"Integrated Management of Gundhi bug, *(Leptocorisa varicornis Fabr.)* in Rice crop (*Oryza sativa L.)* under Rewa condition"

Thesis

Submitted to the

Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur

In partial fulfillment of the requirements for
The Degree of

MASTER OF SCIENCE

In

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(Entomology)

By

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Rewa (M.P.)

2013

CERTIFICATE-I

This is to certify that the thesis entitled **"Integrated Management of Gundhi bug, (*Leptocorisa varicornis Fabr.)* in Rice crop (*Oryza sativa L.)* under Rewa conditions"**

Submitted in partial fulfillment of the requirement for the degree of "**MASTER OF SCIENCE** in **AGRICULTURE"** of Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur is a record of the bonafide research work carried out by **Mr. Mahendra Singh Chouhan** under my guidance and supervision. The subject of the thesis has been approved by the Student's Advisory Committee and the Director of Instructions.

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

(Dr. M.R. Dhingra)
Chairman of the Advisory Committee

THESIS APPROVED BY THE STUDENT'S ADVISORY COMMITTEE

Chairman	**(Dr. M.R. Dhingra)**	…………….
Member	(Prof. M.A. Alam)	…………….
Member	*(*Dr.S.K. Tripathi)	……………...
Member	(Dr.A.K. Jain)	……………...

CERTIFICATE-II

This is to certify that the thesis entitled **"Integrated Management of Gundhi bug, (*Leptocorisa varicornis Fabr.)* in Rice crop (*Oryza sativa L.)* under Rewa conditions"** submitted by **Mr. Mahendra Singh Chouhan** to Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE** in **AGRICULTURE** in the **Department of Entomology,** College of Agriculture, Rewa (M.P.) has after evaluation been approved by the Student's Advisory Committee after an oral examination of the same.

Place: Rewa

Date: / / **(Dr. M.R. Dhingra)**

Chairman of the Advisory Committee

THESIS APPROVED BY THE STUDENT'S ADVISORY COMMITTEE

Chairman	**(Dr. M.R. Dhingra)**	…………….
Member	(Prof. M.A. Alam)	…………….
Member	*(*Dr. S.K. Tripathi)	……………..
Member	(Dr. A.K. Jain)	……………..

Head of the Department/Section	…………….
Director of Instructions	…………….

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College of Agriculture, Rewa (M.P.) ***(Mahendra Singh Chouhan)***

Date -------------

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LIST OF ABBREVIATIONS

cv	:	Cultivars
cm	:	Centimeter
%	:	Percentage
@	:	At the rate of
d.f.	:	Degree of freedom
DAP	:	Days after planting
et. al.	:	And other
&	:	And
FYM	:	Farm yard manure
g	:	Gram
kg	:	Kilogram
ha	:	Hectare
i.e.	:	That is
JNKVV	:	Jawaharlal Nehru Krishi Vishwa Vidyalaya
Max.	:	Maximum
Min.	:	Minimum
No.	:	Number
mm.	:	Millimeter
Fig.	:	Figure
Viz.,	:	Which is/are
Rh	:	Relative humidity
hr.	:	Hour

S.E. (m)	:	Standard error of mean
q/ha	:	Quintal per hectare
Anova	:	Analysis of variance
S.V.	:	Source of variation
MSS	:	Mean sum of square
DRR	:	Director of Rice Research
ETL	:	Economic Threshold Level
EIL	:	Economic Injury Level
GB	:	Gundhi bug
DH	:	Dead heart
WE	:	White ears
SS	:	Silver shoots
LFDL	:	Leaf folder damage leaf
WMDL	:	Whorl maggot damage leaf
CWDL	:	Case worm damage leaf

CHAPTER- I

Introduction

Rice is a monocotyledonous crop, belongs to the Family Poaceae (Graminae) and genus *Oryza.* It has two cultivated & 22 wild species. *Oryza sativa* and *Oryza glaberrima* are the cultivated species of rice. *Oryza sativa* is globally cultivated species, while *Oryza glaberrima* is cultivated in West Africa. The crop is grown under different agro climatic conditions and production systems. But, the most common practice is the transplanting method in puddled condition. It is a staple crop which is cultivated in diverse agro ecosystem in India and abroad. This crop occupies a key position in Indian Agriculture. About 60 to 65 % of the population at global & national level depends upon rice as a primary source of energy. Rice is cultivated mainly in Asian countries viz. India, China, Japan, Srilanka, Pakistan, Bangladesh etc. and more than 90 percent of the rice produce is consumed in these countries. The total area under the rice cultivation in the world is about 153.9 million ha, and the production is about 618 million tones. Amongst the rice producing countries, India occupies the first position with regard to the area (44.3 million ha), followed by China (29.3 million ha.). As far as productivity is concerned, India occupies 15th rank in the World with a productivity of 3.01 ton/ha (FAO 2006). Since India is far behind in term of productivity is comparison to many national and International level. Various factors has been attributed for low productivity in the country, But among them the cause of low productivity of the crop in our country are various. Biotic stress i.e. insect pests, diseases and weeds, are the main constraint. Among the biotic stress, insect pests are major factors for low yield, More than 100 pests have been recorded on this crop, which attack the crop right from germination to harvesting. There are a dozen pests which are recognized as a key or major pest of rice. Among the infesting insects, there is a group of sucking pests which caused havoc sometime back in various regions of the country. Brown plant hopper (*Nilaparvata lugens, Stal.*), White backed plant hopper (*Sogatella frucifera, Horvath*), Green leaf hopper (*Nephotettix nigropictus, Stal.)* and Gundhi bug (*Leptocorisa varicornis Fabr.*)] are the well known pests in different parts of country as well as in Madhya Pradesh from the group. Rewa is situated in the north-eastern part of Madhya Pradesh at latitude 24º31’ N, longitude 81º15’ E and altitude of 306.06 m above the mean sea level. The region falls under subtropical climate with extreme winter and summer seasons. The agro climatic condition of Rewa is suitable for rice–wheat cultivation. The annual average rainfall varied from 1100 to 1200 mm. with humidity ranging between 71 to 89 % which is suitable more or less for the development all kind of rice pests, but most suitable for the sucking pests, while are the responsible for stunted growth to complete wilting or drying up of the crop besides as acting vector of diseases like yellow mosaic & tungro etc. Gundhi bug (*Leptocorisa varicornis Fabr.*) is also one of them which is responsible for crop damage at vegetative and reproductive stage particularly at milky stage. It causes heavy losses from (68.7 to 98.7% with an average loss of 19.8%) in Madhya Pradesh. The severity of this pest has also been reported from Rewa district and need plant protection measures to save the crop, particularly by the ecofriendly approaches. The perusal of literature reveals that the studies so far conducted for the management of this pest, shows the missing of important aspects like effect of sowing/planting time and varieties & evaluation of cultivar/variety at local level besides testing of new molecules. Keeping these facts in view, the present study had been undertaken with the following objectives.

Objectives –

1. To identify the resistant genotypes of rice against Gundhi bug.
2. To study the effect of planting dates on the incidence of Gundhi bug
3. To study the efficacy of new insecticides against Gundhi bug.

CHAPTER-II
REVIEW OF LITERATURE

A brief resume work done in India and abroad

2.1: Screening of different cultivar:

Anand Prakash (1999). Rice grain sterility caused by infestations of rice earhead bug (*Leptocorisa acuta*) was studied in farmers' paddy fields in coastal Orissa, India for four wet seasons (1994-97) and under controlled conditions in the caged rice (cv. Ratna) plants in net house conditions from 1996-97. In the farmers' paddy fields, the mean percent grain sterility ranged from 6.08 to 14.77 along with the bug populations' range of 4.50 to 8.80 bugs/m^2. Under controlled conditions, infestation of first and second nymphal instars failed to cause any grain sterility. Feeding of the third, fourth and fifth nymphal instars and adults male and female caused grain sterility at all the three infestation levels (1, 2 and 5 bugs per panicle). Grain sterility caused by adult female bugs was higher than caused by the adult male, which varied with the different infestation levels.

Bhadauria and Singh (2009). Conducted field experiment during kharif 2004-05 and 2005-06 to determine the insect-pest complex of rice (c.v. kranti) in north west Madhya Pradesh in India to estimate the losses caused by the gundhi bug (*Leptocorisa acuta*). They reported significantly less population of gundhi bug in the protected plots than unprotected plots (7.6-33.2%) besides significantly less ear head damage in the protected plots than unprotected (68.7-98.7%).

Bhatnagar and Saxena (1999). Studies on the effect of climate on the population buildup of rice insect pests was studied using light traps in Jagdalpur, India, over 4 years (1994-97). Yellow stem borer (*Scirpophaga incertulas*), leaf folder (*Cnaphalocrocis medinalis*) and caseworm (*Nymphula depunctalis* [*Parapoynx stagnalis*]) maintained a low level during the first 3 months of the cropping season. Relatively higher moth numbers were trapped during October, with highest activity in the final week. *S. incertulas* numbers showed a significant negative correlation with minimum temperature, evening relative humidity and rainfall. *C. medinalis* showed a significant negative correlation with minimum temperature, evening relative humidity and rainfall and a positive significant correlation with sunshine hours and maximum temperature. Green leaf hopper

(GLH), *Nephotettix virescens*, had a significant negative correlation with minimum temperature, evening relative humidity and rainfall. Another species of GLH (*N. nigropictus*) also showed a negative significant correlation with minimum temperature, evening relative humidity and rainfall and a positive significant correlation with sunshine hours. *P. stagnalis* showed a negative significant correlation with evening relative humidity and rainfall, along with a positive correlation with sunshine hours. Similarly, rice gundhi bug, *Leptocorisa acuta* had a significant negative correlation with minimum temperature, evening relative humidity and rainfall and a positive correlation with sunshine hours and maximum temperature. Path analysis revealed that minimum temperature played an important role in population buildup of yellow stem borer, green leaf hoppers and gundhi bug, while sunshine hours and evening relative humidity were responsible for the population buildup of leaf folder and caseworm, respectively.

Dhaliwal, *et al.,* (2010). Insect pest problems in agriculture have shown a considerable shift during first decade of twenty-first century due to ecosystem and technological changes. While there has been an overall decline in the severity of *Helicoverpa armigera* (Hubner), the incidence of several other insect pests like mealy bugs, particularly *Phenacoccus solenopsis* Tinsley on cotton; sugarcane woolly aphid, *Ceratovacuna lanigera* Zehntner on sugarcane; and tobacco caterpillar, *Spodoptera litura* (Fabricius), on several crops, has shown an increasing trend. The diamondback moth, *Plutella xylostella* (Linnaeus), has consistently remained the most destructive pest of cruciferous vegetables. The global losses due to insect pests have declined from 13.6 per cent in post-green revolution era to 10.8 per cent towards the beginning of this century. In India, the crop losses have declined from 23.3 per cent in post-green revolution era to 17.5 per cent at present. In terms of monetary value, the Indian agriculture currently suffers an annual loss of about Rs 8, 63,884 million due to insect pests.

Mishra, *et al.,* (1991). In field studies conducted in India, of 53 varieties/cultures of rice, RR 19-2 and RR 50-3 were found to be most resistant to attack by *Leptocorisa varicornis* [*L. acuta*].

Prakash and Rao (1999). Age specific fecundity, life tables and intrinsic rate of increase of *Leptocorisa acuta* were studied on rice plants in a net-house in India during April-June 1994-96. Longevity of ovipositing females was 27-57 days, with an average of 44.5 days. The oviposition period was 4-20 days. The intrinsic rate of increase, rate of multiplication, generation time and finite rate of increase were: 1.105/female per day; 39.69 times; 35.05 days; and 1.110, respectively.

Prasad*, et al.,* (2003). A field study was conducted in Bihar, India during 1992 (in Madanpur) and in 1993 (in Ranchi) to evaluate the pest incidence in upland rice cv. Birsa Dhan-101 in relation to fertilizer application. The treatments included N: P: K at 60:60:0 kg/ha (N as basal), 60:60:60 kg/ha (N and K applied in 2 splits), 90:60:0 kg/ha (N as basal) and 90:60:60 kg/ha (N and K in 2 or 3 splits). N: P: K at 90:60:90 kg/ha was applied in combination with farmyard manure (FYM) at 10 t/ha (with N and K at 3 splits). N and K applied in 2 or 3 splits significantly decreased the incidence of stem borer (*Scirpophaga incertulas*), green leaf hopper [*Nephotettix virescens*] and earhead bug [*Leptocorisa acuta*], and increased the grain yield, compared to N applied as basal. Application of N at 90 kg/ha and K at 90 kg/ha resulted in low pest incidence and high grain yield. A basal dressing of FYM along with the split application of N and K each at 90 kg/ha resulted in the lowest pest incidence.

Rao and Prakash (1999). In a survey of paddy fields in eastern India during the rabi seasons of 1995-96, *A. nigripes* has been reported as a nymphal and adult predator of *L. acuta* (a pest of tropical rice) for the first time, with its predation ranging from 1.66 to 5.66 bugs per day. Incubation period of the eggs of *A. nigripes* was 4-6 days and its egg to adult life cycle completed through 4 different nymphal instar in 20-25 days. Males survived longer than females. Tabulated data on the life cycle of *L. acuta* are presented.

Singh, (2006). Seven spices, asafoetida, cardamom, cloves, nutmeg, garlic, ginger and cinnamon, and four plant products, basil leaf, neem oil, neem seed kernel extract and neem seed kernel powder, along with a control and chemical control methyl parathion dust were evaluated against rice gandhi bug in upland early rice cv. Birsa dhan 101 for four years (kharif 2000 to 2003) in Jharkhand, India. All the spices and plant products except garlic and cinnamon protect the rice crop up to two days after treatment (DAT). At 4 DAT nutmeg, ginger, cinnamon, and basil failed to protect the rice crop. At 6 DAT, all the spices except asafoetida were ineffective in reducing the bug population. Asafoetida moderately controlled the rice bug. The incidence and yield recorded with the application of neem products were at par with that observed with conventional insecticide treatment.

Takeuchi, *et al.,* (2005). The population dynamics of two major rice bug species in the fields of Italian ryegrass and gramineous weeds were compared in southern Ibaraki Prefecture, Japan from 2002 to 2004. Overwintered adults of *Leptocorisa chinensis* appeared in grass fields from late June to early July. Their progeny appeared soon, and the population fluctuation until October was bimodal. In contrast, overwintered adults of *Cletus punctiger* appeared much earlier, in early May, while the next-generation nymphs were seldom detected until late June. Based on the immigration dates of overwintered adults and the cumulative effective temperature for development and ovarian maturation, it was confirmed that *L. chinensis* is bivoltine in the study area. The first appearance date of first-generation adults of *L. chinensis* in grass fields did not coincide with the heading date of mid-season rice cultivated most widely in southern Ibaraki Prefecture. This reveals that current rice cultivation practices in this area are suitable to prevent the massive invasion of *L. chinensis*.

2.2: Effect of planting dates:

Bashir, *et al.,* (2010). Field experiment was conducted to evaluate the effect of different sowing dates on yield and yield components of the direct sown coarse rice during the Kharif season of 2008, at Agronomic Research Area, University of Agriculture, Faisalabad. Experiment comprised of six sowing dates i.e. 31st May, 10th June, 20th June, 30th June, 10th July and 20th July. Data on agronomic parameters and economics of coarse rice were recorded. Results revealed that direct seeded rice sown on 20th June proved to be the best for obtaining maximum grain yield and net return. 20th June sowing also gave maximum number of productive (panicle bearing) tillers, number of kernels per panicle, 1000-grain weight and benefit-cost ratio.

Gupta, *et al.,* (1993). *Leptocorisa acuta, L. oratorius, Nezara viridula, Dolycoris indicus, Gerris nitida* and *Horridipamera nietneri* were found infesting rice grains in the milky and dough stages in Orissa, India. *Leptocorisa* spp. damaged 1.72-5.23% of grains during the dry season and 2.5-6.21% during wet seasons. The pentatomids *E. ventralis* [*Eurydema ventralis*], *M. histrio* [*Menida histrio*] and *N. viridula* infested grains in rainfed upland and irrigated medium land paddy fields during both seasons only in Cuttack and Puri districts. The grain damage caused by these species was 3.24-14.98 and 3.11-11.96% during dry and wet seasons, resp. *G. nitida* only infested grains during wet seasons in lowland paddy fields in Puri district, causing 1.98-5.17% damage. *H. nietneri* infested grains in irrigated medium land and rainfed lowland fields in the Ganjam district and damaged 0.840-2.28% of grains during dry seasons and 1.60-4.65 during the wet seasons.

Girish, *et al.,* (2012). A study was conducted to monitor the population status of leaf hopper (*Nephotettix virescens*), Grasshopper (*Hieroglyphus banian*), Horned caterpillar (*Melanitis leda ismene*) and Ear head bug (*Leptocorisa acuta*) on upland rice at Agricultural Research Station, Mugad on three different rice planting methods *viz.*, transplanting, drill sowing and aerobic method during *Kharif* (June to November) 2010. The leafhopper appeared in the vegetative phase of the crop growth and disappeared during reproductive phase of the crop. Their population was significantly high in drill sown rice, followed by transplanted and least in aerobic method. However, the incidence was low and almost static throughout the period of incidence. The grasshopper population starts appearing at late vegetative phase of the crop, attained their peak at 75 days after sowing (DAS) and remained there up to maturity with a marginal incidence level in all the three planting methods. The horned caterpillar appeared at 45 DAS, attained peak at 75 DAS and disappeared at 105 DAS. Transplanted rice supported significantly higher population compared to other planting methods. Ear head bug population appeared during reproductive phase of the crop and as such there was no significant difference in the population of bug between the planting methods.

Khalifa and El-Rewainy (2012). Field research was conducted for 2 year 2009 and 2010 to evaluation in between rice varieties (*Oryza sativa* L.) under different sowing dates. at Rice research and training center (RRTC)-Sakha, Kafr-El sheikh, governorate, Egypt. To study five new rice varieties, Sakha 106, Sakha 105, G.Z 7576, G.Z. 9057 and G.Z. 9362 under five sowing dates April 1st, April 10th April 20th, may 1st and may 10th. Seedling age at transplanting was 26 days from sowing and planting spacing 20x20 cm in between hills. All agricultural practices were applied as recommended for each cultivar. As split plot design and four replication were used, five sowing dates allocated in the main plots, and five rice varieties were allocated in sup-plots. Main results induced that sowing date at April 1st gave the highest value on number of days from sowing up to maximum tillering, panicle initiation and flowering dates. And also Rote length(cm), leaf area index, No. of tillers/hill at PI, Chlorophyll content at H.D, Number of tillers/M^2 t maturity stage, Panicle length (cm), Number of grains/panicle, 1000-grains weight(g) and Grains yield/ha except light penetration it was the lowest value. While may 10th gave the lowest value for all Preview attributes. As Sakha surpassed other varieties under study to all previous attributes whoever G.Z. 9362 gave the lowest value.

Rao and Prakash (1990). In a survey of paddy fields in eastern India during the rabi seasons of 1995-96, *A. nigripes* has been reported as a nymphal and adult predator of *L. acuta* (a pest of tropical rice) for the first time, with its predation ranging from 1.66 to 5.66 bugs per day. Incubation period of the eggs of *A. nigripes* was 4-6 days and its egg to adult life cycle completed through 4 different nymphal instar in 20-25 days. Males survived longer than females. Tabulated data on the life cycle of *L. acuta* are presented.

Reji and Chander (2008)**.** The rice bug, *Leptocorisa acuta* (Thunb.) is a major pest of the rice crop in India. A computer simulation model of the bug's population dynamics was formulated using the information generated on the thermal requirements of development stages. It is a mechanistic model which follows the state variable-rate variable approach. The model works based on the accumulation of heat units over stage-specific thresholds of development. Validation using light trap catches has shown that the model has satisfactory predictive value. Simulated population dynamics over the years were compared and the influence of global warming on bug population dynamics was predicted. The model can forecast the pest population in the field and help in timely adoption of management practices.

Sachan, *et al.,* (2006*).* A survey was conducted during the crop seasons of 2000-02 to determine the insect fauna associated with basmati rice, along with their nature of damage, seasonal incidence and economic importance, in Tarai region of Uttar Pradesh, India. A total of 28 insect species were recorded. The yellow stem borer, *Scirpophaga incertulas* (July-October), leaf-folder, *Cnaphalocrocis medinalis* (August-September), and brown planthopper, *Nilaparvata lugens* (August-September), were found as major pests. The striped stalk borer, *Chilo suppressalis* (July-October), gundhi bug, *Leptocorisa acuta* (September-October), white-backed planthopper, *Sogatella furcifera* (August-September), green leafhopper, *Nephotettix virescens* (August-September), grasshoppers, *Hieroglyphus banian* and *Atractomorpha crenulata* (August-October), and root weevil, *Echinocnemus oryzae* (July-September), were found moderate.

2.3: Efficacy of insecticides:

Anonymous (2007). Three spray formulations were compared with the standard check insecticide Monocrotophos (Monocrown 36 WSC) @ 500 g.a.i/ ha. An untreated control without any insecticide application was also included for comparison. The insecticide was applied at different locations on need basis. However, it has been suggested to give an initial application at about 10 DAT to assess the efficacy of the treatments around 25 to 30 DAT. The insecticide were applied as high volume spray @ 500 litres of spray fluid/ha. The observations on insect pests were recorded as per standard procedures. In case of gundhi bug the population of the pest after three days of treatment and damage were assessed. At the time of harvesting, the gundhi bug infestation was low at Rewa and all the insecticides were moderately effective (2.0 to 3.3 Adult&Nymph/10 hills) compared to untreated control (14.3 Adult&Nymph/10 hills).

Anonymous (2008). Efficacy of Flubendiamide 36% + Fipronil 30% (@ 33 g. a.i./ha.), Flubendiamide (Fame) 39.35 SC (@25 g.a.i./ha), Fipronil (Reagent 5 sc) @50 g.a.i/ha, besides the standard check, Monocrotophos 36 WSC (@ 500 g.a.i./ha.) and untreated control treatment at Rewa, Madhaya Pradesh were tested against gundhi bug. Lowest population of gundhi bug was recorded in insecticides treated plot (1.5 to 2.8 Adult,Nymph/10 hills) as compared to untreated control (13.8 Adult,Nymph/10 hills), Least grain damage (11.2%) was observes in Monocrotophos treated plot. ,while,in rest of treatments including untreated control there were non significant difference in the damage(26.8 to 35.3%).

Anonymous (2009). Three never insecticides formulations, one combination product viz. a new pre-mixture insecticides Flubendiamide 4%+Buprofezin 20% SC @ 875 ml/ha. (35 g.a.i + 175 g.a.i/ha.) and two single product viz. Dinotefuron 20 SG @150 and 200 g.a.i./ha.(30 and 40 g.a.i). A new formulation of acephate, Acephate 95% SG (RIL-059/FL 95% SG),@562.2 g.a.i/ha. Was evaluated. The combination product, Flubendiamide 4% + Buprofezin 20% SC is target against broad spectrum pest complex of pests of rice, as the components. In case of Gundhi bug, the population of the pest after three days of treatment and percentage grain damage were recorded. Gundhi bug populations recorded at Chinsurah and Navasari were low in insecticide treatments (1.3 to 2.8 Nymph&Adult/10 hill) compared to untreated control (6.8 Nymph&Adult/10 hill).

Anonymous (2010). Two new insecticides i.e. a combination product viz. an insecticide pre-mixture, Buprofezin 20 % + Acephate 50 % (RIL- 049) at three dose (800-900 and 1000 g/ha.), a new formulation of acephate. Acephate, 95% SG (RIL-059/F1 95% SG) @ 562 g. a. i./ha, These two newer insecticides compared with buprofezin (Applaud 25 SC), Acephate 75% SP and standard check insecticide Monocrotophos 36% WSC and an untreated control treatment plot. Population of Gundhi bug at Rachi were significantly lower in Monocrotophos (1.3 bugs/10 hills), combination product treatments (2.0 to 3.3 bugs/10 hills) as well as acephate treatment (4.0 to 5.7 bugs/10 hills), compared to buprofezin (11.7 bugs/10 hills) and control (15.3 bugs/10 hills) which were at par.

Chen, (1992). The life cycle of *Leptocorisa acuta*, a pest of rice in Hainan, China, is described. Synthetic pyrethroids (20% fencyclate [of unknown composition], 10% cypermethrin and 2.5% deltamethrin) produced >90% mortality. Natural enemies recorded were ants, spiders, beetles (including ladybirds [Coccinellidae]) and *Telenomus* sp.

Durairaj and Venugopal (1993). Several extracts of neem and *Vitex negundo* were tested for their effectiveness, compared with that of malathion, against *Leptocorisa acuta* on rice in the field in India. The plot treated with 0.05% malathion showed a reduction in pest incidence of 86.2%, followed by 0.5% Neemark (82.8%), 2.0% neem oil (69.0%), 2.5% and 5.0% *V. negundo* leaf extract (50.7 and 38.0%, resp.), and 5.0% neem seed kernel extract (39.0%).

Dhingra, *et al.,* (2003). Assessed the field efficacy of new combination product of different insecticides and found Acephate 45% +cypermethrin5% (@500ga.i./ha.) and Beta cyfluthrin (@12.5 g a.i./ha), + chloropyriphos 250 a.i./ha(@262.5 g a.i./ha.) effective aganist gundhi bug under field condition.

Monocrotophos 36% SL (Devi) were conducted in Cachar district of Assam to see its efficacy against the pest. Among pesticides tested Monocrotophos 36% SL (0.2%) recommended dose showed 95.28% reduction of pest population on 1st day of treatment followed by malathion (87.61%), endosulfan (85.71%) and phosphamidon (85.83%). The spray of monocrotophos 36% SL (0.2%) and Phosphamidon 40% SL (0.2%) proved better performances upto 15th day of treatment against the pest species with 85.71% and 78.68% reduction rates respectively. Monocrotophos 36% SL (0.1%) also gave good result upto 15th day of treatment with 75% mortality rate. Both concentration of Malathion 50% EC proved to be the least effective with 11.33% reduction of pest population with lower dose and 50.09% with recommended dose at 15th day of treatment.

Devi and Ray (2010). The bio-efficacy of pesticides and bio-pesticides against *Leptocorisa acuta* (Thunb.) (Hemiptera: Alydidae), was studied in Cachar district of Assam. Among pesticides tested viz., fenvelerate 20% EC (tatafen) (0.1%) and mixture of pyrethroids chlorpyrifos 50% EC+cypermethrin 5% EC (fighter-505) (0.003%) proved better performance upto day 15 of application against the pest species with cent percent reduction rate. Quinalphos 25% EC (flash) proved to be the least effective group. As regards the bio-efficacy of bio-pesticides prithvi's (garlic gold) was the most effective group with 81% reduction followed by achook (azadirachtin 0.03%) which afforded reduction 79.29% and sonata (plant origin) gave 78.32% reduction upto day 7 after treatment. Statistical analysis proved non-significant effect among the treatments.

Jena, *et al.,* (2012). A study was conducted during *kharif* of 2010 in Odisha to evaluate the effectiveness of some integrated pest management modules against major insect pests of rice. In Odisha the major insect pests invading the rice and causing severe loss in rice production are yellow stem borer (*Scirpophaga incertulas*), leaf folder (*Cnaphalocrocis medinalis*), whorl maggot (*Hydrellia philippina*), hispa (*Dicladispa armigera*), brown plant hopper (*Nilaparvata lugens*), white-backed plant hopper (*Sogatella furcifera*), and gundhi bug (*Leptocorisa acuta*). Treatments were: chemical based module IPM1 (Application of carbofuran 36 at 1.0 kg ai/ha); Non-chemical based module IPM2 (Installation of yellow stem borer (YSB) pheromone traps 5mg lure at 20/ha + field release of *Trichogramma japonicum* 1,00,000 parasitized *Corcyva* eggs/ha at 30 and 45 DAT); chemical + Non-chemical based module, IPM3 (Application of carbofuran 3G 1.0kg a.i/ha at 20 DAT + installation of YSB pheromone traps 5mg lure at 20/ ha + release of *Trichogramma chilonis* at 1,00,000 parasitized *Corcyva* eggs at 30 and 45 DAT); and farmers practices IPM4 (Application of monocrotophos 36 WSC at O.5Kg ai/ha at 50 and 65 DAT). Results revealed that IPM3 resulted in the lower incidence of stem borer (03.38% dead heart and 11.50% white ear head), whorl maggot (11.84% damaged leaves), leaf folder (04.20% damaged leaves) hispa (0l.66% damaged leaves), gundhi bug (01.74/m2), white backed plant hopper (8.7 hoppers/clump), brown plant hopper (7.45 hoppers/clump), caseworm (1.26% damaged leaves) and produced the highest grain yield (08.92 t/ha) with cost: benefit ratio (1:3.08).

Kushrestha and Nigam (1987). Dusting with malathion, BHC or folidor dust 20 kg/ha, when bug population reach two insect per square meter is suitable for the control of this pest. Benerjee, (1975). Found that L. acuta is effectively controlled by the application of DDT or BHC dust or spray of aldrin or chloradane phenthote 92 % U.L.V. gave better reduce of the pest (Ahmmed et. al) U.L.V spraying of lindane and dichlorovas 500 g.a.i/ha, effectively reduced the population. Nigam and Kumar (1982). Found 5% malathion dust 20kg/ha, significantly superior to 4% endosulphan, 5% BHC, 5% aldrin and 5% gardona dust.

Krishnakumar and Visalakshi (1989). The toxicity of 12 insecticides to adults of *Leptocorisa acuta* was determined in the laboratory. Malathion was the most toxic (LC50 0.00575), followed by formothion, fenthion, methyl-parathion [parathion-methyl],phosphamidon,fenitrothion, monocrotophos, dimethoate, phosalone, carbaryl, quinalphos and HCH (with LC50s of 0. 00583, 0.00592, 0.00729, 0.00952, 0.01603, 0.01762, 0.01864, 0.03282, 0.03540, 0.03911 and 0.04180, resp.).

Krishnaiah, *et al.,* (1994). Cartap granules were superior to carbofuran in quick knockdown kill (mortality within 0.5 to 5 hour) and persistent toxicity. Cartap spray showed knockdown ill similar to Monocrotophos and exhibited superior persistent toxicity over Monocrotophos. Field observations on GLH infestation at Patna during.

Krishnaiah, *et al.,* (1996). In green house studies buprofezin at a concentration of 0.1% exhibited high degree of persistent toxicity to nymph of rice brown plant hopper (BPH) but moderate against green leaf hopper (GLP).

Synthetic pyrethroids, cypermethrin (0.005%) and deltamethrin (0.0025%) showed moderate efficacy agaist BPH and WBPH but were highly effective against GLP. The combinations of cypermethrin + buprofezin and deltamethein + buprofezin were highly effective against all the three hopper pests. Buprofezin was safe to nymph and adults of mired bug (MB) but synthetic pyrethroids and combination treatments were relatively more toxic to MB. In field studies, cypermethrin (50 g.a.i/ha and deltamethrin 25 g.a.i/ha) caused BPH resurgence but, when used in combimation with buprofezin (100 g.a.i./ha) resulted in good control of BPH and leaf folder similar or superior to Monocrotophos (500 g.a.i/ha) without detriment to the predatory mired bug. In view of relatively low mammalian toxicity, combinations of cypermethrin + buprofezin and deltamethein + buprofezin can be used effectively against BPH,GLP and leaf folder in integrated pest management programs in rice.

Kumar Vinod, *et al.,* (2009). Efficacy of insecticides against gundhi bug (*Leptocorisa acuta* Thumb.) in rice (*Oryza sativa*) was assessed in field. The experiment had 9 treatments, viz. thimet 10 G, furadan 3 G, thiodan 4 D, malathion 5 D, carina 50 EC, calfos 45 EC, rocket 44 EC and Neem oil along with control (untreated) in a randomized block design replicated four times. Insecticides, viz. malathion was quite effective to reduce gundhi bug population closely followed by rocket. Other insecticides were less effective but were better over control. Highest grain yield of 2.320 t ha^{-1} was recorded with application of colfos, closely followed by thiodan (2.311 t ha^{-1}) and furadan (2.281 t ha^{-1}). Neem oil was least effective in reducing incidence of gundhi bug in rice crop.

Kaushik Chakraborty (2011**).** Extent of suppression of rice ear head bug (*gundhi bug*), *Leptocoryza acuta* Th. population by six selected neem formulations were carried out in the field of paddy cultivar *Swarna mashuri* (MTU 7029) during four consecutive *kharif* crop seasons of 2005-2008 at Raiganj, Uttar Dinajpur, West Bengal, India. Apart from this there is a plot with no pesticide application considered as control. Experiment was laid out in randomized block design and had three replications for each year. All the treatments were effective significantly to suppress *L. acuta* incidence and accordingly the extent of grain damage. Chaffy grain formation due to *L. acuta* infestation was also minimized in all cases. Numerically least damage with minimum *L. acuta* incidence was noted from the field treated with monocrotophos 36 WSC (1.46 adult +2.01 nymphs/5 hills and 2.41 chaffy grains). This was followed by commercial formulation of nimbecidine (5%), neem oil (2%), neem seed kernel extract (5%), neem leaf extract (5%), neem root extract (5%) and neem bark extract (5%) in descending order. The pesticide untreated plot has registered 4.73 adult +8.62 nymphs' population/5 hills and 33.81% chaffy grains. In consideration of yield increase over control, maximum efficacy was registered when monocrotophos 36 WSC was applied @ 1125 ml/ha. This was followed by commercial formulation of nimbecidine, neem oil, neem seed kernel extract, neem leaf extract, neem root extract, neem bark extract in descending order.

Mishra, (1999). Studid the efficacy of two organophosphate i.e. malathion & phosphamidon, two neem products i.e. multineem & RD-9 repelin and a fermented snails against the Rice gundhi bug. Fermented snails which was used as a bait, controlled the gundhi bugs effectively. He found the lowest infestation of 8.37 percent in this treatment. It was also found at par with the neem product, i.e. multineem.

Mishra, (2003). The efficacy of fenobucarb, imidacloprid, malathion, carbaryl, abamectin and dichlorvos against the gundhi bug, *Leptocorisa* sp. infesting rice cv. Jaya was determined in a field experiment conducted in Orissa, India during the kharif season of 2000. All the insecticides reduced the number of gundhi bugs one day after spraying, and provided better control of the pest compared to the control. No significant differences in the number of bugs observed after the insecticidal treatments were observed, although spraying with dichlorvos resulted in the highest yield of the crop.

Pangtey (1990). Field studies were conducted in Nagaland, India, during 1978-79 to determine the efficacy of 7 insecticides to control the coreid *Leptocorisa acuta* infesting rice. Malathion dust applied at 1 kg a.i./ha was the most effective insecticide (as determined by the highest rice yield, 48.23 qt/ha) during 1978, followed by BHC [HCH] dust applied at 1 kg a.i./ha (43.75 qt/ha) and parathion-methyl dust applied at 1 kg a.i./ha (43.25 qt/ha). Malathion dust applied at 1 kg a.i./ha was also the most effective insecticide during 1979 (40.49 qt/ha), followed by carbaryl dust applied at 1 kg a.i./ha (39.80 qt/ha) and endosulfan dust applied at 1 kg a.i./ha (39.34 qt/ha).

Ramudu and Misra (2005). Field experiments were conducted in

Orissa, India, during the 2004 and 2005 kharif seasons, to study the residual effects of 3 rounds of spray of 9 insecticides, i.e. clothianidin 50 WDG, flubendiamide 20 WDG, flubendiamide 480 SC, lambda -cyhalothrin 5 CS, indoxacarb 15 EC, acetamiprid 0.4% + cypermethrin 2% EC, acetamiprid 0.4% + quinalphos 20% EC, acetamiprid 0.4% + chlorpyriphos 20% EC and monocrotophos 36 WSC (control) at 15, 25, 24, 12.5, 30, 60, 510, 510 and 500 g a.i./ha, respectively, against the rice gundhi bug (*Leptocorisa* spp.) incidence. The results revealed that among the insecticides evaluated, significantly lowest bug population was observed (1.31-3.35/m^2) in clothianidin and the combination products involving acetamiprid with quinalphos/chlopyriphos and monoctorophos treated plots. The highest percent reduction (43.22-77.80) in the bug population over the control was recorded in these insecticide treatments during both seasons of field testing compared to the other insecticides.

Revathy and Binoy (2010). Laboratory bioassay of four commonly used organophosphate insecticides against the rice bug, *Leptocorisa acuta* Thunb showed that dimethoate was the best, followed by triazophos, profenofos and chlorpyrifos.

Ray and Devi (2011). The rice Gundhi bug, *Leptocorisa acuta* (Thunb.) (Hemiptera: Alydidae) is one of the serious pest of rice in all rice growing tracts of India, which can reduce yield by as much as 30-40% and sometimes total lost at the time of severe infestation. A field trial of four pesticides *viz.*, Endosulfan 35% (Endocel), Malathion 50% (Kunamala 50), Phosphamidon 40% SL (Kinadon plus).

Sudhakar, *et al.,* (1993). The rice earhead bug, *Leptocorisa sp.* commonly called Gundhi bug, has become serious in Telangana zone of Andhra Pradesh. Farmers field were surveyed for ear head bug damage. Damage varied from 23-100% in situations where control measure was not undertaken, while it was 0.5-2.9% in fields treated with insecticides in time (milky grain hardening stage). Experiments conducted on different dates of planting indicated that the damage was higher in September-October. The yield was nil when the crop flowered during this period. Monocrotophos, Endosulfan, Malathion, Repelin, Neemgaurd and Carboryl were assessed for their effectiveness in controlling the rice ear head bug.

Saha, *et al.,* (2005). A survey was conducted in 2002-03 in Midnapur, West Bengal, India to determine the bottlenecks of rice production with special emphasis on biotic constraints. The crop was surveyed from seedbed to maturity stage. Pest levels and crop damage were recorded from three fixed plots at each block. The intensities of the diseases and pests were low to moderate, with sheath rot (*Sarocladium oryzae*) and yellow stem borer (*Scirpophaga incertulas*) being the highest, respectively. Weeds such as *Cyperus rotundus, Cynodon dactylon* and *Cyperus iria* were also observed. Sheath blight (*Rhizoctonia solani*) and rice bug (*Leptocorisa acuta*) and green leafhopper (*Nephotettix* sp.) were the next major disease and insect pests next to sheath rot and yellow stem borer. Most of the farmers did not use any pesticides for their control. Although some farmers use acephate, propiconazole or validamycin sprays to control sheath blight and sheath rot insect-pest.

Singh, *et al.,* (2009). A field trial was conducted during the kharif season in Madhya Pradesh, India, to determine the efficacy of insecticides (malathion, Multiplex (neem product), beta-cyfluthrin, thiacloprid, phosphamidon and monocrotophos) and an untreated control against rice gundhi bug (*Leptocorisa varicornis* [*Leptocorisa acuta*]) on rice cv. Basmati. Data on the effect of the different treatments on gundhi bug population (before and after spraying), grain damage (%) and grain yield of rice (q/ha) are tabulated. In 2000, all treatments, except Multiplex recorded significantly superior yield over the control. Grain yield ranged from 13.47 q/ha (control) to 21.17 q/ha (thiacloprid-treated rice). The pooled data showed that all treatments gave significantly higher yield than the control (13.13 q/ha). The lowest grain damage and highest grain yield were recorded in the thiacloprid treatment, followed by beta-cyfluthrin treatment.

Verma and Gupta (2001). In a field experiment, seven emulsifiable concentrate insecticides @ 250 ml a.i./ha were sprayed after 45 and 60 days of transplanting the paddy crop against *Cnaphalocrocis medinalis* Gn. The spray of quinalphos and phosphamidon effectively reduced the pest population up to 88.17 and 87.44 percent and consequently increased the yield of paddy by 17.92

and 16.24 q/ha. The percent reduction of pest population and corresponding increase of paddy yield q/ha by other treatments was as follows: fenthion (82.24, 13.68); chlorpyrifos (80.00, 9.96); lindane (79.91, 8.72); oxydemeton-methyl (79.91, 8.44) and phenthoate (74.81, 6.20). At the milky stage of the paddy crop, the spraying of phosphamidon @ 250 ml/ha after 3 and 5 days of spraying was found to be most effective in reducing the incidence of gundhi bug *Leptocorisa varicornis* [*Leptocorisaacuta*].

Vinod, *et al.,* (2009). Efficacy of insecticides against gundhi bug (*Leptocorisa acuta* Thumb.) in rice (*Oryza sativa*) was assessed in field. The experiment had 9 treatments, viz. thimet 10 G, furadan 3 G, thiodan 4 D, malathion 5 D, carina 50 EC, calfos 45 EC, rocket 44 EC and Neem oil along with control (untreated) in a randomized block design replicated four times. Insecticides, viz. malathion was quite effective to reduce gundhi bug population closely followed by rocket. Other insecticides were less effective but were better over control. Highest grain yield of 2.320 t ha^{-1} was recorded with application of colfos, closely followed by thiodan (2.311 t ha^{-1}) and furadan (2.281 t ha^{-1}). Neem oil was least effective in reducing incidence of gundhi bug in rice crop.

CHAPTER-III

MATERIAL AND METHODS

The present investigation entitled **"Integrated Management of Gundhi bug (*Leptocorisa varicornis Fabr.)* in Rice (*Oryza sativa L.)* under Rewa conditions"** was undertaken at College of Agriculture, Rewa Madhya Pradesh**.** The details of material and methods applied during the investigation are described in this chapter.

Experimentation site:

The experiments were conducted under All India Co-ordinated Rice Improvement Project. JNKVV, College of Agriculture Rewa (M.P.) during *Kharif* 2012 The experimental site was the representative of major rice growing area of the region. The experimental field was levelled and all the required facilities including irrigation, transportation etc, were also available on the site.

Climate:

Rewa is situated in the north-eastern part of Madhya Pradesh at latitude 24º31' N, longitude 81º15' E and altitude of 306.06 m above the mean sea level. The region falls under subtropical climate having extreme winter and summers seasons.The weather conditions throughout the crop season were more or less quite favourable for growth and development of the crop. The weekly maximum and minimum temperatures, rainfall, relative humidity, number of rainy days, number of bright sunshine hours and wind velocity during crop growth beginning from 23rd standard week to 46th standard week, 2012 are presented in Table 3.1 and graphically illustrated in Fig.1.

Tab 3.1: Weekly meteorological data during *Kharif* season 2012-13

SMW	Rainfall (mm)	Temperature °C		Humidity %	Bright S.S.
		Max.	Min.	Max.	(hr.)
23	0.00	41.20	24.60	71.00	9.30
24	2.40	38.90	24.40	74.70	8.30
25	30.60	37.80	26.50	81.00	6.70
26	200.60	30.50	22.90	91.10	3.10
27	74.80	31.08	23.80	87.10	4.40
28	120.60	30.20	24.10	85.00	3.90
29	166.80	30.70	22.40	88.28	1.71
30	122.0	28.80	22.90	89.00	1.77
31	107.60	29.20	22.40	86.85	4.60
32	48.00	31.97	22.90	86.00	4.40
33	140.00	30.62	22.40	86.20	1.70
34	57.00	30.80	24.30	85.00	5.08
35	101.12	30.10	24.51	88.20	3.90
36	101.12	30.10	23.60	87.00	4.37
37	0.00	32.10	21.80	83.10	6.60
38	21.20	33.57	21.80	84.20	6.20
39	0.00	33.20	20.00	86.00	8.10
40	0.00	32.10	18.20	87.20	8.50
41	0.00	32.20	18.50	87.00	8.02
42	0.00	31.20	17.20	85.12	7.35
43	0.00	29.80	14.20	80.30	7.20
44	0.00	29.80	13.10	83.30	5.80
45	0.00	28.80	11.20	82.20	7.02
46	0.00	28.30	10.40	80.00	6.60
Total	1293.84				

Source: Meteorological observatory, College of Agriculture Rewa (M.P.)

Soil of the experiment field:

In order to determine the textural class and fertility status of the soil of the experimental area, 10 soil samples drawn from 15 cm depth, randomly collected from the whole field with the help of soil agar before the experimentation. These soil samples were thoroughly mixed together to prepare a composite sample. Requisite quantity of the composite sample was taken and form it subjected to analysis for physio-chemical properties as per standard methods.

The values, obtained from the soil analysis are presented in Table 3.2.

Tab 3.2: Physio-chemical properties of soil of experimental field.

Properties	Value	Method used
A. Mechanical composition		
Sand (%)	30.4	International Pipette method (Piper, 1967)
Silt (%)	32.4	
Clay (%)	35.6	
B. Chemical composition		
Organic carbon (%)	0.62	Walkely & Black rapid titration method (Black, 1965)
Available N (kg/ha)	236	Alkaline permanganate method (Jackson, 1967)
Available P (kg/ha)	18.5	Colorimetric method (Olsen *et al.,* 1954)
Available K (kg/ha)	352	Flame photometer (Jackson, 1967)
Soil pH (1:2.5 soil water ratio)	7.11	Glass electrode pH meter (Piper, 1967)
Electrical conductivity (ds/m)	0.29	Solubridge (Black, 1965)

Cropping history of the field:

The cropping history of the experimental field for last six years is given in Table 3.3.

Tab 3.3: Cropping history of the experimental field:

Year	Rainy	Winter	Summer
2006-07	Rice	Wheat	Fallow
2007-08	Rice	Wheat	Fallow
2008-09	Rice	Wheat	Fallow
2009-10	Rice	Wheat	Fallow
2010-11	Rice	Wheat	Fallow
2011-12	Rice	Wheat	Fallow
2012-13	Present experiment	....	....

Traditional method of rice cultivation was adopted for experiment purpose:

Sowing of the nursery was done on 30/07/2012, 02/08/2012 and 18/08/2012 for experiment 1st, 2nd and 3rd respectively. Raised seed bed was prepared above 10 cm of the ground level with 1 meter wide and 20 meter long. Vermi compost 1 kg/sq. meter was thoroughly mixed. After mixing the vermin compost, seed sown 100-125 gm/sq. meter and covered with fine of compost mixed soil.

Transplanting:

The 22-27 day old seedlings were transplanted in well puddled experimental field. Two seedlings per hill were transplanted manually. The plant spacing and fertilizer application were as per scheduled above.

Fertilizer Application:

Nitrogen was applied through urea in three split doses. Half dose of N was given as basal at the time of transplanting; remaining half dose of N was applied in two equal doses as top dressing at tillering and panicle initiation stage of the crop. Phosphorous and potash were applied through DAP and Murate of potash respectively as basal dose before the transplanting in each plots.

Weeding and Interculture operations:

Field was dominated by weeds like *Echinochloa crusigalli, Commelina benghalensis*, *Eclipta alba* and *Cyperus iria.* Therefore, two hand weeding was done at 25 days & 40 days after transplanting.

Grain yield (q/ha):

The yield of grains obtained from each net plot was recorded in kilograms after sun drying of grains and the grain yield per plot was converted into quintal per hectare.

Per cent incidence of gundhi bug in rice cultivars:

The total number of panicle per hill and the total number of infected panicles per hill were observed for each variety. Nine observations were taken randomly from each variety. Per cent incidence of gundhi bug in panicles per hill or per cent infested tillers were calculated using following formula-

$$\text{Per cent grain damage} = \frac{\text{Damage grain/ panicles}}{\text{Total grain/ panicles}} \times 100$$

The percent reduction in the population was calculated by using the formula given below.

$$\text{Percent reduction in pest population} = \frac{\text{Population of pest before treatment} - \text{Population of pest after treatment}}{\text{Population of pest before treatment}} \times 100$$

The data collected on the population were transformed to square root by using the following formula given below.

X=x+0.5

Statistical analysis:

Wherever required the experimental data were analyzed using RBD designs.

The skeleton of Anova for RBD is given below-

Source of Variation	D. F.	S. S.	M. S.	F ratio
Replication				
Treatments				
Error				
Total				

All the statistical analysis were done in the Department of Agricultural Statistics, JNKVV, College of Agricultural Rewa.

Symptoms of insect infestation:

Gundhi bugs belong to the order Hemiptera and family coriedae. It has piercing and sucking type of mouth parts. The damaging stages of the insects are nymph and adults. They infest the crop at both vegetative and panicle stages. When the insect infest the crop at vegetative stage, it causes whitish spots on the leaf blades. The symptom of damage at panicle stage particularly at milky stage is characterized by the discoloration of the panicle and the presence of some chaffy grains along with black to brownish spots around the feeding site.

The experimental details for various objectives are given below-

Expt.1: Screening of different paddy cultivar against Gundhi bug.

Experimental design	:	Augmented
Replication	:	Non replicated
Plot Size	:	One row of 20 hills (11 m.x3 m.)
Plant Spacing		
Row to row	:	20 cm.
Plant to plant	:	15 cm.
Fertilizer dose	:	120:60:30 Kg NPK/ha.
Date of sowing	:	13-07-2012
Date of Transplanting	:	08-08-2012
Seedling age	:	27 days
Genotype	:	55

Fifty five rice cultivars were screened against gundhi bug under natural conditions during Kharif 2012. Twenty seven days old seedlings were transplanted in one row, consisting of 20 hills. Other details like plant spacing, fertilizer application and design followed are described above-

Observation: Rice gundhi bug populations per 5 hills was recorded at the milking stage of the crop as per IRRI, Philippines procedure and evaluated on the basis of 0-9 scale.

Tab3.4: IRRI, Philippines on basis of the 0-9 Scale.

Damage score (Scale)	Percent damage
0	Nill
1	Less than 3
3	4-7
5	8-15
7	16-25
9	26-100

Method of observation: Observations were recorded as per following schedule

(i) Five hills per row and 5 panicles/hill were selected and tagged for recording the infestation of the pest.

(ii) No. of damaged panicle/hill.

(iii) No. of grain per damaged panicle.

(iv) No. of damaged grain per panicle.

Expt.2: Effect of planting dates on the incidence of Gundhi bug.

Experimental design : Randomized Block Design

Treatments : Three dates of sowing

1. Early
2. Normal
3. Late

Replication : Ten

Plot Size : 50 sq. m. (10x5m)

Plant spacing

Row to row : 20 cm.

Plant to plant : 15 cm.

Fertilizer dose : 120:60:30 Kg NPK/ha.

Time of nursery sowing : Three dates

1. Early sowing (03-07-2012)
2. Normal sowing (18-07-2012)
3. Late sowing (02-08-2012)

Time of transplanting : Three dates

1. Early (30-07-2012)
2. Normal (13-08-2012)
3. Late (28-08-2012)

Variety : Pusa sugandha - III

Observations:

(i) From each plot (50 sq. m) 5 hills were selected at randomly and marked for further observations for recording rice gundhi bug population at 10 days interval starting, from the first appearance of the pest.

(ii) The insects population (Nymph&Adult) were counted on marked hills during the morning time.

(iii) At the time of harvesting two border rows were excluded and the yield was recorded in kg/plot & converted to q/ha. The data obtained were analysed as per the design followed.

Tab 3.5: Layout plan of the field experiment:

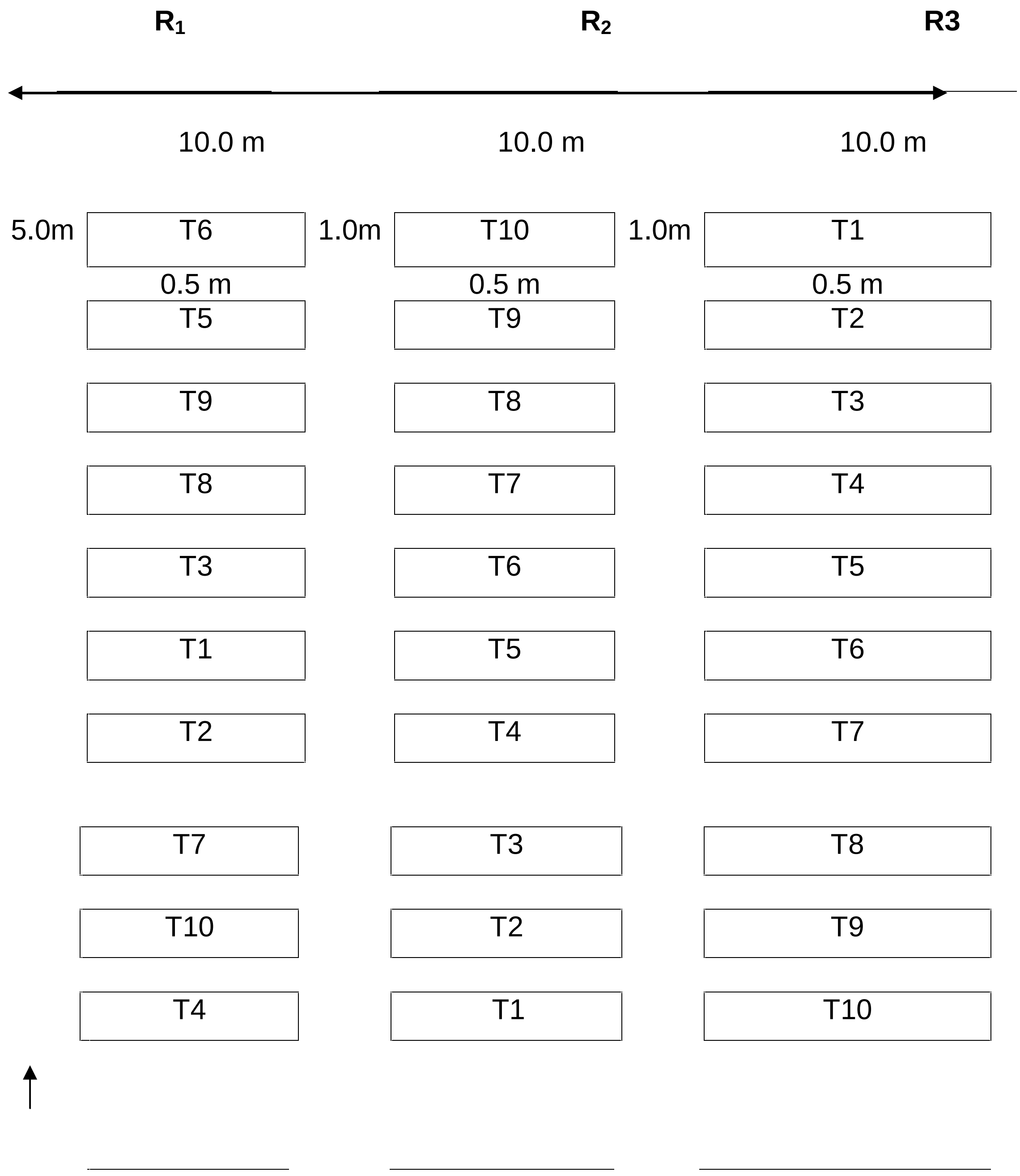

Fig.2: Layout plan of the field experiment

Expt.3: Efficacy of new insecticides against Gundhi bug.

Experimental design	:	Randomized Block Design
Replication	:	Three
Treatments	:	Nine
Plot Size	:	5x4 m.
Plant Spacing		
Row to row	:	20 cm.
Plant to plant	:	15 cm.
Fertilizer dose	:	120:60:30 Kg NPK /ha.
Date of sowing	:	14:07:2012
Time of transplanting	:	05-08-2012
Date of spraying	:	27:10:2012
Date of harvesting	:	19:11:2012
Variety	:	Pusa sugandha 3

Details of treatment

S.NO.	Chemical component	Trade Name	Formulation	Formulation/ha. Quantity g./ml. Of
1	Triazophos	Sutathion	40 *EC*	750 ml
2	Triazophos	Sutathion	40 EC	1250 ml
3	Sulfoxaflor	-------	24 *SC*	313 ml
4	Sulfoxaflor	-------	24 SC	375 ml
5	Buprofezin	Applaud	25 SC	800 ml
6	Rynaxypyr	Coragen	20 SC	150 ml
7	Acephate	Starthene	75SP	667 gm
8	Monocrotophos	Sulfox	36 SL	1390 ml
9	Untreated	Water spray	----	-----

Tab 3.6: Layout plan of the field experiment:

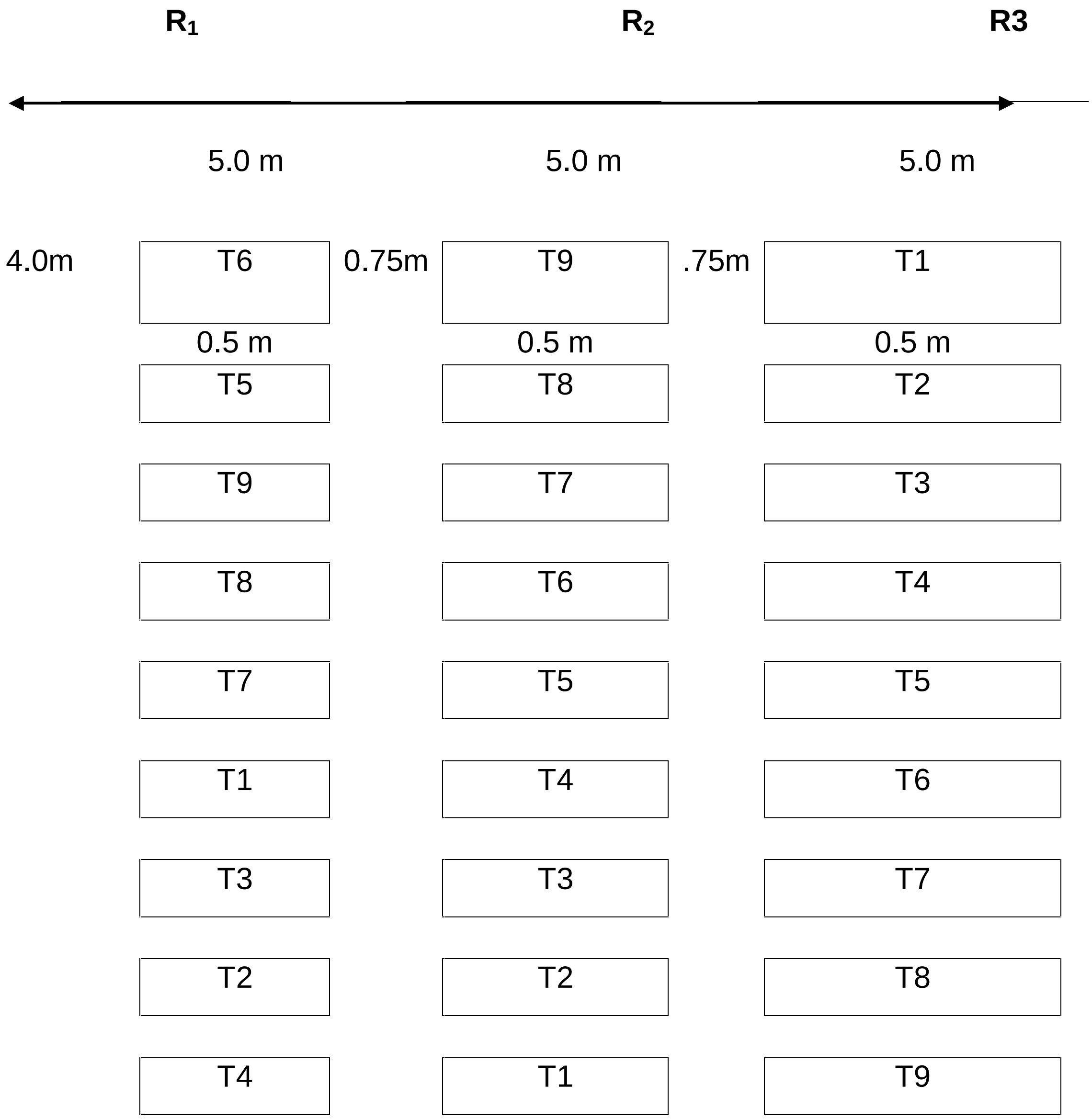

Fig.3.6: Layout plan of the field experiment

(i) Spraying of insecticide was done at the panicle [milky] stage of the crop.

(ii) Ten plants were tagged in each treatment and observations were recorded on those plants for the bug population, prior and after the treatment.

(iii) The population were recorded 24 hour before the treatment and thereafter three days ten days of the treatments.

(iv) The Insecticides solution were prepared in given strength and sprayed by knapsack sprayer fitted with hollow cone nozle, in the plots specified for that insecticide in the experiments.

(v) For each insecticide spray, the sprayer was thoroughly cleaned with water before filling them in the sprayer tank.

(vi) A polythene sheet was used around the plot to protect another plot from the drift of the insecticide.

CHAPTER IV

RESULTS

The present chapter deals with the experimental results obtained during the course of investigation on "**Integrated Management of Gundhi bug (*Leptocorisa varicornis Fabr.)* in Rice crop (*Oryza sativa L.)* under Rewa conditions**" The data obtained under the various objectives of the present investigation were statistically analyzed as per the statistical design adopted and the findings obtained are presented below.

Expt.4.1: Screening of different paddy cultivar against Rice gundhi bug.

Fifty five rice cultivars including susceptible check, variety TN-1 were evaluated against gundhi bug infestation, under field condition, during *kharif* 2012, at the farm of college of Agriculture, Rewa. The data pertaining to the study in presented in table (4.1), it is conspicuous from the table that out of 55 cultivars, four were not germinated. The reason is not known probably due to seed problem.

The infestation of the pest was recorded at milky stage of the crop in each cultivar. Total number of grains and damaged grains from each tagged panicle were taken in account for the determination of the per cent damage grain.

Tab.4.1: Evaluation of rice cultivars against Gundhi bug under field condition

Damage score	No. Of cultivar	Name of cultivar/cultivars
0	Nil	Nil
1	Nil	Nil
3	Nil	Nil
5	4	**CR 2711-76*,** Suraksha, CB-10-504 and CB-09-570
7	25	CR 3005-77-2, CR 3006-8-2*, JGL 17974, RP Bio 4918-230S, W 1263 (DRR), W 1263 (ACC11057) IRRI, T(N)1, RP Patho-03, RP Bio Patho-01, BPT 5204, C 101LAC, Tetep, HR-DRR-04, BG 380-2, RP 4918-212 (S), RP 4918-212 (S), RP 4918-212 (S), CB 05-031, CB 06-124, RP 4680-1-2-23, CB 09-125, CB 09-526, CB 09-538, TNRH 206, TN 1, TNRH 244.
9	22	CR 3005-230-5, IRGA 318-11-6-9-2B, RP Patho-01, RP Patho-02, RP Patho-04, PR Bio Patho02, B 95-1, C 101A 51, HR-DRR-01, HR-DRR-02, HR-DRR-03, RP 4918-212 (S), RP 4918-212 (S), CB 05-022, CB 07-540, CB 09-512, CB 09-526, CB 09-537, TNRH 222, TNRH 237, TNRH 241, TNRH 258.

On the basis of percent damaged grain, the total tested cultivars were scored in the scale of 0-9 out of the 55 cultivars. Four cultivars namely i.e. CR 2711-76(10%), Suraksha(12%), CB-10-504(12%) and CB-09-570 (15%), were categorourised in the scale 5, showed the percentage of grain infestation ranging from 10-15%, which was minimum among the tested cultivars CR 2711-76,received the minimum 10% grain damage followed by Suraksha(12%) and CB-10-504(12%). Cultivar CB-09-570 showed 15 percent grain loss which was greater than former cultivars. 10 percent grain loss in the cultivars CR 2711-76 has also been reported by earlier worker (Anonymous, 2012). Twenty five cultivars showed the moderate damage by the bug at the panicle stage and were grouped in scale-7. The damage level in those varied from 16 to 25 percent. These cultivars have been arranged in the ascending order, on the basis of severity of pest on them i.e. per cent grain damage caused by the insects as

W 1263 (DRR) < RP Bio Patho-01 < TNRH 244, C B09125, C101 LAC < RP Bio 4918-230S, RP Patho-03 < BPT 5204, CR 3006-8-2, Tetep, BG 3802, CB 06-124, CB 09-526, CB 09-538, TNRH 206 < RP 4680 1-2-23, RP 4918 212(S) < W 1263 (ACC11057) IRRI < CR 3005 7-72, JGL 17974, T (N)1, HR DRR-04, RP 4918-212(S), CB 05-031, TN 1.

The cultivars which had shown the damage ranging from 28 to 40 percent were grouped in the scale– 9, twenty two cultivars came under this category. The highest damage was shown by TNRH 237, HR DRR-01, HR DRR-02, RP Patho-02, CB 09-537, IRGA 318-11-6-9-2B, which appears to be most susceptible cultivar against gundhi bug. These cultivars were arranged below, as per their susceptibility against gundhi bug, in ascending in order as

CR 3005-2305 < RP Patho-04, PR Bio Patho-02, TNRH 258, RP 4918-212(S) < HR DRR-03 < CB 09-512, CB 09-526, TNRH 241, RP 4918-212(S), B 951, C 101 A 51, RP Patho-01 < TNRH 222, CB 07-540 < CB 05-022 < TNRH 237, HR DRR-01, HR DRR-02, RP Patho-02, CB 09-537, IRGA 318-11-6-9-2B.

Tab.4.2: Screening of different paddy cultivars against Gundhi bug.

Si. No.	Name of cultivar	Average Plant height	Average tillers/plant	Average No. of grain/ panicle	Average No. of damaged grain/ panicle	Percent grain Damage	Severity of pest (0-9 Scale)
1	CR 2711-76	101.98	17.8	111.6	11.8	10	5
2	CR 3005-77-2	102.3	17.6	120.6	30.2	25	7
3	CR 3005-230-5	101.3	17.9	125.0	35.2	28	9
4	CR 3006-8-2	104.56	18.2	126.6	26.4	20	7
5	JGL 17974	105.8	19.0	128.6	33.4	25	7
6	RP Bio 4918-230S	109.2	16.6	128.8	24.6	19	7
7	IRGA 318-11-6-9-2B	104.54	17.2	130.4	53.0	40	9
8	W 1263 (DRR)	109.2	20.2	134.6	21.8	16	7
9	W 1263 (ACC11057) IRRI	110.4	24.6	126.2	29.4	23	7
10	T(N)1	115.2	20.0	126.2	31.6	25	7
11	RP Patho-01	123.6	20.0	137.6	48.4	35	9
12	RP Patho-02	118.8	20.4	132.8	53.2	40	9
13	RP Patho-03	116.6	15.6	135.6	26.0	19	7
14	RP Patho-04	115.2	18.8	134.2	40.4	30	9
15	RP Bio Patho-01	115.2	16.4	129.8	23.4	17	7
16	PR Bio Patho02	124.4	19.6	130.8	39.4	30	9
17	B 95-1	122.0	22.4	127.2	44.6	35	9
18	BPT 5204	118	14.2	134.4	27.0	20	7
19	C 101A 51	119.0	19.4	137.2	48.2	35	9
20	Suraksha	116.2	19.	126.2	15.2	12	5
21	C 101LAC	123.6	18.0	135.4	24.4	18	7
22	Tetep	118.8	18.0	120.4	24.2	20	7
23	HR-DRR-01	117.4	18.2	136.0	54.6	40	9
24	HR-DRR-02	126.8	19.4	131.2	52.6	40	9
25	HR-DRR-03	118.0	15.4	125.0	41.4	33	9
26	HR-DRR-04	128.0	19.2	137.8	34.6	25	7
27	HR-DRR-05	Not germinated	-	-	-	-	-
28	HR-DRR-06	Not germinated		-	-	-	-
29	HR-DRR-07	Not germinated	-	-	-	-	-
30	T(N)1	Not germinated	-	-	-	-	-
31	BG 380-2	117.8	18.2	137.2	27.6	20	7
32	RP 4918-212 (S)	119.8	17.00	125.8	27.8	22	7
33	RP 4918-212 (S)	118.8	16.4	125.6	37.8	30	9

34	RP 4918-212 (S)	120.0	17.2	126.4	44.4	35	9
35	RP 4918-212 (S)	121.8	17.4	126.4	31.8	25	7
36	CB 05-022	129.6	17.8	130.0	49.6	38	9
37	CB 05-031	128.2	17.0	128.4	33.2	25	7
38	CB 06-124	123.6	16.8	125.0	25.0	20	7
39	CB 07-540	1250	18.4	133.2	48.2	36	9
40	RP 4680-1-2-23	120.0	15.4	123.6	27.2	22	7
41	CB 09-125	120.8	15.6	125.2	22.6	18	7
42	CB 09-512	119.0	15.4	127.2	44.6	35	9
43	CB 09-526	124.4	14.8	124.4	43.6	35	9
44	CB 09-526	125.4	15.6	124.2	25.0	20	7
45	CB 09-537	123.6	14.2	126.4	50.6	40	9
46	CB 09-538	127.0	14.6	124.0	24.8	20	7
47	CB 09-570	123.8	15.2	125.0	18.8	15	5
48	CB 10-504	124.6	14.6	127.8	15.4	12	5
49	TNRH 206	123.0	15.4	128.8	25.8	20	7
50	TN 1	128.2	17.8	134.6	33.8	25	7
51	TNRH 222	127.6	17.4	132.8	48.4	36	9
52	TNRH 237	127.	17.2	131.2	52.6	40	9
53	TNRH 241	129.5	15.2	129.0	45.2	35	9
54	TNRH 244	128.8	15.4	129.6	23.6	18	7
55	TNRH 258	129.0	15.0	127.6	38.4	30	9

Expt.4.2: Effect of planting dates on the incidence of Gundhi bug.

An experiment was laid out to find the effect of planting dates on the infestation of gundhi bug i.e. early, normal and late i.e. 3rd July 2012, 18th July 2012 and 2nd August 2012 respectively. Subsequently the transplanting of the seedling of above sowing dates were done on 30th July, 13th August and 28th August 2012, respectively in the main field. The population of gundhi bug was (Nymph&Adult) recorded at 10 days interval beginning from 10 days after transplanting. The data collected on the population of bug (Nymph&Adult) and analyzed as per scheduled experimental design. The findings are presented in the table (4.3). It is clear from this table that the average plant height in various treatments varied from 108.58 to 119.06 cm. and number of tiller ranged between11.98 to 15.06. As far as the infestation of gundhi bug in different treatment was concerned, there was a significant difference in the population, in different date sown and planted crops of rice, beyond 50 days of transplanting.

However, no population of the pest up to 40 days was recorded in all the treatments. The pest status & their effective on the yield in different date sown crop is given below in the table.

Tab.4.3: Effect of planting dates on growth and yield.

Treatment	Average Plant height (cm)	Average tillers/plant	Yield	
			kg/Plot	q/ha-1
T1(30/07/12)	117.08	15.06	14.57	29.14
T2(13/08/12)	119.06	14.90	15.44	30.88
T3(28/08/12)	108.58	11.98	7.23	14.46
SEM	0.47	0.46	0.78	…..
CD	1.39	1.35	2.32	…..

After 50 days of transplanting: The significant difference in the bug population between the treatments were noted. The average population of bug varied from 0.00 to 1.5/hill. No infestation was recorded in the early planting crop i.e. 30th July 2012. While higher population of the bug was recorded in the late planted crop i.e. 30th August 2012.

After 60 days of transplanting: The population of insect after 60 days of transplanting was recorded minimum 0.8/hill, in the normal planting time **(**13th August 2012) and maximum 2.2/hill in the late planted crops.

After 70 days of transplanting: The population of gundhi bug after 70 days indicate a significant difference among the sowing times. The population was recorded minimum 0.9/hill, in the early planting and 4.1/hill, in the late planted crop. However, non-significant difference was not between the normal and late planted crop.

After 80 days of transplanting: The date depicted in the table (4.4) reveal that after 80 days of transplanting the population of the pest among various treatments showed a significant difference. The early shown crop received minimum population (2.8/hill) but the maximum population (6.9/hill) was noted in late planted crop.

After 90 days of transplanting: The record of population /hill after 90 days again shows non-significant difference among the treatments. Minimum, 4.9 bugs per hill and maximum 6.7 bugs per hill were recorded in early and late sown crop, respectively.

Effect 0f sowing dates on yield: The data is presented in table 4.3 which indicate yield range from 14.46 to 30.88 q/ha-1 in various treatment. The lowest yield was recorded in late sown crop (14.66q/ha) and the highest yield (30.88q/ha) in timely sown (13^{th} August 2012) crop. However, the difference in the yield between early and normal sown crop was non-significant.

Tab.4.4: Effect of planting dates on the infestation of gundhi bug.

Treatment	10 day	20 day	30 day	40 day	50 day	60 day	70 day	80 day	90 day
T1(30/07/12)	0	0	0	0	0.70	1.15	1.12	1.78	2.30
T2(13/08/12)	0	0	0	0	0.84	1.06	1.68	2.19	2.28
T3(28/08/12)	0	0	0	0	1.35	1.60	2.11	2.70	2.66
SEM	0	0	0	0	0.14	0.29	0.23	0.17	0.19
CD	0	0	0	0	0.42	0.62	0.68	0.50	0.56

Expt.4.3: Efficacy insecticides on the infestation of Gundhi bug:

Efficacy of nine insecticides including check i.e. Monocrotophos were determined against gundhi bug in Rewa condition, following the Randomized block design in three replications. The populations of gundhi bug per10 plants/plot were recorded 24 hour before the treatment and thereafter 3 days &

10 days of the treatment. The data related to the study presented in the table 4.6. It is evident from it that the number of tillers in all the treatments was non-significantly different. The average number of tillers in the trial ranged between 16.07 to 17.4/plant and the plant height between114.53 to 119.40 cm. Although, average plant height were found significantly more in the plot scheduled for the untreated treatment (T9) in comparison to rest of the plots of the experiments.

The plant height in the plots, reserved for various insecticide treatments, did not show any significant difference. Keeping in view the nature of experiment the significant difference in the plant height between untreated plot & treated plots carry non-significance, as regard to the efficacy of insecticides.

Tab.-4.5: Effect of different insecticides on yield of rice.

S.No.	Comman name of insecticides	Trade name of insecticides	Formulation	Formulation (quantity gm./ ml./ha)	Plant height/ plant (cm)	Number of tiller/plant	Yield	
							Kg/ plot	q/ha
1	Triazophos	Sutathion	40 EC	750 ml	119.40	16.07	5.16	36.64
2	Triazophos	Sutathion	40 EC	1250 ml	117.40	16.87	4.47	31.67
3	Sulfoxaflor	…………..	24 SC	313 ml	117.87	16.87	4.43	31.46
4	Sulfoxaflor	……………	24SC	375 ml	117.67	16.87	4.33	30.75
5	Buprofezin	Applaud	25 SC	800 ml	117.20	17.40	3.97	28.12
6	Rynaxypyr	Coragen	20 SC	150 ml	115.83	16.60	3.33	23.65
7	Acephate	Starthene	75 SP	667 gm	118.27	16.47	4.70	33.38
8	Monocrotophos	Sulfox	36 SL	1390 ml	118.80	16.67	5.13	36.43
9	Untreated	Waterspray	----	-----	114.53	16.17	2.83	20.09
	SEM				0.57	0.84	0.20	....
	CD				1.23	1.27	0.41	….

Effect of insecticide on the population of gundhi bug:

The population of gundhi bug (Nymph & Adults) before and after the treatments of insecticide were recorded and presented in the table 4.3.

(A).Population of Gundhi bug before treatment of insecticides:

The population of gundhi bug, (*Leptocorisa acuta*), in all the plots, before the spray of insecticides, were found non significant. The lowest population (15.68) was recorded in the uncontrolled plot. While maximum (20Nymph&Adults/10hills) in the treatment Sulfoxaflor.

(B). Population of Gundhi bug after treatments of insecticide:

Population of gundhi bug was counted after 3 and 10 days of the insecticide treatments. The findings are presented below-

(a).<u>Three day after treatment:</u> The population of pest after the spray of insecticide can be seen from the table4.6 that the population of gundhi bug numbers in the insecticide treated plot varied from 7.33 to 11.0 adult & nymph/10 hills in comparison to untreated (23.67 nymph & adult/10 hills) plot. It further, indicates that all the treatments were effective in suppressing the pest population. Among the tested insecticide, however, the check Monocrotophos (36 SL) @ 1.39 l/ha, gave maximum suppression 62.17 percent of the pest population table 4.6. But, it was at par with the acephate 75 SP (Starthene) @ 667 gm/ha. It gave population reduction to the turn 57.38 %. The other tested insecticide However, showed, a non-significant difference among them. The insecticide has been arranged below in the ascending order to show their efficacy against the gundhi bug.

Rynaxypyr(T6) < Sulfoxaflor(T4) < Triazophos(T1) < Buprofezin(T5) <Triazophos(T2) < Sulfoxaflor (T5) < Acephate(T7) < Monocrotophos(T8).

Tab.4.6: Efficacy of different insecticides against Gundhi bug.

S. No.	Comman name of insecticides	Trade name of insecticides	Formu lation	Formulation (quantity (gm./ ml./ha)	Population of Gundhi bug (Nymph and Adult/ hill)		
					One day Before application	After Three days of application	After Ten days of application
1	Triazophos	Sutathion	40 EC	750 ml	19.66(4.26)	9.00(3.07)	2.67(1.77)
2	Triazophos	Sutathion	40 EC	1250 ml	18.33(4.33)	10.67(3.33)	5.00(2.33)
3	Sulfoxaflor	…………	24 SC	313 ml	20.00(4.51)	10.67(3.33)	6.00(2.54)
4	Sulfoxaflor	…………	24 SC	375 ml	17.66(4.25	8.67(3.02)	4.67(2.27)
5	Buprofezin	Applaud	25 SC	800 ml	18.00(4.27)	9.00(3.06)	6.00(2.54)
6	Rynaxypyr	Coragen	20 SC	150 ml	20.00(4.51)	11.00(3.39)	6.67(2.66)
7	Acephate	Starthene	75 SP	667 gm	18.00(4.29)	7.67(2.85)	3.33(1.95)
8	Monocrotophos	Sulfox	36 SL	1390 ml	19.66(4.47)	7.33(2.78)	1.67(1.46)
9	Untreated	Water spray	----	-----	15.68(4.00)	23.67(4.89)	30.00(5.50)
	SEM				0.23	0.17	0.14
	CD at 5%				0.49	0.38	0.31

*** Values in parthesis are square root transformed value i.e. (x+0.5)**

(b). **Ten days after treatment:** The data is depicted in the table and it is Conspicuous from the above table that all the insecticides were effective and significantly superior over the control in reducing the pest population even after 10 days of spray. The population in various treatments varied from 1.67 to 6.67 nymph & adult/10 hills as against 30.0 nymph & adult/10 hills in control. However, the intra response among the insecticide is given below in the ascending order significantly Rynaxypyr(T6) < Buprofezin(T5) Sulfoxaflor(T3) < Triazophos(T2) < Sulfoxaflor(T4) < Acephate(T7) < Triazophos(T1) < Monocrotophos(T8).

However, the differences in the effectiveness of insecticide were found significant. Monocrotophos (T8) proved best among all insecticide bringing by down the population to the extent of 1.67/10 hill after 10 days of treatment. It was followed by Triazophos (T1) and Acephate(T7). There was non-significant difference among them.

Yield: From the table (4.5) it is obvious that all the insecticidal treatments recorded good yield of crop in comparison to untreated control. All the insecticide the tested check insecticides like Triazophos 40 EC @ 750 and Acephate 75% SC @ 667 gm/ha almost recorded similar yield ranged from 2.83 to 5.17 kg/plot ,while control gave minimum yield respectively.

Tab.-4.7: Percent reduction in gundhi bug population, 3 and 10 days after insecticide application.

S. No.	Comman name of insecticides	Trade name of insecticides	Forum lation	Formulation (quantity (gm./ ml./ha)	Population of Gundhi bug (Nymph and Adult/10 hills)		
					One day Before application	Percent reduction	
						After 10days application	After 10 days application
1	Triazophos	Sutathion	40 *EC*	750 ml	19.66	54.22	86.41
2	Triazophos	Sutathion	40 EC	1250 ml	18.33	41.78	72.73
3	Sulfoxaflor	………….	24 SC	313 ml	20.0	46.65	70.00
4	Sulfoxaflor	………..	24 SC	375 ml	17.66	50.90	73.55
5	Buprofezin	Applaud	25 SC	800 ml	18.0	50.00	66.66
6	Rynaxypyr	Coragen	20 SC	150 ml	20.0	45.00	66.65
7	Acephate	Starthene	75 SP	667 gm	18.0	57.38	81.50
8	Monocrotophos	Sulfox	36 SL	1390 ml	19.66	62.17	91.50
9	Untreated	Water spray	----	-----	15.68	-50.90	-91.32

CHAPTER-V

DISCUSSION

The findings of the present investigation entitled **"Integrated Management of Gundhi bug, (*Leptocorisa varicornis Fabr.)* in Rice crop (*Oryza sativa L.)* under Rewa conditions,"** presented in the preceding chapter, being discussed in this, chapter in the light of available literatures.

Expt.1: Screening of different paddy cultivar against Rice gundhi bug.

The use of resistant cultivar/variety is a most effective, economical, environmentally safe and compatible with other methods of pest control. Research on this aspect had led to the identification of some cultivars which were resistant/tolerant against the gundhi bug. Identification of such cultivar is also important for varietal improvement programme with a view to develop high yielding gundhi bug resistant varieties. The percent damaged grains were utilized to measure the relative plant resistant in the present investigation. In the screening trial there were four cultivars, found resistant/tolerant to gundhi bug and categorized under scale-5 with 8 to 15% grain damage. Minimum damage (10%) was found in cultivar CR 2711-76 and also maximum in CB 09-570. Cultivar CR 2711-76 has been reported less susceptible against gundhi bug at Jagdalpur (Anonymous, 2011). The order of resistance in four cultivars given below-

CR 2711-76>Suraksha>CB 10-504>CB 09-570.

The present finding are in conformity with the earlier finding on this aspect, carried out at national level (DRR, 2011). It has also been reported in the scale of "5" from Rewa in the year 2011 (Annon, 2011).

Expt.2: Effect of planting dates on the incidence of Gundhi bug.

Date of sowing has important role in receiving or avoiding the incidence of the pest. Present study conducted on this aspect showed that in early sown crop (30/07/2012) the bug infestation beginning from the 60days after transplanting and continued up to 90 days. The initial population was found 0.9 bug/hill, which was below ETL (1/hill) and the population went up to 4.90 bugs/hill up to 90 days. The crop sown on normal date i.e. (13/08/2012) showed the beginning of infestation from 70 days, and the record of initial population was 0.30 bug/hill and reached maximum 4.8 bug/hill. In late transplanted crop (30/08/2012) bug appeared after 50 days and the crossed the ETL limit of population from the beginning i.e. 1.5/hill and received highest number i.e. 6.70/hill, after 90 days of transplanting. As the date of sowing/planting is an important factor for the insect infestation, from this point of view the present study clearly indicated that late sown crop was more, prone to bug infestation. While the crop sown on early and normal times showed comparatively less attack of bug. The more attack of bug on the late sown crop is responsible for reducing productivity the crop due to availability of suitable stages of crop growth, which is preferred by the insect population. Less population of bug on early sown crop was probably due to escape of suitable stage of this crop up to 80 days (0.90bug/hill) of crop. Present findings i.e. less attack/population in early and normal sown and more attack on late sown crop, find the support from the finding of Dhingra, (2012) who reported high incidence of Gundhi bug in late planted rice and Sararo, (2012) also reported high incidence of many rice pests i.e. stem borer, leaf folder and plant hoppers all the late planted rice. Similar findings have also been reported by rice entomologists of the country, (DRR, 2012).

Yield: There was non-significant difference in the yield between early and normal sown crop but significant difference were recorded between the late and normal sown crops. The higher incidence of bug in late sown crop appeared to be the main reason for low yield of crop. Since the pest directly caused damage to the grain. Rice entomologists have also reported the similar findings from the various part of the nation (DRR, 2012).

Expt.3: Efficacy of new insecticides against Gundhi bug.

On the basis of average population after of gundhi bug in 3 and 10 days of insecticide application and percent reduction in bugs population and yield, Monocrotophos (Sulfox 36 SL) @ 1390 ml/ha, and Triazophos (Sutathion 40 EC) @ 750 ml/ha, were found quite effective insecticides against rice gundhi bug with minimum population record and higher population suppression. Rynaxypyr (Coragen 20 SP) @ 150 ml/ha, followed by Buprofezin (Apploud 25 SC) @ 800 ml/ha, were next in the order. The present findings got support from the earlier workers, who found Monocrotophos to be the most effective insecticide (anonymous; 2008, anonymous; 2010, Dhingra *et al.*, 2003, Jena *et al.*, 2012, Kaushik Chakraboty; 2011, Ramudu and Mishra; 2005, Singh *et al.,* 2009, Vinod *et al.*, 2009 and). Triazophos (40 EC) @ 750 ml/ha, which stood second best insecticide after Monocrotophos, reduced the population of gundhi bug to the extent of 86.41 percent. Revanthy and Binoy (2010) also found this insecticide effective after the systemic insecticide Dimethoate under Laboratory condition. This finding indicate that systemic insecticides are superior over contact insecticide (Triazophos). However, Acephate being a systemic insecticide was next to Triazophos which appears to be contradicting. Since the toxicity of the acephate was found at par with Triazophos. Hence, the order of insecticide plays not much significant importance as regard to efficacy of acephate against gundhi bugs. Dhingra et. al. (2003) also found Acephate an effective insecticide against the pest which is in accordance to the earlier finding.

Buprofezin (Apploud) @ 800 ml/ha and Rynaxypyr (Coragen) @ 150 ml/ha were in order of merit at sixth & seventh position with the killing efficacy of 66.66 & 66.65 percent, respectively. Krishnaiah *etal*, (1996) found Buprofezin quite effective against plant hopper i.e. sucking insect of paddy under green house condition. Perhaps the low toxicity of these insecticides is due to more mobility of the pest and preference for the grain as compared to plant hopper. As the grain have less contact surface area in comparison to leaf stem besides less penetration of insecticides in the grain due to hard covering over them.

Over all, among the tested insecticides Monocrotophos @ 1300 ml/ha was the best molecule and followed by Triazophos for the management of gundhi bug.

CHAPTER-VI

SUMMARY, CONCLUSIONS AND SUGGESTIONS FOR THE FURTHER WORK

Summary:

Rice is a staple crop which is cultivated in diverse agro ecosystem in India and abroad. This crop occupies a key position in Indian Agriculture. About 60 to 65 % of the population at global & national level depends upon rice as a primary source of energy. It is cultivated mainly in Asian countries viz. India, China, Japan, Srilanka, Pakistan, Bangladesh etc. and more than 90 percent of the rice produce is consumed in these countries. The total area under the rice cultivation in the world is about 153.9 million ha, and the production is about 618 million tones. Amongst the rice producing countries, India occupies the first position with regard to the area (44.3 million ha), followed by China (29.3 million ha.). So far productivity is concerned, India occupies 15th rank in the World with a productivity of 3.01 ton/ha (FAO 2006). There are a dozen pests which are recognized as a key or major pest of rice. Among the infesting insects, there is a group of sucking pest which is cause havoc sometime in various region of the country. Brown plant hopper (*Nilaparvata lugens, Stal.*), White backed plant hopper (*Sogatella furcifera, Horvath*), Green leaf hoper (*Nephotettix nigropictus, Stal.*) and Gundhi bug (*Leptocorisa varicornis Fabr.*) are the well known pests in different part of country as well as in Madhya Pradesh and Rewa condition. It is one of the major insect pests responsible for poor yield of rice. Hence, to manage the pest, ecofriendly; studies were conducted to find out the tolerant/resistant cultivar/varieties, of rice suitable time of planting for the Rewa condition and new safer molecules of insecticide. The finding of the objective based, studies has been summarized below-

Screening of different paddy cultivar against Rice gundhi bug.

Among the 55 screened cultivars CR 2711-76 was found least infested cultivar with 10% percent grain damage. There were 3 more cultivars i.e.

Suraksha (12), CB-10-504 (12%) and CB-09-570 (15%), which were categorized under scale 5, 25 cultivars were categorized scale -7 with damage ranging between 16-25 percent grain damage and the remaining 22 cultivars under scale 09 with percent damage more than 40 percent.

Effect of planting dates on the incidence of Gundhi bug.

Three date of planting i.e. early, normal and late were tried to find, the suitable planting time with less infestation of gundhi bug. It was found that planting time of crop had influence on gundhi bug population. The bug infestation began 50 days after transplanting in all the treatments but variation in the infestation reflected after 60, 70, 80 and 90 days of transplanting. Higher number of bug population was noted in the late planted crop (30/08/2013) with a significant reduction in yield (14.46 q/ha) as compared to the normal and early planting crop.

Efficacy of new insecticides against Gundhi bug.

To find out the ecofriendly molecules of insecticides, this experiment was conducted with six insecticides. Two of them with two different doses i.e. Triazophos (@ 750, 1250 ml/ha) and Sulfoxaflor (@ 313, 375 ml/ha). All the tested molecules were found effective in the tested doses as compared to untreated check. The insecticides application brought down the population of gundhi bug to 66.65% after 3 days of application to 91.50% after 10 days of spraying. Monocrotophos @1390 ml/ha proved superior over all tested insecticide with population reduction to the extent of 91.50% followed by Triazophos @ 750 ml/ha and Coragen @ 150 ml/ha proved least effective (66.65%) among insecticides but keeping in view their nature and mode of action it can be used in rice ecosystem for the IPM practice, which allow the some population to survive for the consumption of natural enemies. However, their time of application need further research. The order of field efficacy of tested insecticides at their normal and variable doses given below- Rynaxypyr(T6) < Sulfoxaflor(T4) < Triazophos(T1) < Buprofezin(T5) <Triazophos(T2) < Sulfoxaflor (T5) < Acephate(T7) < Monocrotophos(T8).

The above insecticides showed their effectiveness at 3 & 10 days after treatment. The response of insecticide treatment also divulged in the form of high yield in the insecticide treated plot (36.36 q/ha) as compared to control (20.08 q/ha).

Conclusion:

From the above experimental findings, it can be concluded that cultivars i.e. CR 2711-76, Suraksha, CB-10-504 and CB-09-570 can be used as IPM tool for the control of gundhi bug, beside using them for breeding programme to develop gundhi bug resistant/tolerant variety for Rewa condition. The best time of planting, avoiding gundhi bug menace, is normal planting date i.e 13 August 2012. This date planted crop not only received less infestation but, also gave higher yield (36.46 q/ha). So, it can be considered the right time for rice planting. Among the tested molecules, though Monocrotophos proved best followed by Triazophos but, the importance of Rynaxypyr in the rice ecosystem cannot be neglected as it allow some population of the insect in the crop for the buildup of biotic stress, which is important for Integrated Pest Management strategy & sustainable agriculture.

Future plan: The identified cultivar i.e. CR 2711-76, should be compared with locally available cultivars/variety and can be included in breeding programme to develop resistant variety. The date of planting effect on gundhi bug infestation should be studied with a weekly interval instead of 10 or 15 days gap. Insecticide influence should be emergence evaluated by applying prior to ear head. In addition, the role of micronutrient and macronutrient on the pest should also be evaluated. Role of salayia attack, a prevailing ITK, should also be scientifically evaluated, for finding its significance in gundhi bug control.

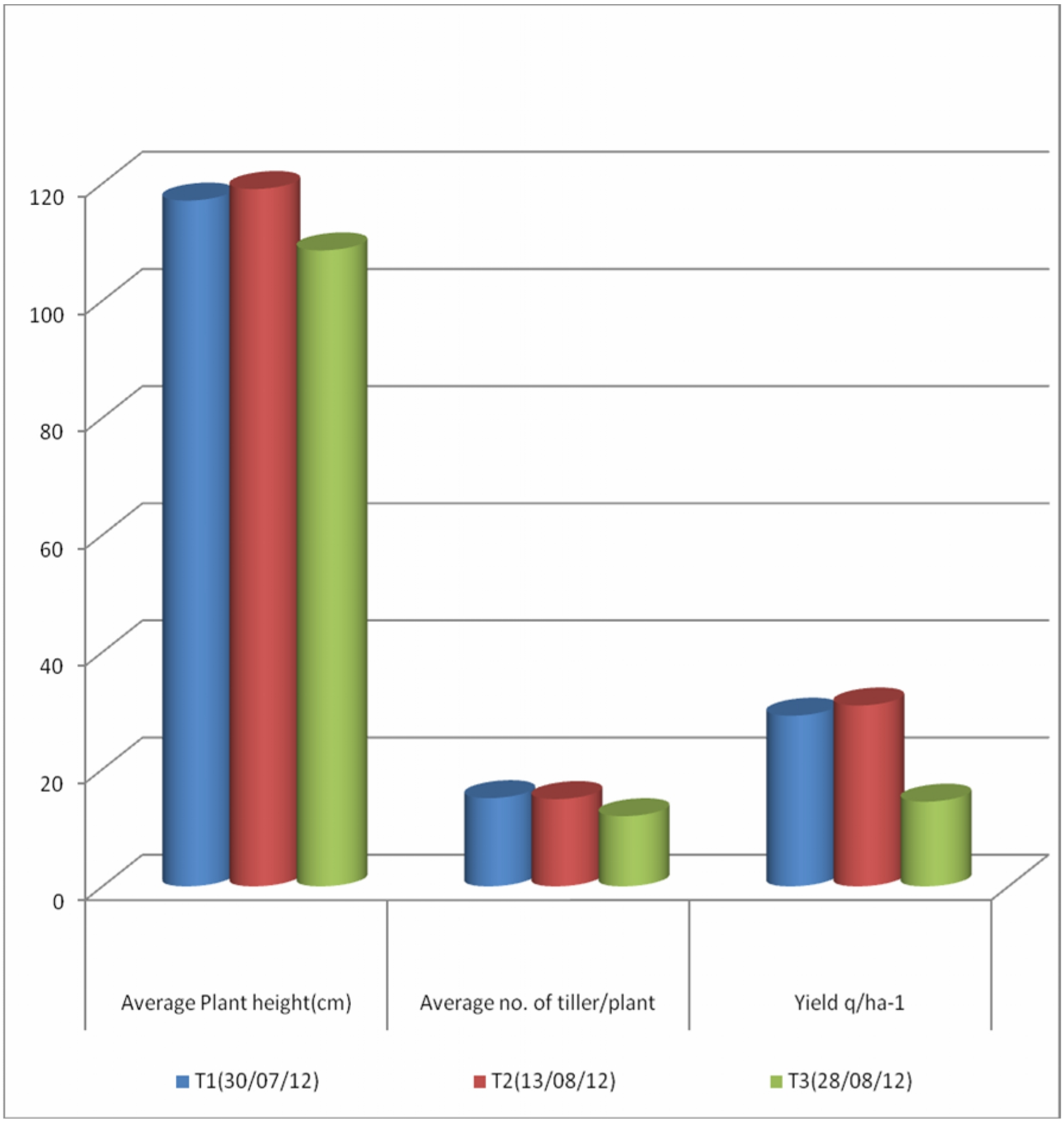

Fig.4.3: Effect of planting dates on growth and yield.

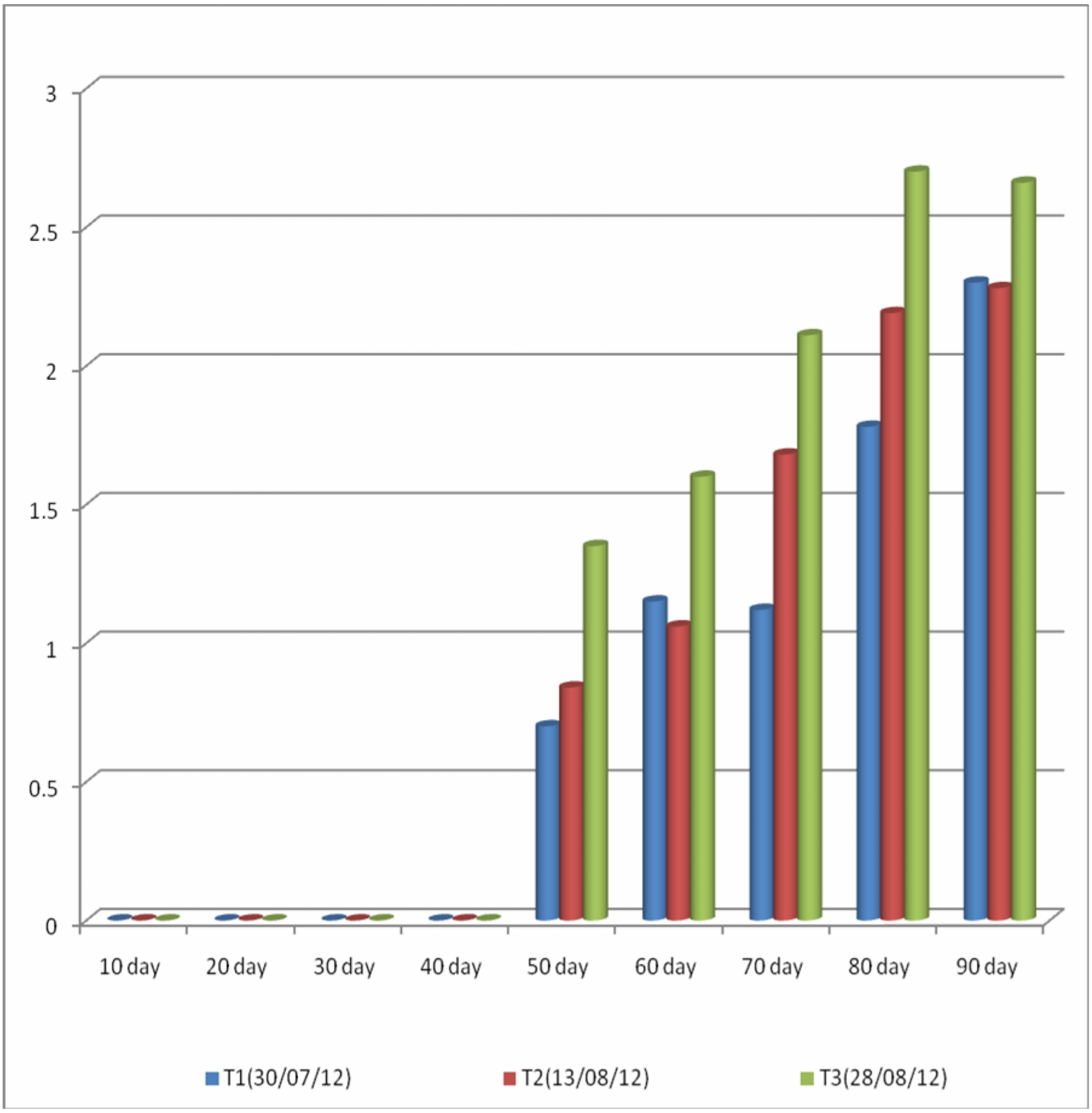

Fig.4.4: Effect of planting dates on the infestation of gundhi bug.

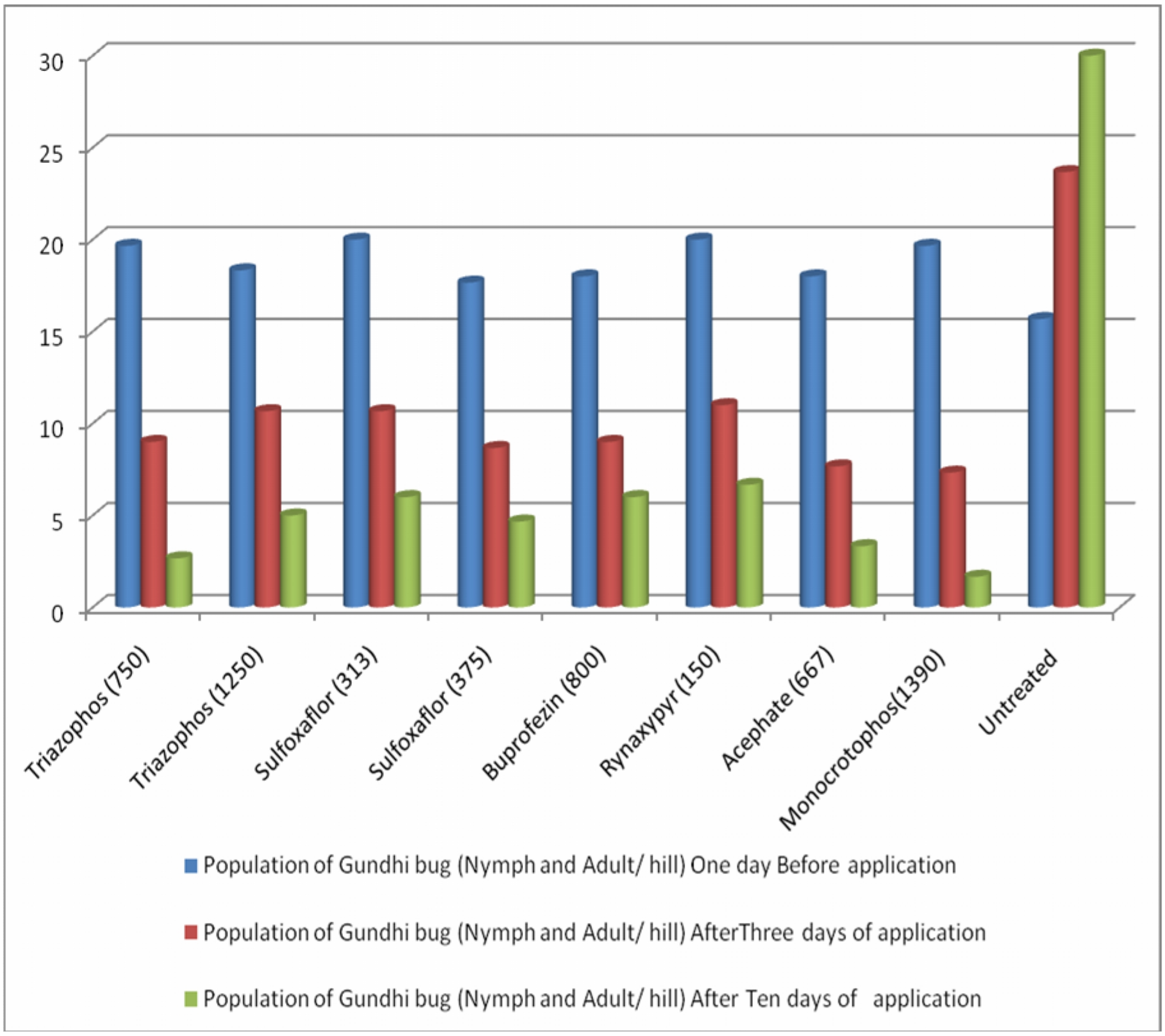

Fig.4.6: Efficacy of different insecticides against Gundhi bug.

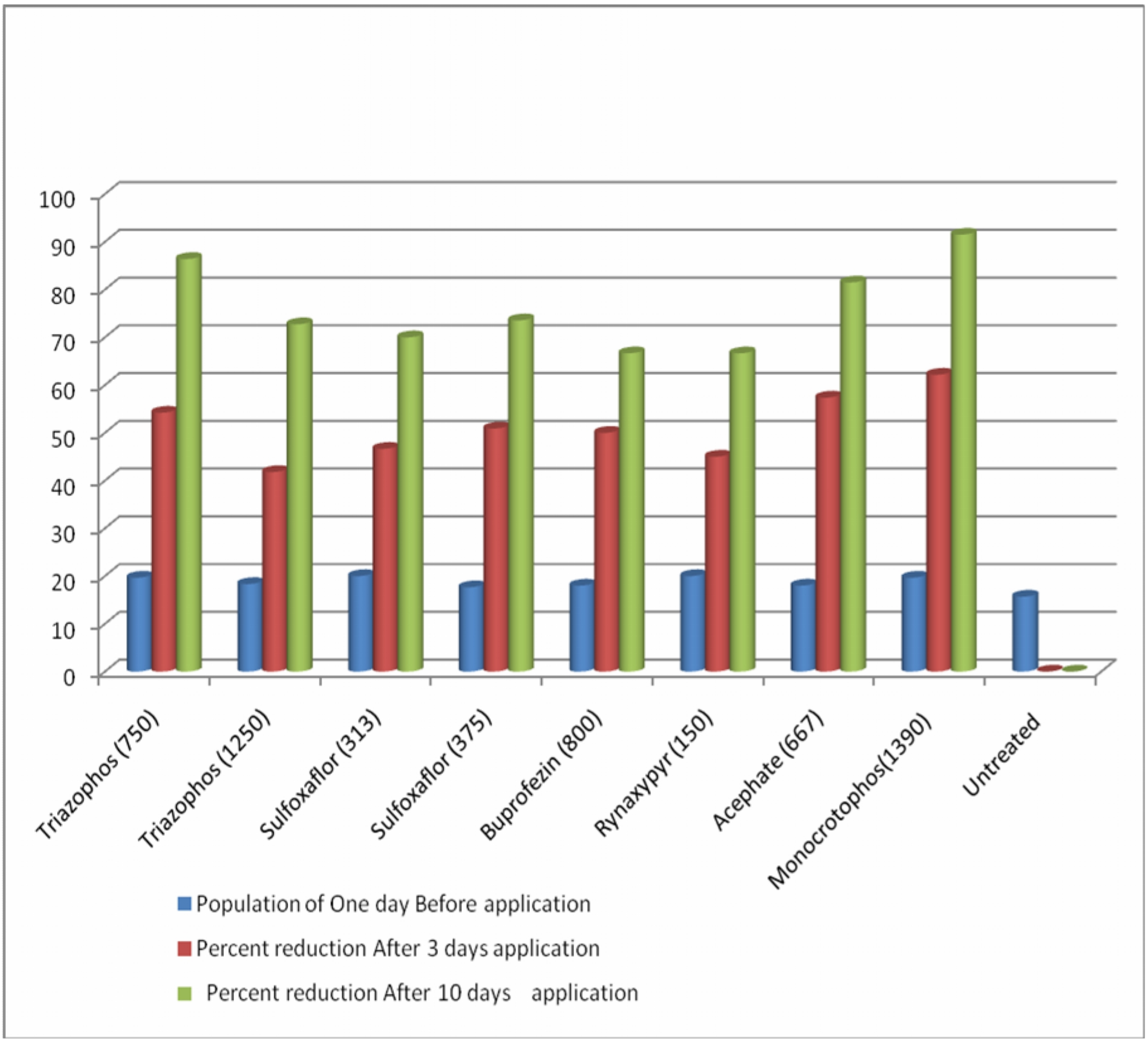

Fig.4.7: Percent reduction in gundhi bug population, 3 and 10 days after insecticide application.

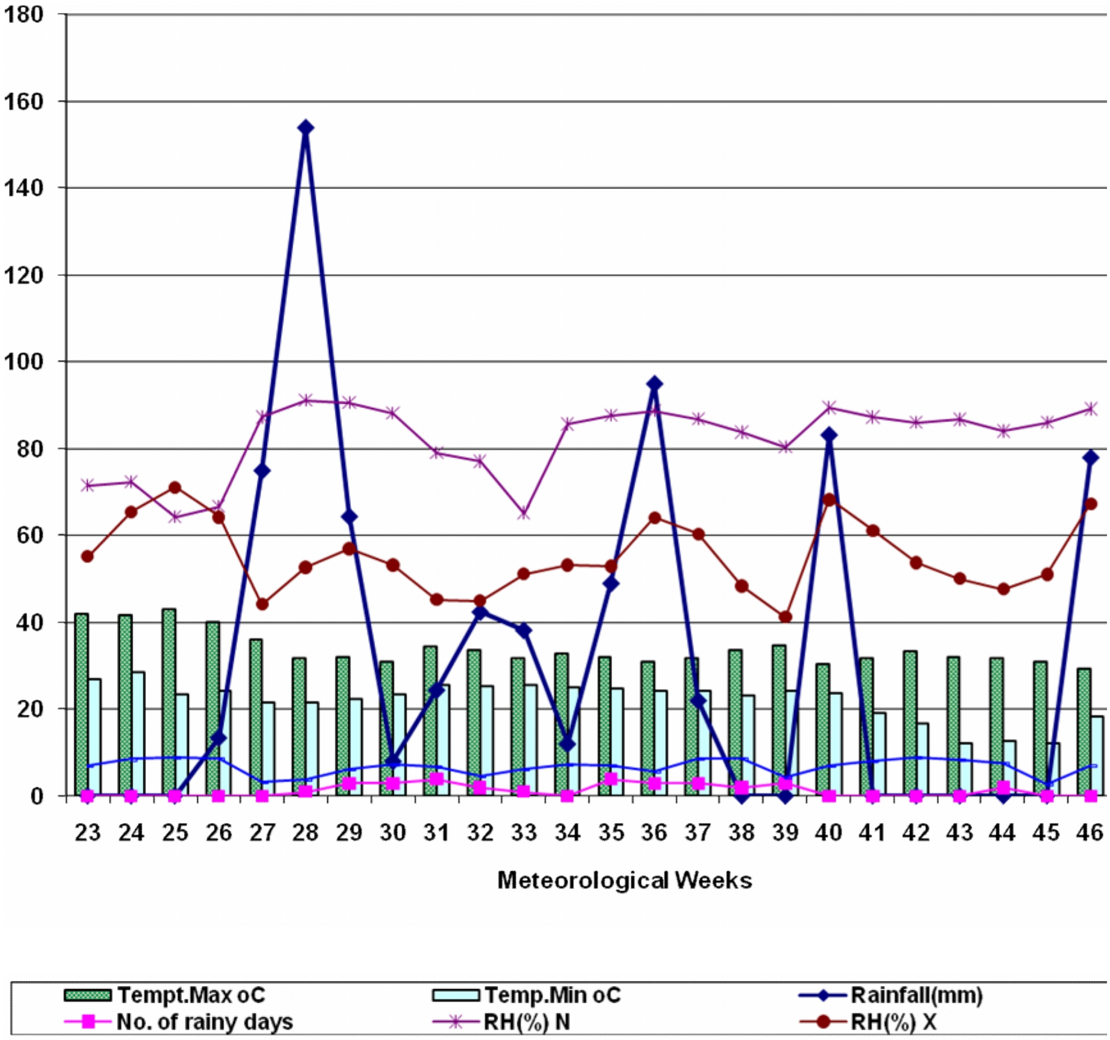

Fig. 3.1 Weekly meteorological data of *Kharif* 2012-13

Gundhi Bug on Rice

Nymph of gundhi bug

Fig: Nymph of Gundhi bug

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APPENDICES

Analysis of variance for the comparatives efficacy of new and some commonly recommended insecticides against gundhi bug of Rice crop.

Exp.1: Effect on population of gundhi bug

(i) One day before application:

S.No.	Source of variance	D.f.	S.S.	M.S.S.	Cal. F.	Tab. F.
1	Replication	2	0.52	0.26	1.61	3.74
2	Treatment	8	0.63	0.08	0.48	2.77
3	Error	16	2.56	0.16		
	Total	26	3.71	SEm± =0.23 CDat5% =0.49		

(ii) Three days after application:

S.No.	Source of variance	D.f.	S.S.	M.S.S.	Cal. F.	Tab. F.
1	Replication	2	0.07	0.03	0.35	3.74
2	Treatment	8	9.63	1.20	12.57	2.77
3	Error	16	1.53	0.10		
	Total	26	11.23	SEm± = 0.17 CD at 5% 0.38		

(iii) Ten days after application:

S.No.	Source of variance	D.f.	S.S.	M.S.S.	Cal. F.	Tab. F.
1	Replication	2	0.02	0.01	0.17	3.74
2	Treatment	8	33.03	4.13	63.95	2.77
3	Error	162	1.03	0.06		
	Total	26	33.08	SEm± 0.14 CD at 5% 0.31		

(iv) Effect on plant height:

S.No.	Source of variance	D.f.	S.S.	M.S.S.	Cal. F.	Tab. F.
1	Replication	2	0.29	0.14	0.14	3.74
2	Treatment	8	53.09	6.64	6.63	2.77
3	Error	16	16.01	1.00		
	Total	26	69.39	SEm± = 0.57 CD at 5% = 1.23		

(v) Effect no. of tiller/plant:

S.No.	Source of variance	D.f.	S.S.	M.S.S.	Cal. F.	Tab. F.
1	Replication	2	6.82	3.41	3.22	3.74
2	Treatment	8	3.94	0.49	0.46	2.77
3	Error	16	16.94	1.06		
	Total	26	27.70	SEm± =1.08 CD at 5% = 3.14		

(iv) Effect on grain yield (kg/plot):

S.No.	Source of variance	D.f.	S.S.	M.S.S.	Cal. F.	Tab. F.
1	Replication	2	0.15	0.07	0.66	3.74
2	Treatment	8	14.51	1.81	16.6	2.77
3	Error	12	1.75	0.11		
	Total	26	15.71	SEm± =0.19 kg/plot CD at 5% 0.40		

Analysis of variance for the comparatives effect on planting dates against gundhi bug of Rice crop.

Exp. 2: Effect on planting dates in population of gundhi bug:

(i) 10 days after transplanting:

S.No.	Source of variance	D.f.	S.S.	M.S.S.	Cal. F.	Tab. F.
1	Replication	0.0	0.0	0.0	0.0	0.0
2	Treatment	0.0	0.0	0.0	0.0	0.0
3	Error	0.0	0.0	0.0		
	Total	00	15.63	SEm± =0.0 CD at 5% = 0.0		

(ii) 20 days after transplanting:

S.No.	Source of variance	D.f.	S.S.	M.S.S.	Cal. F.	Tab. F.
1	Replication	0.0	0.0	0.0	0.0	0.0
2	Treatment	0.0	0.0	0.0	0.0	0.0
3	Error	0.0	0.0	0.0		
	Total	00	15.63	SEm± =0.0 CD at 5% = 0.0		

(iii) 30 days after transplanting:

S.No.	Source of variance	D.f.	S.S.	M.S.S.	Cal. F.	Tab. F.
1	Replication	0.0	0.0	0.0	0.0	0.0
2	Treatment	0.0	0.0	0.0	0.0	0.0
3	Error	0.0	0.0	0.0		
	Total	00	15.63	SEm± =0.0 CD at 5% = 0.0		

(iv) 40 days after transplanting:

S.No.	Source of variance	D.f.	S.S.	M.S.S.	Cal. F.	Tab. F.
1	Replication	0.0	0.0	0.0	0.0	0.0
2	Treatment	0.0	0.0	0.0	0.0	0.0
3	Error	0.0	0.0	0.0		
	Total	00	15.63	SEm± =0.0 CD at 5% = 0.0		

(v) 50 days after transplanting:

S.No.	Source of variance	D.f.	S.S.	M.S.S.	Cal. F.	Tab. F.
1	Replication	9	0.91	0.10	1.19	3.26
2	Treatment	2	2.37	1.18	13.96	2.49
3	Error	18	1.52	0.08		
	Total	29	4.80	SEm± = 0.14 CD at 5% = 0.42		

(vi) 60 days after transplanting:

S.No.	Source of variance	D.f.	S.S.	M.S.S.	Cal. F.	Tab. F.
1	Replication	9	1.42	0.15	0.88	3.26
2	Treatment	2	1.68	0.84	4.72	2.49
3	Error	18	3.20	0.17		
	Total	29	6.30	SEm± = 0.21 CD at 5% = 0.62		

(vii) 70 days after transplanting:

S.No.	Source of variance	D.f.	S.S.	M.S.S.	Cal. F.	Tab. F.
1	Replication	9	1.54	0.17	0.80	3.26
2	Treatment	2	4.94	2.47	11.55	2.49
3	Error	18	3.85	0.21		
	Total	29	10.23	SEm± =0.23 CD at 5% = 0.68		

(viii) 80 days after transplanting:

S.No.	Source of variance	D.f.	S.S.	M.S.S.	Cal. F.	Tab. F.
1	Replication	9	052	0.05	0.48	3.26
2	Treatment	2	4.20	2.14	17.98	2.49
3	Error	18	2.14	0.11		
	Total	29	6.86	SEm± = 0.17 CD at 5% = 0.50		

(ix) 90 days after transplanting:

S.No.	Source of variance	D.f.	S.S.	M.S.S.	Cal. F.	Tab. F.
1	Replication	9	0.23	0.02	0.17	3.26
2	Treatment	2	0.89	0.44	3.05	2.49
3	Error	18	2.64	0.14		
	Total	29	3.76	SEm± = 0.19 CD at 5% = 0.56		

(x) Effect on plant height:

S.No.	Source of variance	D.f.	S.S.	M.S.S.	Cal. F.	Tab. F.
1	Replication	9	6.93	0.77	0.86	3.26
2	Treatment	2	6.20	310.00	347.07	2.49
3	Error	18	16.07	0.89		
	Total	29	29.20	SEm± = 0.47 CD at 5% = 1.39		

(xi) Effect no. of tiller/plant:

S.No.	Source of variance	D.f.	S.S.	M.S.S.	Cal. F.	Tab. F.
1	Replication	9	13.97	1.55	1.82	3.26
2	Treatment	2	60.12	30.06	35.40	2.49
3	Error	18	15.28	0.84		
	Total	29	89.37	SEm± = 0.46 CD at 5% = 1.35		

(xii) Effect on grain yield (kg/plot):

S.No.	Source of variance	D.f.	S.S.	M.S.S.	Cal. F.	Tab. F.
1	Replication	9	50.77	5.64	2.26	3.26
2	Treatment	2	406.78	203.39	81.62	2.49
3	Error	18	44.85	2.49		
	Total	29	502.40	SEm± =0.78 CD at 5% = 2.32		

"Integrated Management of Gundhi bug, (*Leptocorisa varicornis Fabr.)*

in Rice crop (*Oryza sativa L.)* under Rewa condition"

Thesis Abstract

Submitted to the

Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur

In partial fulfillment of the requirements for
The Degree of

MASTER OF SCIENCE

In

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(Entomology)

By

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ABSTRACT

1.	**Title of the Thesis**	**:**	**"Integrated Management of Gundhi bug, (*Leptocorisa varicornis Fabr.)* in Rice crop (*Oryza sativa L.)* under Rewa condition"**
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Abstract

Rice is a monocotyledonous cop, belongs to the Family Poaceae (Graminae) and genus *Oryza.* It has two cultivated & 22 wild species. *Oryza sativa* and *Oryza glaberrima* are the cultivated species of rice. *Oryza sativa* is globally cultivated species, while *Oryza glaberrima* is cultivated in West Africa. The crop is grown under different agro climate conditions and production systems. But, the most common practice is the transplanting method in puddled condition. It is an staple crop which is cultivated in diverse agro ecosystem in India and abroad. This crop occupies a key position in Indian Agriculture. About 60 to 65 % of the population at global & national level depends upon rice as a primary source of energy. Rice is cultivated mainly in Asian countries viz. India, China, Japan, Srilanka, Pakistan, Bangladesh etc. and more than 90 percent of the rice produce is consumed in these countries. The total area under the rice cultivation in the world is about 153.9 million ha, and the production is about 618 million tones. Amongst the rice producing countries, India occupies the first position with regard to the area (44.3 million ha), followed by China (29.3 million ha.). So far productivity is concerned, India occupies 15th rank in the World with a productivity of 3.01 tone/ha (FAO 2006). Since the India is far behind in term of productivity is comparison to many national and International level. Various factors has been attributed for low productivity in the country, But among them the cause of low productivity of the crop in our country are various. Biotic stress i.e. Insect pests, diseases and weeds, are the main constraint. Among the biotic stress, insect pests are major factors for low yield, More than 100 pests have been recorded on this crop, which attack the crop right from germination to harvesting. There are a dozen pests which are recognized as a key or major pest of rice. Among the infesting insects, there is a group of sucking pest which is cause havoc sometime in various region of the country. Brown plant hopper (*Nilaparvata lugens, Stal.*), White backed plant hopper (*Sogatella frucifera, Horvath*), Green leaf hoper (*Nephotettix nigropictus, Stal.)* and Gundhi bug (*Leptocorisa varicornis Fabr.*)] are the well known pests in different part of country as well as in Madhya Pradesh from the group. Rewa is situated in the north-eastern part of Madhya Pradesh at latitude 24º31’ N, longitude 81º15’ E and altitude of 306.06 m above the mean sea level. The region falls under subtropical climate with extreme winter and summers seasons. The agro climatic condition of Rewa is suitable for rice–wheat cultivation. The annual average

rainfall varied from 1100 to 1200 mm. with humidity ranging between 71 to 89 % which is suitable more or less for the development all kind of rice pests, but most suitable for the sucking pests, who are the responsible for stunted growth to complete wilting or drying up of the crop besides as acting vector of disease like yellow mosaic & Tungro dieses etc. Gundhi bug (*Leptocorisa varicornis Fabr.*) is also one of them which is responsible for crop damage at vegetative and reproductive stage particularly at milky stage. It causes heavy losses from (68.7 to 98.7% with an average loss of 19.8%) in Madhya Pradesh. The severity of this pest has also been reported from Rewa district and need plant protection measures to save the crop, particularly by the ecofriendly approaches. The perusal of literature reveals that the studies so fare conducted for the management of this pests, shows the missing of important aspects like effect of sowing/planting time and varieties & evaluation of cultivar/variety at local level besides testing of new molecules Keeping these facts in view, the present study had been undertaken with the following objective.

Objectives –

1. To identify the resistant genotype of rice against Gundhi bug.
2. To study the effect of planting dates on the incidence of Gundhi bug
3. To study the efficacy of new insecticides against Gundhi bug.

Summary:

Rice is an staple crop which is cultivated in diverse agro ecosystem in India and abroad. This crop occupies a key position in Indian Agriculture. About 60 to 65 % of the population at global & national level depends upon rice as a primary source of energy. It is cultivated mainly in Asian countries viz. India, China, Japan, Srilanka, Pakistan, Bangladesh etc. and more than 90 percent of the rice produce is consumed in these countries. The total area under the rice cultivation in the world is about 153.9 million ha, and the production is about 618 million tones. Amongst the rice producing countries, India occupies the first position with regard to the area (44.3 million ha), followed by China (29.3 million ha.). So far productivity is concerned, India occupies 15th rank in the World with a productivity of 3.01 tone/ha (FAO 2006). There are a dozen pests which are recognized as a key or major pest of

rice. Among the infesting insects, there is a group of sucking pest which is cause havoc sometime in various region of the country. Brown plant hopper (*Nilaparvata lugens, Stal.*), White backed plant hopper (*Sogatella frucifera, Horvath*), Green leaf hoper (*Nephotettix nigropictus, Stal.*) and Gundhi bug (*Leptocorisa varicornis Fabr.*) are the well known pests in different part of country as well as in Madhya Pradesh and Rewa condition. It is one of the major insect pests responsible for poor yield of rice. Hence, to manage the pest, ecofriendly ; studies were conducted to find out the tolerant/resistant cultivar/varieties, of rice suitable time of planting for the Rewa condition and new safer molecules of insecticide. The finding of the objective based, studies has been summarized below-

Screening of different paddy cultivar against Rice gundhi bug.

Among the 55 screened cultivars CR 2711-76 was found least infested cultivar with 10% percent grain damage. There were 3 more cultivars i.e. Suraksha (12), CB-10-504 (12%) and CB-09-570 (15%). Which were categorized unde scale 5, 25 cultivars taken under scale -7 with damage ranging between 16-25 percent grain damage and the remaining 22 cultivars were categorized under scale 09 with percent damage more than 40 percent.

Effect of planting dates on the incidence of Gundhi bug.

Three date of planting i.e. early planting, normal planting and late planting were tried to find. The suitable planting time with less infestation of gundhi bug. It was found that planting time of crop had the influence on gundhi bug population. The bug infestation began 50 days after transplanting in all the treatment but variation in the infestation reflected after 60, 70, 80 and 90 days of transplanting. The higher number of bug population was noted in the late planted crop (30/08/2013) with a significant reduction in yield (14.46 q/ha) as compared to the normal and early planting crop.

Efficacy of new insecticides against Gundhi bug.

To find out the ecofriendly molecules of insecticides, this experiment was conducted with six insecticides. Two of them with two different doses i.e. Triazophos (@ 750, 1250 ml/ha) and Sulfoxaflor (@ 313, 375 ml/ha). All the tested molecules were found effective in the tested doses as compared to untreated check. The insecticides application brought down the population of gundhi bug to 66.65% after 3 days of application to 91.50% after 10 days of spraying. The Monocrotophos @1390 ml/ha proved superior over all tested insecticide with population reduction to the extent of 91.50% followed by Triazophos @ 750 ml/ha and Coragen @ 150 ml/ha proved least effective (66.65%) among insecticides but keeping in view their nature and mode of action it can be used in rice ecosystem for the IPM practice, which allow the some population to survive for the consumption of natural enemies. However, their time of application need further research. The order of field efficacy of tested insecticides at their normal and variable doses given below-

Rynaxypyr(T6) < Sulfoxaflor(T4) < Triazophos(T1) < Buprofezin(T5) < Triazophos(T2) < Sulfoxaflor (T5) < Acephate(T7) < Monocrotophos(T8).

The above insecticides showed their effectiveness at 3 & 10 days after treatment. The response of insecticide treatment also divulged in the form of high yield in the insecticide treated plot (36.36 q/ha) as compared to control (20.08 q/ha).

Conclusion:

From the above experimental findings, can be concluded that Cultivars i.e. CR 2711-76, Suraksha, CB-10-504 and CB-09-570 can be used as IPM tool for the control of gundhi bug, beside using them for breeding programme to develop gundhi bug resistant/tolerant variety for Rewa condition. The best time of planting, avoiding gundhi bug menace, is normal planting date i.e 13 August 2012. This date planted crop not only received less infestation but, also gave higher yield (36.46 q/ha). So, it can be considered the right time for rice planting. Among the tested molecules, though Monocrotophos proved best followed by Triazophos but, the importance of Rynaxypyr in the rice ecosystem cannot be neglected as it allow some population of the insect in the crop for the buildup of biotic stress. Which is important for Integrated Pest Management strategy & sustainable agriculture.

VITA

The author of this thesis **Mahendra Singh Chouhan s/o Shri Bahadur Singh Chouhan** and Smt. Alaka Couhan was born on 04th August 1987 at Village- Mahammadpur, Tehsil- Gogawa, Distt- (west nimar) Khargone (M.P.). He passed his Higher Secondary School Certificate examination from Govt. Higher Secondary School, Gogawa with **56.22%** second division. He joined the College of Agriculture, Ganjbasoda, Distt.- Vidisha (M.P.) sub campus of Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.) in the year 2007-08 and successfully completed the degree of B.Sc. (Ag.) during the year 2010-11 with **7.05** OGPA at 10 point scale.

For further study he got admission in M.Sc. (Ag.) specialization in Entomology at College of Agriculture Rewa JNKVV, Jabalpur where he successfully completed the entire course requirement for master's degree with **7.25** OGPA at 10 point scale.

For the partial fulfillment of the master's degree programme he was allotted a research problem on **"Integrated Management of Gundhi bug, (*Leptocorisa varicornis Fabr.)* in Rice crop (*Oryza sativa L.)* under Rewa conditions"** which was successfully conducted by him and being submitted in the form of this thesis.