No.	Treatment	Conc. (%)	Mean population of aphids per three leaves per plant					
			Pre count	3 DAS	7 DAS	10 DAS	14 DAS	Overall Mean
1	*Beauveriabassiana*	-	29.20 (5.49)	21.20 (4.71)	13.20 (3.76)	5.20 (2.47)	2.70 (1.89)	10.57 (3.20)
2	*Lecanicilliumlecanii*	-	2.39 (1.84)	0.89 (1.36)	0.64 (1.27)	0.17 (1.07)	0.00 (1.00)	0.42 (1.17)
3	*Bacillus thuringiensis*	-	55.84 (7.53)	45.34 (6.80)	29.84 (5.54)	14.34 (3.88)	7.84 (2.90)	24.34 (4.78)
4	*Azadirachtin 1000 ppm*	0.003	11.72 (3.55)	6.72 (2.74)	3.22 (1.95)	1.03 (1.38)	0.42 (1.17)	2.84 (1.81)
5	*Metarrhiziumanisopliae*	-	31.18 (5.66)	23.18 (4.89)	15.18 (3.97)	5.57 (2.55)	3.07 (2.00)	11.75 (3.35)
6	*Chlorpyriphos*	0.06	6.38 (2.71)	1.38 (1.51)	0.88 (1.32)	0.23 (1.11)	0.07 (1.03)	0.64 (1.24)
7	Untreated control	-	59.46 (7.76)	58.46 (7.70)	44.46 (6.70)	30.46 (5.40)	25.46 (4.85)	39.71 (6.16)
	S.Em. ±		0.23	0.27	0.34	0.43	0.49	0.38
	CD (P= 0.05)		0.70	0.84	1.05	1.33	0.51	1.18

Figures in parentheses are arcsine transformed values

DAS- Days After Spraying

Table11: Cumulative efficacy of different insecticides against aphids infesting dolichos bean

Sr. No.	Treatment	Conc.%	Mean population of aphids per three leaves per plant			Cumulative Mean Population
			First spray	Second spray	Third spray	
1	*Beauveriabassiana*	-	63.2 (7.99)*	40.2 (6.38)	10.57 (3.20)	37.99 (5.85)
2	*Lecanicilliumlecanii*	-	46.22 (6.61)	15.07 (3.80)	0.42 (1.17)	20.57 (3.86)
3	*Bacillus thuringiensis*	-	73.96 (8.65)	60.96 (7.80)	24.34 (4.78)	53.08 (7.07)
4	Azadirachtin 1000ppm	0.003	49.48 (7.07)	15.28 (4.01)	2.84 (1.81)	22.53 (4.29)
5	*Metarrhiziumanisopliae*	-	66.18 (8.17)	42.18 (6.53)	11.75 (3.35)	40.03 (6.01)
6	Chlorpyriphos	0.06	36.45 (6.03)	12.41 (3.54)	0.64 (1.24)	16.5 (3.60)
7	Untreated control	-	127.46 (11.29)	98.96 (9.85)	39.71 (6.16)	88.71 (9.1)
S.Em. ±			0.2	0.24	0.38	0.27
CD (P=0.05)			0.63	0.75	1.18	0.85

*Figures in parentheses are $\sqrt{x+1}$ values

Table12: Efficacy of diffeerent insecticides against pod borers infesting dolichos bean after first spray

Sr. No.	Treatment	Conc. (%)	Per cent pod damage per five plants					
			Pre count	3 DAS	7 DAS	10 DAS	14 DAS	Overall Mean
1	*Beauveriabassiana*	-	31.29 (33.99)	31.73 (34.28)	28.73 (32.41)	25.23 (30.15)	21.73 (27.78)	26.85 (31.15)
2	*Lecanicilliumlecanii*	-	32.65 (34.83)	32.65 (34.84)	29.85 (33.11)	29.35 (32.80)	27.85 (31.84)	29.92 (33.14)
3	*Bacillus thuringiensis*	-	32.10 (34.51)	29.10 (32.64)	26.10 (30.72)	21.60 (27.69)	17.10 (24.42)	23.47 (28.86)
4	*Azadirachtin 1000 ppm*	0.003	30.50 (33.52)	29.17 (32.69)	27.17 (31.41)	22.50 (28.31)	18.50 (25.47)	24.33 (29.47)
5	*Metarrhiziumanisopliae*	-	32.32 (34.62)	31.85 (34.35)	28.85 (32.47)	25.69 (30.43)	22.52 (28.29)	27.22 (31.38)
6	*Chlorpyriphos*	0.06	32.14 (34.44)	26.81 (31.08)	22.81 (28.39)	18.56 (25.31)	14.31 (21.89)	20.62 (26.66)
7	Untreated control	-	32.43 (34.68)	42.93 (40.93)	47.43 (43.52)	52.93 (46.68)	58.43 (49.86)	50.43 (45.24)
	S.Em. ±		1.50	0.98	1.03	1.16	1.30	1.11
	CD (P= 0.05)		NS	3.02	3.17	3.57	4.01	3.44

Figures in parentheses are arcsine transformed values

DAS- Days After Spraying

Table13: Efficacy of different insecticides against pod borers infesting dolichos bean after second spray

Sr. No.	Treatment	Conc. (%)	Per cent pod damage per five plants					
			Pre count	3 DAS	7 DAS	10 DAS	14 DAS	Overall Mean
1	*Beauveriabassiana*	-	21.73 (27.78)	18.23 (25.26)	14.73 (22.55)	10.23 (18.62)	5.73 (13.76)	12.23 (20.04)
2	*Lecanicilliumlecanii*	-	27.85 (31.84)	26.35 (30.88)	24.85 (29.89)	22.35 (28.20)	18.85 (25.71)	23.10 (28.67)
3	*Bacillus thuringiensis*	-	17.10 (24.42)	11.60 (19.91)	6.10 (14.29)	0.60 (4.42)	0.12 (1.92)	4.60 (10.13)
4	*Azadirachtin 1000 ppm*	0.003	18.50 (25.47)	14.50 (22.39)	10.50 (18.89)	5.50 (13.53)	2.00 (7.94)	8.12 (15.68)
5	*Metarrhiziumanisopliae*	-	22.52 (28.29)	19.35 (26.04)	16.19 (23.64)	10.29 (18.67)	5.79 (13.82)	12.90 (20.54)
6	*Chlorpyriphos*	0.06	14.31 (21.89)	10.06 (17.81)	7.81 (16.09)	1.19 (6.11)	0.45 (3.60)	4.87 (10.90)
7	Untreated control	-	58.43 (49.86)	60.93 (51.32)	63.43 (52.80)	60.93 (51.32)	52.43 (46.39)	59.43 (50.45)
	S.Em. ±		1.30	1.56	1.01	0.87	1.04	1.12
	CD (P= 0.05)		4.01	4.82	3.12	2.70	3.22	3.46

Figures in parentheses are arcsine transformed values

DAS- Days After Spraying

Table14: Cumulative efficacy of different insecticides against pod borers infesting dolichos bean

Sr. No.	Treatment	Conc. (%)	Mean per cent pod infested		Cumulative per cent infestation
			First spray	Second spray	
1	*Beauveriabassiana*	-	26.85 (31.15)*	12.23 (20.04)	19.54 (25.59)
2	*Lecanicilliumlecanii*	-	29.92 (33.14)	23.10 (28.67)	26.51 (30.90)
3	*Bacillus thuringiensis*	-	23.47 (28.86)	4.60 (10.13)	14.03 (19.49)
4	Azadirachtin 1000ppm	0.003	24.33 (29.47)	8.12 (15.68)	16.22 (22.57)
5	*Metarrhiziumanisopliae*	-	27.22 (31.38)	12.90 (20.54)	20.06 (25.96)
6	Chlorpyriphos	0.06	20.62 (26.66)	4.87 (10.90)	12.74 (18.78)
7	Untreated control	-	50.43 (45.24)	59.43 (50.45)	109.86 (47.84)
S.Em. ±			1.11	1.12	1.11
CD (p= 0.05)			3.44	3.46	3.45

Figures in parentheses are arcsine transformed values

13.Experimental findings

The study on seasonal incidence revealed that there was marked difference in aphids population as regard Standard Meteorological Weeks. The population of aphids (2.8±76.81) was noticed in the 48th SMW (26th November- 2nd December). During cropping season, the population was in the range of 2.8 to 239.6 aphids per three leaves per plant. Minimum(2.8 ± 76.81) aphid population was recorded in 48th SMW (26th November- 2nd December), while maximum (239.6±76.81) population was recorded during 8th SMW (19th February- 25th February).

The correlation data between mean aphid population and weather parameters indicated that the maximum temperature (r=0.131) recorded positive non-significant correlation with mean population of aphids. The minimum temp. (r=-0.175), morning relative humidity (r=0.045) and evening relative humidity (r=-0.315) showed negative non-significant correlation with mean population of aphids.

The infestation of pod borers was started after flower initiation in the 4th week of December (52th SMW). During cropping season, the infestationvaried from 3.9 to 28.1 per cent on number basis. The minimum(3.9±10.35) per cent pod borers infestation was recorded in 2ndSMW (8th-14th January) While, maximum (28.10±10.35) per cent infestation was recorded during 6th SMW (5th -11th February).

During cropping season, the data on correlation between mean per cent infestation of pod borers exhibited non-significant positive correlation (r=0.286, 0.076) with maximum temperature and minimum temperature respectively. While, morning relative

humidity (r=-0.374) and evening relative (-0.002) humidity were found to be negatively non-significant.

A field experiment were conducted to study the effect of sowing dates against pests infesting dolichos bean.Based on overall results of field experiment, it was revealed that minimum(6.36%) aphid infestation was recorded in early sown crop i.e. 2ndNovember. The minimum (33.41%) pod borers damage was recorded in early sown crop i.e. 2nd November while, maximum (55.67%) pod borer damage was recorded on late sown crop i.e. 12th December.

Another field experiment was conducted during *Rabi* season to study the efficacy of some insecticides against pests infesting dolichos bean.The results regarding overall mean of all sprays against aphids revealed that treatment chlorpyriphos 20EC @ 0.06 per cent was most effective which recorded 16.5 mean aphid population and was at par with *Lecanicilliumlecanii*which recorded 20.57 mean aphid population and Azadirachtin 1000 ppm @ 0.003 per cent (22.53). The next effective treatment was *Beauve riabassiana* recorded 37.99 mean aphid population and was at par with *Metarrhiziumanisopliae* (40.03). The next effective treatment was *Bacillus thuringiensis*which recorded 53.08 mean aphid population. All the above treatments were found to be superior over untreated control which recorded maximum (88.71) aphid population.

Based on overall mean of two sprays revealed that chlorpyriphos 20EC @ 0.06 per cent was the best treatment which recorded minimum (12.74%) mean pod infestation and was at par with *Bacillus thuringiensis* (14.03%). The next effective treatment was Azadirachtin 1000 ppm @ 0.003 per cent which recorded 16.22 per cent pod damage and was at par with *Beauveriabassiana* which recorded 19.54 per cent pod damage. The treatment

Metarrhiziumanisopliae recorded 20.06 per cent pod damage. *Lecanicilliumlecanii* recorded 26.51 per cent pod damage. All the above treatments were found to be

superior over untreated control which recorded maximum (54.93%) pod damage.

Place: Dapoli

Date : / /2020(Kengare Madhuri Namdev)
Sr.M.Sc. (Agril. Entomology)

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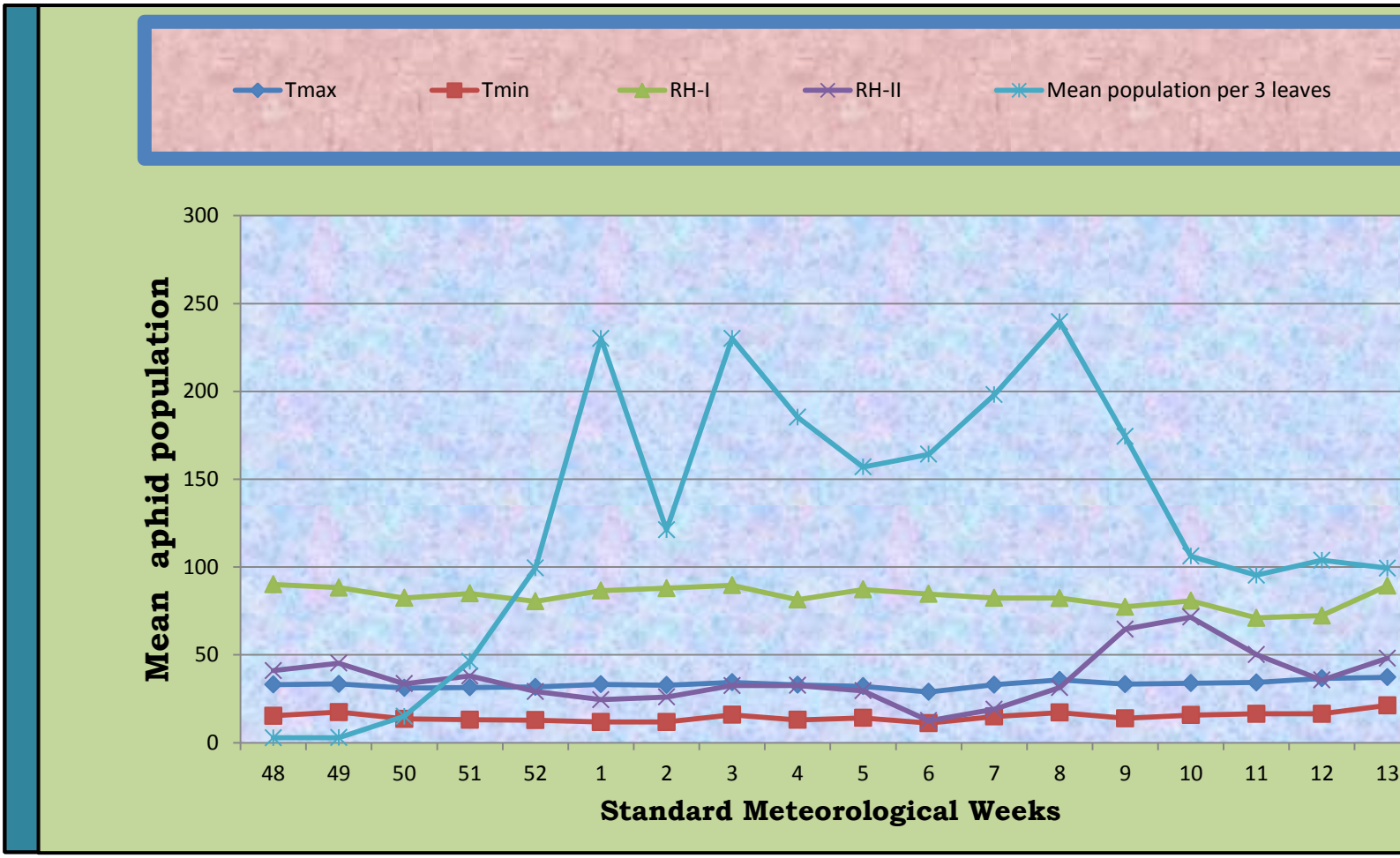
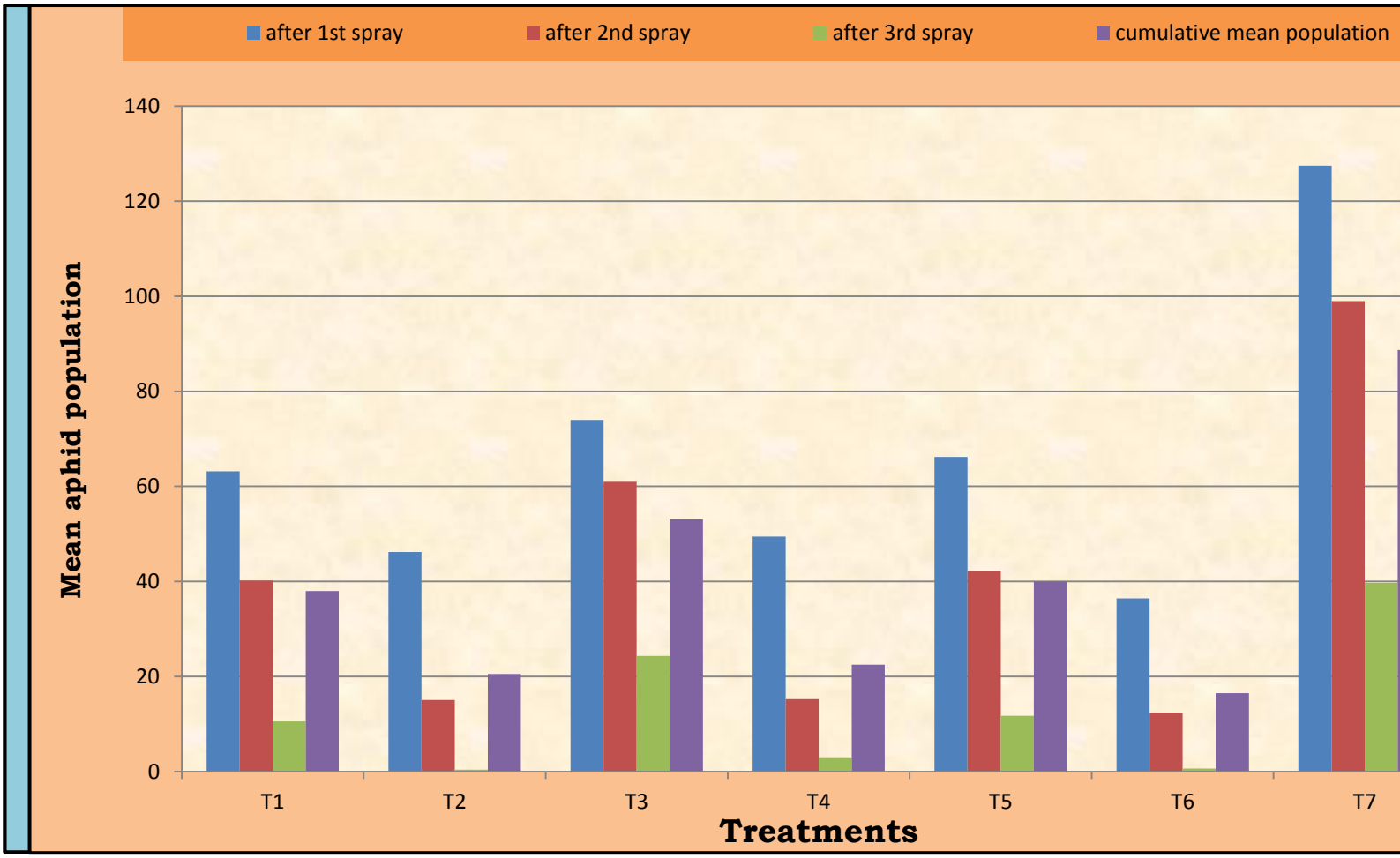
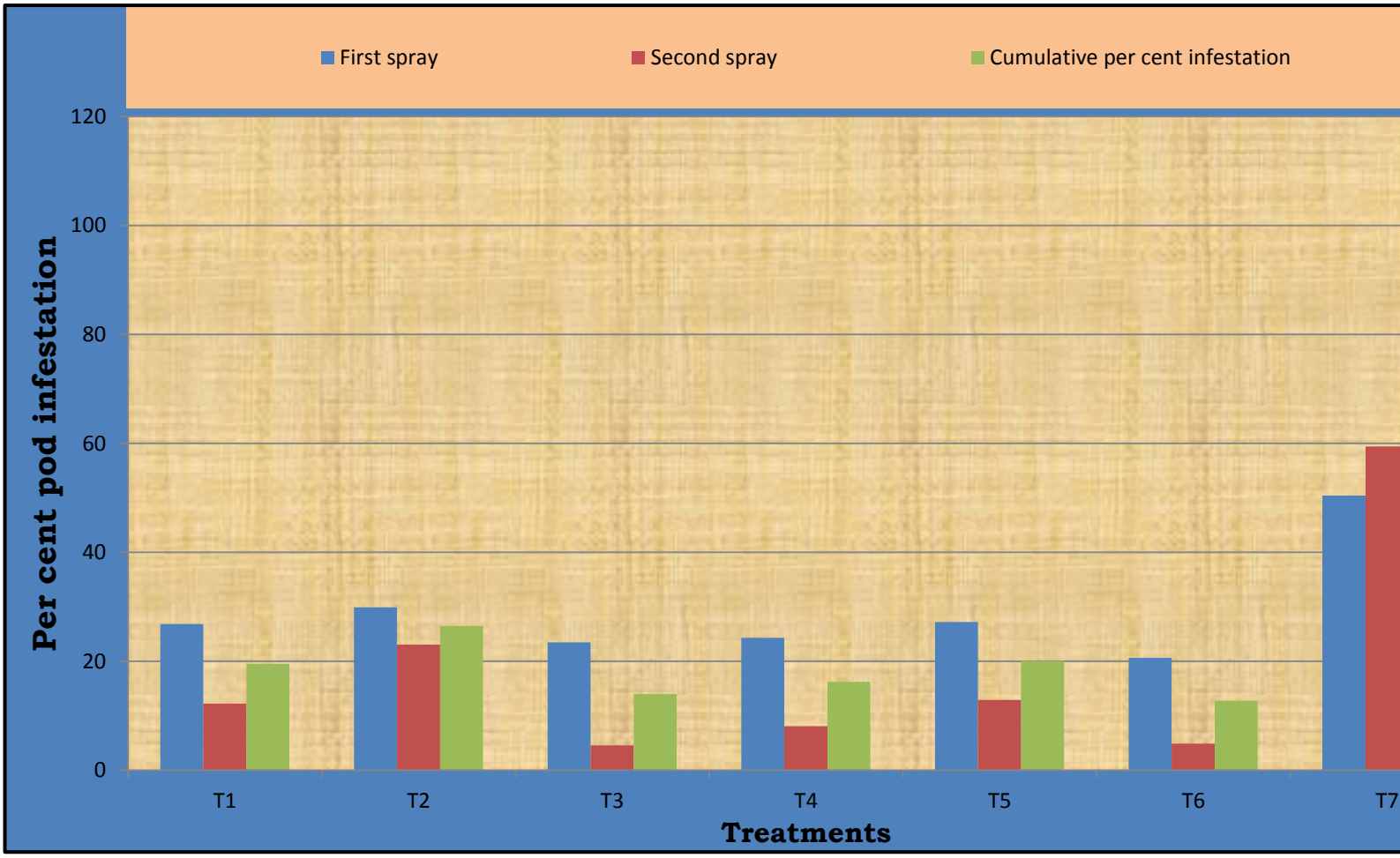


Fig.5:Effect of sowing dates against aphids infesting dolichos bean


after 1st spray
after 2nd spray
after 3rd spray
cumulative mean population
Mean aphid population
140
120
100
80
60
40
20
0
T1
T2
T3
T4
T5
T6
T7
Treatments


First spray
Second spray
Cumulative per cent infestation
Per cent pod infestation
120
100
80
60
40
20
0
T1
T2
T3
T4
T5
T6
T7
Treatments

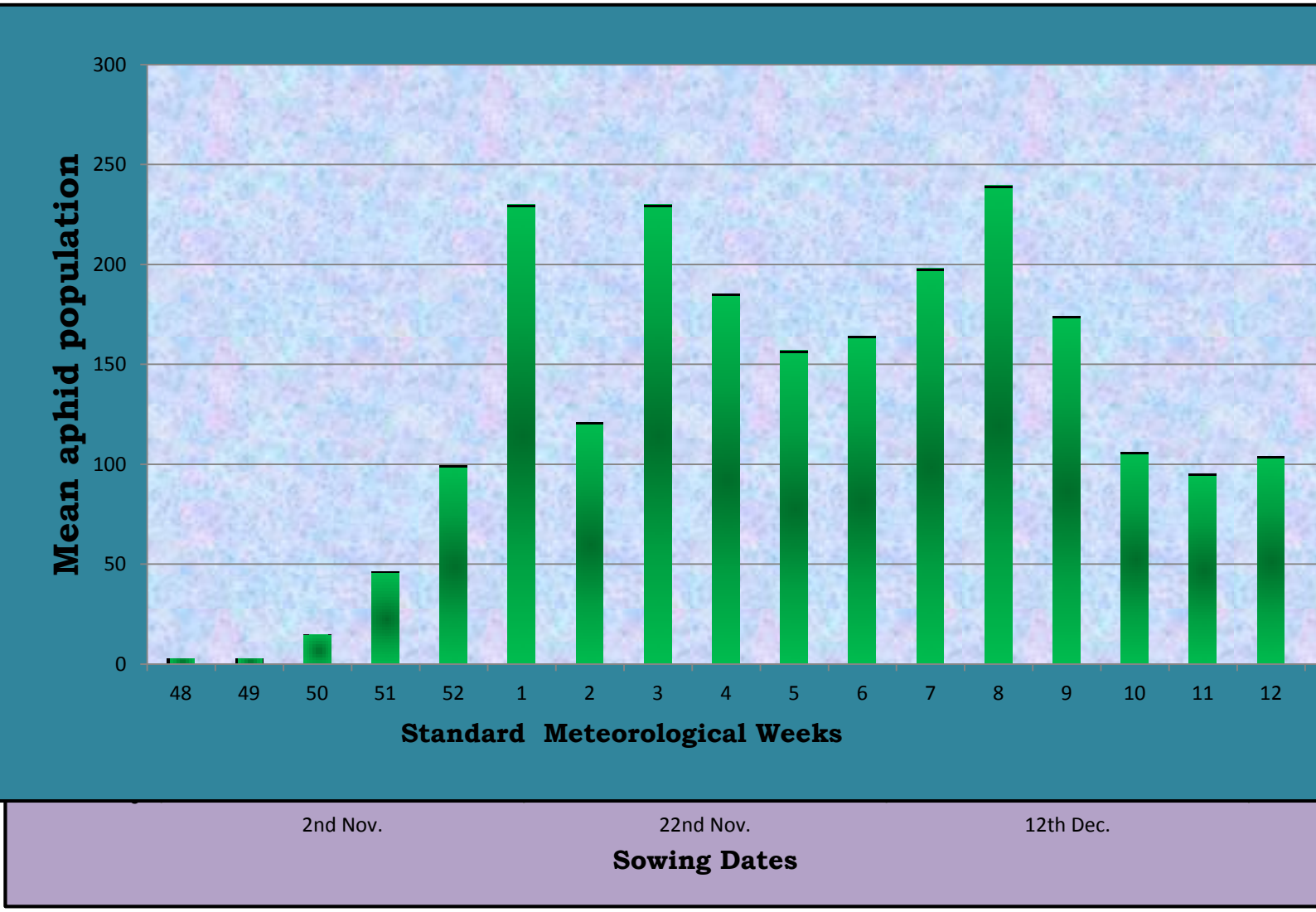


Fig.5:Effect of sowing dates against aphids infesting dolichos bea

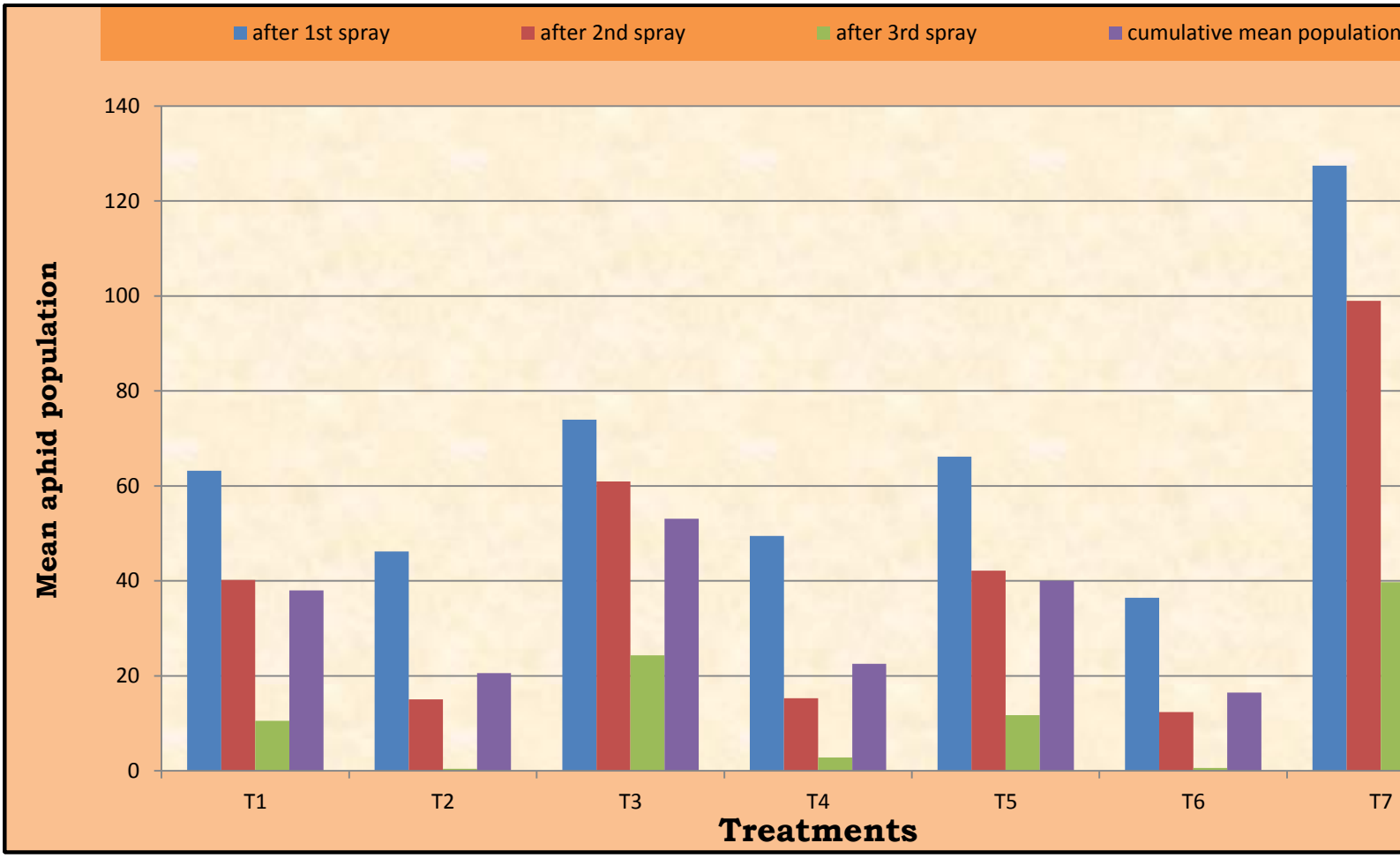
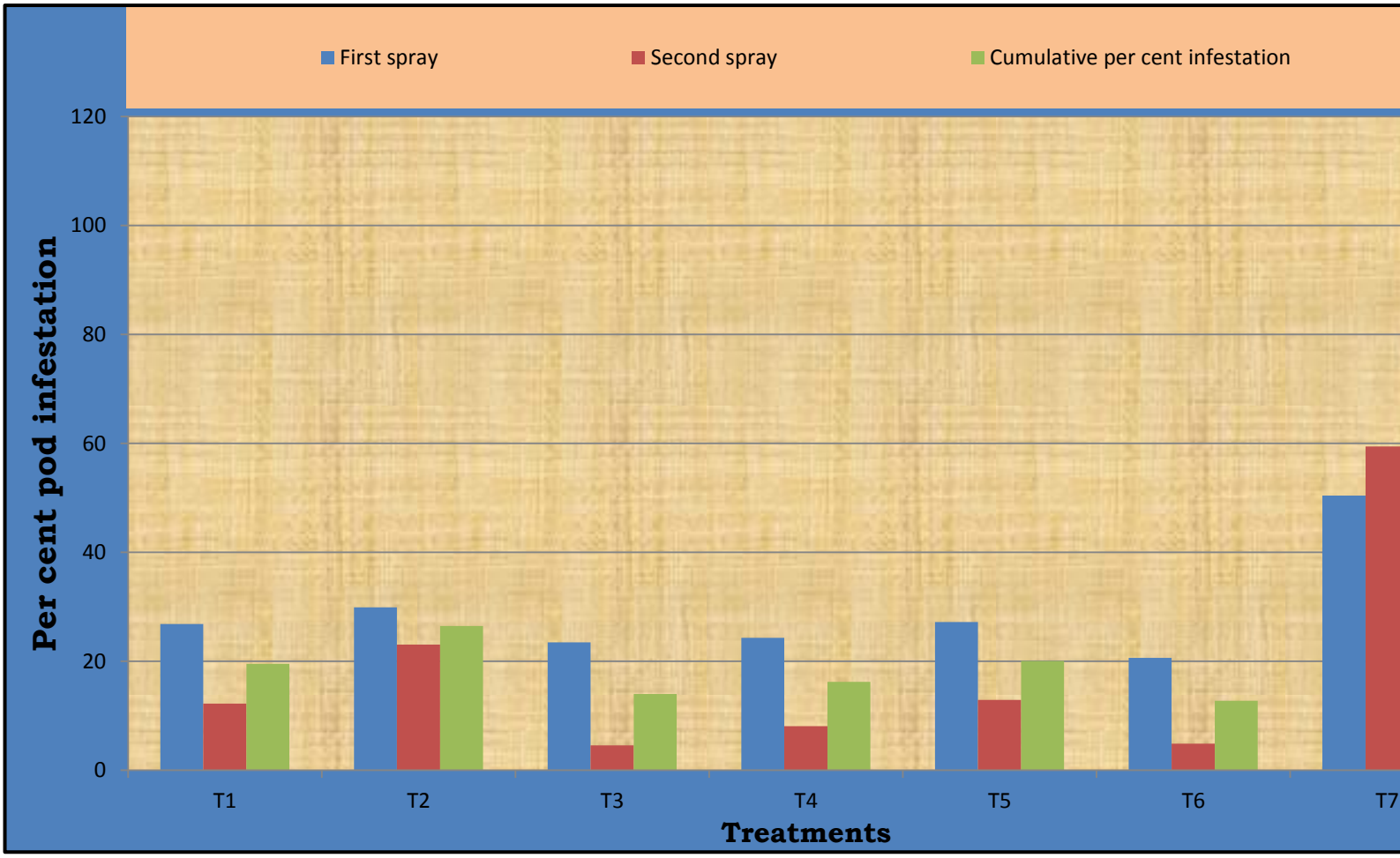


Fig.2: Mean population of aphids infesting dolichos weather parameters


First spray
Second spray
Cumulative per cent infestation
Per cent pod infestation
120
100
80
60
40
20
0
T1
T2
T3
T4
T5
T6
T7
Treatments