SCREENING OF RICE ENTRIES AGAINST RICE LEAF FOLDER, *Cnaphalocrocis medinalis* (GUENEE) AND ITS MANAGEMENT WITH ECOFRIENDLY PRODUCTS

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BY

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2019

DECLARATION

I, **Ms. SUNITHA B**, hereby declare that the thesis entitled **"SCREENING OF RICE ENTRIES AGAINST RICE LEAF FOLDER, *Cnaphalocrocis medinalis* (GUENEE) AND ITS MANAGEMENT WITH ECOFRIENDLY PRODUCTS"** submitted to the **Acharya N. G. Ranga Agricultural University** for the degree of **MASTER OF SCIENCE IN AGRICULTURE** is the result of original research work done by me. I also declare that no material contained in the thesis has been published earlier in any manner.

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CERTIFICATE

Ms. SUNITHA B has satisfactorily prosecuted the course of research and that thesis entitled **"SCREENING OF RICE ENTRIES AGAINST RICE LEAF FOLDER, *Cnaphalocrocis medinalis* (GUENEE) AND ITS MANAGEMENT WITH ECOFRIENDLY PRODUCTS"** submitted is the result of original research work and is of sufficiently high standard to warrant its presentation to the examination. I also certify that neither the thesis nor its part thereof has been previously submitted by her for a degree of any University.

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This is to certify that the thesis entitled **"SCREENING OF RICE ENTRIES AGAINST RICE LEAF FOLDER, *Cnaphalocrocis medinalis* (GUENEE) AND ITS MANAGEMENT WITH ECOFRIEDNLY PRODUCTS"** submitted in partial fulfillment of the requirements for the degree of **'Master of Science in Agriculture'** of the **Acharya N. G. Ranga Agricultural University, Guntur,** is a record of the bonafide original research work carried out by **Ms. SUNITHA B** under our guidance and supervision.

No part of the thesis has been submitted by the student for any other degree or diploma. The published part and all assistance received during the course of the investigation have been duly acknowledged by the author of the thesis.

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Place:

Date:

(Sunitha B)

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LIST OF SYMBOLS AND ABBREVIATIONS

@	:	At the rate
%	:	per cent
/	:	Per
a.i	:	Active ingredient
+	:	Plus
BPH	:	Brown plant hopper
CD (P=0.05)	:	Critical differences at 5 per cent probability
Cm	:	Centimeter
CV (%)	:	Coefficient of variance
CBR	:	Cost benefit ratio
DAS	:	Day after spraying
DBS	:	Day before spraying
DAT	:	Days after transplanting
EC	:	Emulsifiable concentrate
et al.,	:	And other people
ETL	:	Economic threshold level
Fig.	:	Figure
G	:	Gram
HS	:	Highly susceptible
ha	:	Hectare
ha^{-1}	:	Per hectare
i.e.,	:	That is
K	:	Potassium
kg ha^{-1}	:	Kilogram per hectare
kg	:	Kilogram
l	:	Litre
LC	:	Lethal concentration
LD	:	Lethal dose
LSD	:	Least significant difference

l^{-1}	:	Per litre
MR	:	Moderately resistant
MS	:	Moderately susceptible
ml	:	Millilitre
mg	:	Milligram
mg/ml	:	Milligram per millilitre
m	:	Metre
M ha	:	Million hectares
mg	:	Milligram
M t	:	Million tonnes
M^2	:	Square meters
N	:	Nitrogen
NS	:	Non significant
NSKE	:	Neem seed kernel extract
No.	:	Number
P	:	Phosphorous
q/ha	:	Quintal per hectare
R	:	Resistant
RBD	:	Randomized block design
RLF	:	Rice leaf folder
S	:	Susceptible
SC	:	Soluble concentrate
SEd	:	Standard error of difference
SEm	:	Standard error mean
Sig	:	Significant
t	:	tonnes
viz.	:	Namely
WDG	:	Water dispersable granule
WP	:	Wettable powder

ABSTRACT

Name of the Author	:	**SUNITHA B**
I.D No	:	**BAM-17-37**
Title of the Thesis	:	**"Screening of rice entries against rice leaf folder, *Cnaphalocrocis medinalis* (Guenee) and its management with ecofriendly products."**
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The present investigation on "Screening of rice entries against rice leaf folder, *Cnaphalocrocis medinalis* (Guenee) and its management with ecofriendly products" was carried out in the Agricultural College Farm, Bapatla during *kharif* 2018 with an aim to identify the resistant rice entries against rice leaf folder and to know the efficacy of ecofriendly products against rice leaf folder, *Cnaphalocrocis medinalis* (Guenee).

Forty two rice entries were assessed for the leaf damage caused by rice leaf folder, *C. medinalis* under both controlled and natural conditions during *kharif* 2018.

Under controlled condition, the lowest mean per cent leaf folder damage was recorded in W 1263 (6.31 %) and BPT 3034 (10.30 %) and highest mean per cent leaf damage recorded in BPT 3059 (48.63 %) and where as the susceptible check (TN-1) which recorded 51.45 per cent leaf damage.

Under natural condition, the lowest mean per cent leaf folder damage was recorded in W 1263 (6.58 %) and BPT 3034 (9.39 %) and highest mean per cent leaf damage recorded in BPT 3036 (25.88 %) when compared to the susceptible check (TN-1) which recorded 36.33 per cent leaf damage.

In both controlled and natural conditions the entries W 1263 (6.31 and 6.58 %) and BPT 3034 (10.30 and 9.39 %) recorded lowest damage due to rice leaf folder.

In management studies, with ecofriendly products against rice leaf folder, *C. medinalis* revealed that, after three sprays, out of all fifteen treatments flubendiamide 480 SC @ 0.2 ml/l was found to be the most effective by recording the lowest mean per cent leaf damage (6.30 %) with 54.40 per cent reduction over untreated control followed by neem seed kernel extract at 5 per cent (7.24 %) with 48.51 per cent reduction over control when compared to other treatments.

All other ecofriendly products recorded less than 50 per cent reduction over control. Among them, brahmastram at 50 ml/l recorded 8.34 per cent leaf damage with 40.49 per cent reduction over control followed by chilli garlic extract at 50 ml/l (8.42 %), agnastram at 50 ml/l (8.53 %), chilli garlic extract at 25 ml/l (9.48 %), neemastram at 50 ml/l (10.30 %), agnastram 25 ml/l (10.50 %), panchapatra extract at 50 ml/l (11.08 %) and brahmastram at 25 ml/l (11.67 %) with 38.40, 39.01, 38.75, 34.08, 31.30, 29.16 and 31.60 per cent reduction over untreated control respectively.

The highest leaf folder damage was noticed in datura leaf extract at 50 ml/l with 15.44 per cent leaf damage and 17.05 per cent reduction over control followed by neemastram at 25 ml/l, panchapatra extract at 25 ml/l and datura leaf extract at 25 ml/l with 15.07, 14.38 and 13.39 per cent leaf damage and 22.15, 21.18 and 23.82 per cent reduction over control respectively.

Spray with flubendiamide 480 SC @ 0.2 ml/l recorded the highest yield (4664 Kg/ha) with an increase of 69.30 per cent yield over untreated control and it was superior over all other ecofriendly product treatments. Among the ecofriendly products the treatment with neem seed kernel extract at 5 per cent concentration was recorded higher yield (4259 Kg/ha) with 54.58 per cent increased yield over control and other products recorded less than 50.00 per cent yield increase over untreated control.

Chapter – I

Introduction

Chapter I

INTRODUCTION

Rice (*Oryza sativa*) is the one of the principle, dominant food crop and chief grain grown in India. It is the most ancient food crop being cultivated nearly in 17 countries, hence called as 'Global Grain'. Rice is the most widely consumed staple food crop of grasses (Poaceae) family for a large part of the world's human population, especially in Asia and over half of the global population depends on it for their feed (Lal *et al*., 2014). India is the second largest producer and consumer of rice in the world, has an area of about 43.9 M ha under rice cultivation with a production and productivity of 109.96 M t and 2494 kg ha^{-1}, respectively. While, Andhra Pradesh occupies an area of 2.15 M ha with production and productivity of 8.05 M t and 3741 kg ha^{-1}, respectively (Ministry of Agriculture, www.indiastat.com, 2017-18).

Besides diseases and weeds, the major biotic constraint is insect pests in rice production which causes 20 to 30 per cent yield losses every year. The rice crop is attacked by nearly 200 species of insect pests at various stages. Among them notable damage is caused by 23 insect pest species (Pasalu and Katti 2006).

Approximately 100 insect species feed on rice and 20 of these are considered to be major pests, causing 30 per cent yield loss. Generally significant yield loss in crops is caused by lepidopteran insect pests. In all rice growing ecosystems, the rice leaf folder, *Cnaphalocrocis medinalis* (Guenee) Lepidoptera: Pyralidae, is one of the most destructive and prominent foliage feeder. Under epidemic condition, rice leaf folder causes 30 to 80 per cent of yield loss (Raveeshkumar 2015).

In entire country, earlier rice leaf folder, *C. medinalis* was considered as minor pest. But now it has assumed major pest status (Nanda *et al.,* 2000). Leaf damage of 60 to 70 per cent by this pest at maximum tillering and flowering stage which leads to 80 per cent yield reduction. Usually second instar larvae of rice leaf folder stitches and glues the growing rice leaves longitudinally for its shelter and starts feeding the green foliage which leads to the papery dry leaves, stunting, curling or yellowing of green foliage (Yaspal *et al*., 2015).

The development and use of resistant varieties can be a better option to reduce the dependence on chemical insecticides and also to obtain a sustainable rice production. The use of varietal resistance to control insect pests provides no additional cost and is also free from the problems connected with the environmental pollution. As all the existing commercial rice varieties are susceptible to rice leaf folder attack, it has become imperative to find out the resistance sources in rice germplasm in order to evolve new rice varieties resistant to rice leaf folder (Rehman *et al*., 2005).

Indiscriminate use of broad spectrum insecticides have been in the practice to manage the insect pests since long time, which is causing adverse effect on both biotic and abiotic environment. More dependence on chemical insecticides for insect pests control leads to the pesticide residue in soil, air, water and food besides developing pest resurgence.

Recently organic farming gaining importance due to awareness about the toxic effects of chemical insecticides to human beings and also to the environment. By using some natural indigenous products that specifically target the pest with low mammalian toxicity and safe to natural enemies are to be evaluated for their efficacy against rice leaf folder in rice. Identification of resistant varieties always plays major role in integrated pest management.

Keeping this in view the present study entitled "Screening of rice entries against rice leaf folder, *C. medinalis* (Guenee) and its management with ecofriendly products" was conducted with the following objectives.

OBJECTIVES OF INVESTIGATION

1. Screening of rice entries for resistance against rice leaf folder, *C. medinalis*
2. To evaluate the efficacy of ecofriendly products against rice leaf folder, *C. medinalis*.

Chapter – II

Review of Literature

Chapter II

REVIEW OF LITERATURE

A field experiment entitled "Screening of rice entries against rice leaf folder, *Cnaphalocrocis medinalis* (Guenee) and its management with ecofriendly products" was conducted during *kharif*, 2018 at Agricultural College Farm, Bapatla. The literature pertaining to various aspects of rice leaf folder, *C. medinalis* as per the objectives has been reviewed and presented in this chapter.

2.1 SCREENING OF RICE ENTRIES AGAINST RICE LEAF FOLDER *C. medinalis* (GUENEE)

Regmi *et al*. (2017) conducted varietal screening of rice against major insect pests during 2015 in Rampur, Chitwal to know about the resistance of different varieties of rice under field condition and revealed that lowest population of leaf folder, caseworm and grasshopper in Radha-4 followed by Ramdhan and Sabarti varieties.

Chintalapati *et al.* (2017) screened 50 rice genotypes against rice leaf folder and reported six genotypes as resistant including W-1263, ten as a moderately resistant and remaining 32 genotypes including TN-1 as susceptible genotypes.

Ahmad *et al.* (2016) conducted screening of 26 rice entries against rice leaf folder in pot culture experiment including TN-1 as susceptible check in green house and reported that variety PK-8893-4-1-3-1 as moderately resistant, seven genotypes as moderately susceptible, eleven genotypes as susceptible and remaining seven genotypes as highly susceptible with more leaf damage.

Chatterjee *et al*. (2016) evaluated different rice entries against rice leaf folder, stem borer and whorl maggot with four check varieties *viz*. DRRH 2, Surekha, IR 64 and Taichung Native 1 to identify multiple resistant varieties. They reported lowest leaf folder infestation in RP 5588 (0.57 %) followed by DRRH 2 (0.76 %), CR 2274-2-3-3-1 (0.88 %) and RP 5588-B-B-B-B-116

(0.93 %). They also found CN 2008-3-2, CN 2017-3-2 and W1263 with multiple resistant against all the test insect pests and CR 2274-2-3-3-1, RP 5587-3-2, CN 2015-5-4, IET 23148 and 1233-33-9 resistant against stem borer and leaf folder.

Akhter *et al.* (2015) conducted screening of 23 rice varieties against rice leaf folder and found variety KSK-459 as resistant variety with 3.64 per cent leaf damage, followed by PK-8649 (3.65 %), KSK-462 (6.28 %) and KSK-454 (6.23 %) were found moderately resistance to rice leaf folder.

Elanchezhyan and Arumugachamy (2015) evaluated fifteen medium duration rice genotypes with four check entries against rice leaf folder, the genotype AS 12079 recorded resistance reaction by recording less than ten per cent leaf damage, nine genotypes *viz*., AS12005, AS 12010, AS12029, AS12035, AS 12039, AS 12050, AS 12066, AS12073 and ASRH 12001 reacted moderately resistant with ten to twenty per cent leaf damage to leaf folder *C. medinalis* and remaining genotypes expressing susceptible reaction.

Ahmed and Rehman (2014) screened fifty rice entries against rice leaf folder including local and exotic entries during 2011 with TN-1 as susceptible check in pot culture experiment. The results revealed that two wild species of rice viz., *Oryza rufipoga* and *O. brachyntha* were resistant with 8.71 and 8.95 per cent leaf damage, respectively compared to 95.54 per cent leaf damage in highly susceptible varieties.

Yumnam *et al.* (2014) evaluated the effect of ten promising varieties on the incidence of the rice leaf folder in rice crop ecosystem of Manipur valley and reported that variety RCM-9 as moderately resistant, CAUS-1 as susceptible, Matam-phou and Jaya as highly susceptible and remaining six varieties as moderately susceptible to rice leaf folder.

Sarao *et al.* (2013) screened 62 wild rice germplasm belong to different species, *viz*., *Oryza glaberrima, O. rufipoga, O. barthii, O. nivara, O. meridinalis, O. longistaminata, O. latifolia, O. rhizomatis, O. punctate, O. australiensis* and *O. eichngiri* against rice leaf folder under field condition. The accession, IRGC-105137 (*O. punctata*) showed consistently lowest leaf damage of 3.14 per cent in both at vegetative and panicle initiation stage.

Sarao and Mahal (2012) evaluated 66 rice germplasm against rice leaf folder under field condition in two wet seasons, at vegetative stage over two years, eighteen lines showed leaf folder damage from 6.21 to 9.99 per cent. At the panicle initiation stage six variety showed damage between 8.77 to 12.25 per cent and recorded a highly significant correlation between flag leaf width and per cent infested leaves at the vegetative and panicle initiation stage.

Ahmed *et al.* (2010) conducted screening on 50 rice entries against rice leaf folder and reported 18 entries as moderately resistant with 16-30 per cent leaf damage, 25 entries as moderately susceptible with 30-50 per cent leaf damage, six entries as susceptible with leaf damage of 51-75 per cent and one entry as highly susceptible with more than 75 per cent leaf damage.

Sagheer *et al.* (2009) screened different rice varieties against rice leaf folder and reported that the least leaf infestation by rice leaf folder in super basmati (13.42 %), which significantly different from that of basmati-370 (14.29 %), basmati-2000 (18.97 %), KS-133 (19.81 %), IRRI-6 (20.93 %) and KS-282 (21.06 %). Similarly variety 00518-2 (30.84 %) noticed with maximum infestation by rice leaf folder. Overall results showed that with fine grain varieties were comparatively resistant to rice leaf folder than varieties with coarse grain.

Nigam *et al.* (2008) screened 25 rice varieties against rice leaf folder and reported that, among them six varieties with damage rating of 1 (1-15 % damaged leaves), ten varieties with damage rating of 3 (16-30 %), seven varieties with damage rating of 5 (31-50 %) and two varieties with damage rating of 7 (51-75 %).

Lascar *et al.* (2008) conducted screening on forty different rice entries under field condition against rice leaf folder and reported that, fifteen entries with damage rating of 1 (0-10 %), twenty one entries with damage rating of 3 (10-20 %) and remaining four entries with the damage rating of 5 (20-30 %).

Shah *et al.* (2008) conducted screening on fourteen species of wild rice, among them *Oryza rufipogon* and *O. brachyantha* were found resistant, with damage of 3.7 and 5.26 per cent, respectively. However, *O. australiensis* was highly susceptible to leaf folder with maximum per cent infestation of 56.6.

Katlam (2008) screened 532 genotypes against, leaf folder and reported seven genotypes namely, R 1324-1997-1-1, RP 4655-3, IR 75870-5-8-5-B-2-B-3, CN 1449-5-3, CR 924-1, CN 1266-19-16, SJR 7 and R 1219-650-314 grouped under resistant category, whereas, fifty four genotypes were grouped under moderately resistant category and remaining cultivars were categorized under moderately susceptible, susceptible and highly susceptible categories.

Studies on field screening of 30 rice genotypes against leaf folder during 2005 and 2006. None of the genotypes was free from the attack of leaf folder. Whereas, genotypes Ranbir basmati, IET-18470, IET-18572, IET-18494, IET-17571, IET-18033, IET-18571 and IET18572 were scored under 3 damage score. Remaining genotypes grouped under 5 and 7 damage score (Hafeez *et al.*, 2008).

Studies on screening of fifty three cultivars of rice against leaf folder of rice during *Kharif* season of 2002 and 2003 at Masodha, Faizabad (U.P.). Out of these, only four varieties i.e. Mahsuri, Mandya-vijaya, Suraksha and T- Basmati scored 1 damage score (Singh *et al*., 2006).

Fifty cultivars of rice were tested against leaf folder infestation during *Kharif* 2002 in Jammu, India. None of the cultivars were resistant to leaf folder. However, 18 cultivars were moderately resistant. Remaining 25, 6 and 1 cultivars were moderately susceptible, susceptible and highly susceptible respectively (Hafeez *et al*., 2006).

Rekha *et al.* (2002) evaluated seventy four genotypes of rice against rice leaf folder, under field condition. Only four genotypes namely HKR 95-130, PAU 2030-80-1-3, PAU 1920-100-2-1-3-3 and PAU 1973-121-1-2-2-1 were found promising against insect pest.

Mishra *et al.* (2002) screened thirty three rice varieties, against leaf infestation caused by leaf folder at OUAT, Bhubaneswar, Orissa and observed varieties Parijat, Rudra, Sankar, Khandagiri, Sarathi, Samanta, Meher and Rambha with resistance to leaf folder.

Rao *et al.* (2002) screened 87 and 82 INRC germplasm under field conditions during 1999 and 2000 *kharif* seasons respectively in Hyderabad, Andhra Pradesh, India and four lines, namely INRC 15703, 15708, 15725 and 15732 showed a consistent damage rating of one during both the years.

Singh and Singh (2001) tested eighty six rice cultivars (comprising 60 new collections and 26 commercial controls) against rice leaf folder (*C. medinalis*) infestation under natural condition and reported that fifteen cultivars were recorded as resistant, whereas, 14 strains were moderately resistant.

Sridharan *et al.* (2001) screened rice genotypes against *C. medinalis* under field conditions in Aduthurai, Tamil Nadu, India, during *kharif* 1997 and rabi 1998. The results revealed that the genotypes ASD 19, ADT 38, ADT 39 and Improved White Ponni were scored one damage score. Whereas, ADT 42, ADT 41, ASD 16, IR 50, ASD 20, IR 20, ADT 40 and ADT 44 had three damage score. Remaining 10 and 2 entries were received 5 and 7 damage score, respectively.

2.2 EFFICACY OF ECOFRIENDLY PRODUCTS AGAINST RICE LEAF FOLDER

The articles related to various aspects of ecofriendly products like plant extracts and cow based formulation are limited, hence articles related to the plant leaves used in preparation of products evaluated in rice and other crops are also presented here.

2.2.1 Neemastram

Patel *et al.* (2017) studied the bio-efficacy of brahmastram, agnastram and neemastram at two different doses in *Bt* cotton against sucking pests and the results revealed that neemastram @ 20 per cent recorded with 2.41, 2.11, 1.97

and 1.90 number of aphids, leaf hoppers, thrips and whitefly respectively per leaf. Where as in control 3.79, 3.55, 3.17 and 3.06 number of aphids, leaf hoppers, thrips and whitefly per leaf were recorded.

Ravichandran *et al*. (2014) conducted experiment on management of rice insect-pests by organic approaches during *kharif* 2011 at Agricultural Research Station, Gangavathi and reported that among various organic treatment against pests, commercial neem @ 3 ml/l recorded with lower plant hopper BPH (8.45/hill), WBPH (8.13/hill) and leaf folder damage (9.83 %) at 3 days after spraying.

Santhosh *et al*. (2009) evaluated the indigenous components against pod borer complex of soybean and reported that, neemastra with 37.13 and 31.71 per cent pod damage in 10 and 5 per cent concentration respectively, where as in case of untreated control 53.07 per cent pod damage was noticed. And also reported the per cent reduction over control as 29.49 and 39.92 per cent in 10 and 5 per cent concentration, respectively.

2.2.2 Brahmastam

Patel *et al*. (2017) reported that among tested organic products brahmastram @ 20 per cent was most effective in controlling the pests like aphids, leaf hoppers, thrips and whitefly with 2.02, 1.64, 1.48 and 1.39 number of pests per leaf respectively. It also recorded with yield of 27.74 q/ha against 15.72 q/ha yield in control.

Yumnam *et al*. (2017), evaluated the relative efficacy of certain products prepared with cow-urine and plant extracts on the incidence of yellow stem borer and grain yield on rice variety KD 2-6-3 during *kharif* season of 2012 and 2013 and revealed that, cow-urine in combination with *Jatropha gossypifolia* at 7500 ml/ha with 0.97 per cent of mean dead heart and treatment of cow-urine in combination with *Artemisea nilagirica* with 0.87 per cent mean white ear head incidence and with 6.58 t/ha of mean grain yield, where as in control grain yield was 3.44 t/ha.

Santhosh *et al*. (2009) evaluated the indigenous components against pod borer complex of soybean and stated that, among all treatments brahmasthra at 5 per cent concentration recorded 28.06 per cent pod damage and 47.05 per cent reduction over control where as in untreated control 53.07 per cent pod damage was recorded.

Akunne *et al*. (2014) conducted a laboratory experiment with some plant extracts against rice weevil and reported that papaya leaf powder caused 7.67 and 6.33 per cent mortality against rice weevil in 5 and 10 grams concentrations, respectively.

Yumnam *et al*. (2014) evaluated the effect of cow-urine based indigenous plant extracts on the incidence of the rice leaf folder in rice crop ecosystem of Manipur valley and reported the treatment cow urine + *Artemisia nilagirica* @ 7500 ml/ha more effective than other treatments like cow urine + *Jatropha gossypifolia* @ 7500 ml/ha and multineem (Azardirechtin 300 ppm) @ 2500 ml/ha with a record of one per cent leaf damage, where as other treatments recorded 1.19 per cent and 1.35 per cent respectively.

Rossi *et al*. (2012) studied the insecticidal effect of castor leaf extracts against *Spodoptera frugiperda* and reported that, per cent larval mortality of 89.9, 55.7, 7.3 and 10 in 10, 5, 2.5 and 1 per cent concentration of castor leaf extract respectively.

Sharma and Gupta (2009) studied antifeedant effects of aqueous extracts of some plant extracts on *Pieris brassicae* (Linn.) and reported that, the treatment with aqueous extract of castor recorded 8.9 per cent mortality of *P. brassicae* and with 29.2 per cent protection to cabbage foliage.

Gupta (2008) studied efficacy of neem in combination with cow urine against mustard aphid and reported that, mean number of aphid per 5 cm upper twig was 17.1, 14.9, 12.6, 18.2, 14.7 and 11.8 in neem leaf extract in cow urine at 1, 2 and 3 per cent, neem kernel extract in cow urine at 1, 2 and 3 per cent respectively.

Sharma *et al.* (1990) studied the insecticidal property of castor against termites attacking mango tree and found that, castor oil, castor cake and castor leaves were effective agents in controlling them significantly.

2.2.3 Agnastram

Patel *et al.* (2017) reported that agnastram @ 20 per cent was effective with 2.24, 1.93, 1.74 and 1.69 least population of aphids, leaf hoppers, thrips and whitefly per leaf respectively in *Bt* cotton. Seed cotton yield of 25.12 q/ha was recorded in agnastram treated plot, whereas in control 15.72 q/ha yield was recorded.

Ravichandran *et al*. (2014) conducted experiment on management of rice insect-pests by organic approaches during *kharif* 2011 at Agricultural Research Station, Gangavathi and reported that among various organic treatments against pests, agnastram @ 30 ml/l recorded 13.08, 9.53, 9.02 and 9.74 numbers of brown plant hopper per hill and 9.45, 6.27, 5.50 and 6.57 number of WBPH per hill and 9.55, 9.61, 5.74 and 4.5 per cent of leaf folder damage per hill when compared to the untreated control with 14.18, 14.5, 15.65 and 18.48 number of brown plant hopper per hill and 10.00, 10.48, 11.67 and 12.98 number of WBPH per hill and 10.58, 10.61, 12.36 and 16.85 per cent of leaf folder damage per hill at 1 DAS, 3 DAS 7 DAS and 14 DAS respectively.

Santhosh *et al*. (2009) evaluated the indigenous components against pod borer complex of soybean and stated that, among all treatments agnasthra at 5 per cent concentration recorded 24.63 per cent pod damage and 53.45 per cent reduction over control where as in untreated control 53.07 per cent pod damage was recorded.

2.2.4 Neem Seed Kernel Extract

Reddy *et al.* (2018) conducted field experiment to evaluate the efficacy of botanicals and other extracts against plant hoppers in rice. Among the botanical extracts, neem seed kernel extract at 7.5 per cent concentration recorded higher efficacy against hoppers by recording 49.4 per cent mean reduction with a mean grain yield of 4775 kg/ha.

Ritesh Kumar *et al.* (2017) evaluated the efficacy of different plant extracts against *Mythemna separata* in Oats crop and reported that, NSKE @ 5 per cent showed highest control against *M. separata* with highest mean per cent mortality of 46.65 when compared to untreated control with 5.93 per cent mortality. Also reported 87.28 per cent increased yield over control.

Chaudhari *et al.* (2017) assessed the efficacy of neem based insecticides for the management of yellow stem borer, *Scirpophaga incertulas* Walk. in paddy at Research cum Instructional Farm, IGKV, Raipur during *Kharif*, 2015-16 and six commercial biopesticides like, Neembaan, Neemazal, Nimbecidine, Multineem, Neem oil, NSKE and a chemical insecticide *i.e.*, Dinotefuran were evaluated against stem borer in the field conditions. As per the performance of different treatments, Nimbecidine @ 5 ml/l was most effective with overall mean 6.36 per cent dead hearts and 14.00 per cent white ear heads. It was closely followed by Neem oil @ 5ml/l with overall mean 6.82 per cent dead hearts and 16.58 per cent white ear heads.

Dey *et al.* (2012) studied the efficacy of different insectides against rice leaf folder and reported that NSKE @ 5 per cent was effective with 71.81 per cent of mortality, where as in control 6.16 per cent of mortality was recorded.

Kaushik Chakraborty (2011) studied the field efficacy of some bio rational pesticide formulations against yellow stem borer under field condition during 2007-2009 at Raigani, Uttar Dinajpur, West Bengal, India and reported that, the treatment with neem seed kernel extract was highly effective in controlling the yellow stem borer population among all plant extracts evaluated with 56.48 per cent decrease of incidence of dead hearts over control and with 61.22 per cent decrease of incidence of white ears over control.

Ogah *et al.* (2011) studied the effect of neem seed kernel extract against stem borers of rice and reported that neem seed kernel extract significantly reduced stem borers damage compared to untreated check and also significantly increased no. of productive tillers with resultant increase in grain yield than the

control plot. Maximum number of different natural enemies recorded in neem seed kernel extract treated plot against carbofuran treated plot. They suggested that, the neem seed kernel extract as the suitable alternative for management of rice stem borers in rice ecosystem on the basis of borers infestation, conservation of natural enemies and high yield.

Neem oil (2.00, 3.00 and 4.00 %), and neem seed kernel extract (4.00, 5.00 and 6.00 %) were compared with monocrotophos (0.03, 0.04 and 0.05 %) for their relative toxicity to larvae of *C. medinalis*. Second instar larvae released on 24 hours old films of three concentrations of neem oil, neem seed kernel extract and monocrotophos were found to be more susceptible than those released after 48, 72 and 96 hours of residual films. The maximum mortality was observed in monocrotophos (73.53 to 83.05 %) which proved to be the best treatment followed by neem oil (56.32 to 60.58 %) and lowest in neem seed kernel extract (55.22 to 61.48 %) on 24 hour old films. (Arun *et al*. 2000).

Ambethgar (1996) studied the efficacy of different neem [*Azadirachta indica*] products, *i.e.,* neem cake (200 kg/ha basal application), neem cake (200 kg/ha basal application) + neem seed kernel extract 5 per cent (at 25 and 32 days after transplanting), NSKE 5 per cent, neem leaf decoction (0.5 kg/one litre of water), and neem oil 3 per cent was compared with chlorpyriphos 20 EC (0.5 kg a.i./ha) and quinalphos 25 EC (0.4 kg a.i./ha) against *C. medinalis* in rice fields in Pondicherry, India, during 1993-94. Chlorpyriphos proved to be the most effective insecticide against the pest. Neem cake + NSKE 5 per cent was the next best treatment followed by quinalphos, neem seed kernel extract and neem oil. Both, the applications of neem leaf decoction and neem cake, proved to be least effective in reducing the percentage of damaged leaves due to the insect.

Reddy *et al*. (2018) evaluated the efficacy of botanicals against rice plant hoppers during 2009-2011 and found that neem seed kernel extract @ 7.5 per cent concentration with higher efficacy against hoppers by recording 49.4 per cent mean reduction with mean grain yield of 4775 kg/ha.

Santhosh *et al*. (2009) evaluated the indigenous components against pod borer complex of soybean and stated that, among all treatments, significant lowest (23.59 %) per cent pod damage has recorded in NSKE treated plot with 55.83 per cent reduction over control.

2.2.5 Panchapatra Extract

As the literature on panchapatra extract is not available, literature on the plant leaves used for preparation of panchapatra extract is here with revied.

2.2.5.1 Pongamia leaf extract

Reddy *et al.* (2018) evaluated the efficacy of botanicals against rice plant hoppers during 2009-2011 and found that pongamia leaf extract @ 5.0 and 7.5 per cent concentration with 45.4 and 46.0 per cent mean reduction of plant hoppers with mean grain yield of 4725 and 4425 kg/ha respectively.

Pandey *et al.* (2017) studied the effect of different plant products against rice leaf folder population in rice ecosystem and reported that among different plant products karanj oil found to be most effective treatment with the minimum leaf damage of 2.26 per cent and with the maximum of 41.45 per cent reduction over control.

Tran *et al*. (2017) studied the efficacy of pongamia leaf extracts against *Spodoptera exigua and Spodoptera litura* and reported that the acute lethal toxicity of pongam leaf extract was high against the two armyworm species; the LC_{50} values were 1.94, 1.52 and 1.10 per cent at 24, 48 and 72 hours, respectively for *S. litura* whereas the values for *S. exigua* larvae were 3.18, 2.57 and 1.89 per cent at 24, 48 and 72 hours, respectively.

Tran *et al*. (2016) studied the efficacy of pongamia leaf extracts against turnip aphids and reported that, in laboratory tests, pongamia leaf extract with acute toxicity to the turnip aphid and the LC_{50} values were 0.585, 0.151 and 0.113 per cent at 24, 48 and 72 hours, respectively. Laboratory observations also indicated that low concentrations of pongamia leaf extract caused

significant reduction of vitality and fertility of the turnip aphids of the subsequent generation and thus caused an indirect reduction of overall pest numbers in the next generation.

Ravichandran *et al*. (2014) conducted experiment on management of rice insect-pests by organic approaches during *kharif* 2011 at Agricultural Research Station, Gangavathi and reported that among various organic treatments against rice pests, pongamia aqueous extract @ 50 ml/l recorded with 13.91, 10.17, 9.98 and 11.69 number of brown plant hopper per hill and 9.32, 6.48, 7.52 and 9.39 number of WBPH per hill and 9.62, 9.74, 6.15 and 7.35 per cent of leaf folder damage per hill when compared to the untreated control with 14.18, 14.5, 15.65 and 18.48 number of brown plant hopper per hill and 10.00, 10.48, 11.67 and 12.98 number of WBPH per hill and 10.58, 10.61, 12.36 and 16.85 per cent of leaf folder damage per hill at 1 DAS, 3 DAS, 7 DAS and 14 DAS respectively.

Kaushik Chakraborty. (2011) studied the field efficacy of some bio rational pesticide formulations against yellow stem borer under field condition during 2007-2009 at Raigani, Uttar Dinajpur, West Bengal, India and reported that, the treatment with karanj seed kernel extract was effective in controlling the yellow stem borer population among all plant extracts with 40.71 per cent decrease of incidence of dead hearts over control and with 40.85 per cent decrease of incidence of white ears over control.

Mallapur and Ladaji (2010) reported that, leaf extracts of *Pongamia pinnata*, NSKE, cow urine and *Aloe vera* extracts @ 5 per cent in combination reduced 55.71 to 56.11 per cent of *H. armigera* larval populations.

Santhosh *et al*. (2009) evaluated the indigenous components against pod borer complex of soybean and stated that, among all treatments *Pongamia pinnata* leaf extract at 5 per cent concentration recorded 40.07 per cent pod damage and 24.46 per cent reduction over control, where as in untreated control 53.07 per cent pod damage was recorded.

2.2.5.2 Neem leaf extract

Shahzad *et al.* (2016) studied biopesticides effect against sucking pests of brinjal crop and reported that, the first spray of chemical control (confidor) showed highest per cent reduction of white fly (96.62 %) followed by Neem extract (82.60 %), Tobacco extract (75.95 %), Eucalyptus extract (73.93 %) and lowest in untreated control (11.07 %). In the second spray also, chemical control (Diamond) showed highest effect against white fly (78.32 %) followed by Neem extract (67.53 %), Tobacco extract (56.43 %), Eucalyptus extract (42.25 %) and least by untreated plot (5.49 %). Against jassid, chemical control (confidor) showed highest effect (77.90 %) as followed by Neem extract (55.95 %), Tobacco extract (53.38 %), Eucalyptus extract (53.99 %) and untreated control (8.00 %) in first spray, while after second spray also, chemical control (Diamond) showed highest per cent reduction (81.70 %) followed by Neem extract (68.73 %), Tobacco extract (55.72 %), Eucalyptus extract (50.66 %) and the lowest was resulted by untreated control (13.91 %). Against mites population on brinjal the first spray results showed that chemical control (confidor) showed highest effect (98.19 %) followed by Neem extract (96.19 %), Tobacco extract (95.75 %), Eucalyptus extract (86.86 %) and least population was recorded in untreated control (9.96 %). After second spray, chemical control (Diamond) showed highest per cent reduction (99.65 %), followed by Neem extract (98.33 %), Tobacco extract (92.85 %), Eucalyptus extract (88.93%) and the lowest reduction per cent was resulted by untreated control (9.14 %) respectively. Chemical control (confidor/Diamond) showed its superiority in effect to combat sucking insect pests studied in brinjal, followed by Neem extract, Tobacco extract, Eucalyptus extract and untreated control remained the least.

Akunne *et al*. (2014) evaluated the efficacy of some plant products against rice weevil in laboratory and found that 7.67 and 8.33 mean mortality of rice weevil in neem leaf powder treatment in 5 and 10 grams concentrations respectively.

Indiati (2014) evaluated the efficacy of neem and sugar apple extracts against leaf eating pest of soybean and reported that, neem seed, sugar apple leaf and sugar apple seeds extract with water solvent each with concentration of 50 g/l were effective to suppress armyworm populations (47 to 49 %) higher than chemical insecticides.

Sable *et al*. (2014) evaluated the efficacy of different plant extracts against mustard leaf aphid in glass house at Indira Gandhi Krishi Vishwavidyalaya, Raipur during 2011-12 and reported that, neem leaf extract at 5 per cent was effective in managing the mustard aphid with 71.00 per cent mortality followed by tobacco leaf extract at 5 per cent with 63.00 per cent mortality.

Jeyaparvathi *et al*. (2013) studied the pesticidal activity of plant extracts against okra pests and reported that, highest insecticidal activity was in *Azadirachta indica* treated plot within 48 hours.

Kaushik Chakraborty (2011) studied the field efficacy of some bio rational pesticide formulations against yellow stem borer under field condition during 2007-2009 at Raigani, Uttar Dinajpur, West Bengal, India and reported that, the treatment with neem leaf extract was effective in controlling the yellow stem borer population with 50.19 per cent decrease of incidence of dead hearts over control and with 54.17 per cent decrease of incidence of white ears over control.

Mamun *et al*. (2009) evaluated the toxicity effect of botanicals against red flour beetle and found that neem seed extract with highest toxic effect of 52.50 per cent and neem leaf with 48.22 per cent, pongamia leaf with 38.83 per cent and its seeds with 42.60 per cent.

Sharma and Gupta (2009) studied antifeedant effects of aqueous extracts of some plant extracts on *Pieris brassicae* (Linn.) and reported that, the treatment with aqueous extract of *A. indica* recorded 54.2 per cent protection to cabbage foliage and with 18.5 per cent mortality of *P. brassicae*.

Singh and Batra (2001) studied the bioeffecacy of different neem formulations in forage sorghum along with the chemical insectide, endosulfan and reported that among neem formulations, 0.6 eggs/plant and 18.5 per cent of dead hearts were recorded in neem guard treated plot against shoot fly.

2.2.5.3 Custard apple leaf extract

Pareek *et al*. (2018) evaluated the efficacy of custard apple seed extract against pigeon pea pod borer *Helicoverpa armigera* (Hubner) in laboratory and reported that lethal concentration LD_{50} and LC_{90} of the aqueous custard apple seed extract was found to be 53.24 mg/ml and 107.52 mg/ml respectively.

Estrada *et al*. (2013) studied the insecticidal effect of plant extracts on immature stages of whitefly and reported that, lowest LD_{50} value in *A. squamosa* (0.36 %) treatment.

Pandey and Brave (2011) evaluated and reported the biological activity of *Annona squamosa* seed extracts attributed to its several alkaloids contents, such as Squamocins B to N, Anonaine, Squamocin, Annotemoyin-1and 2, Glucopyranoside and Cholestrol etc. which might cause the mortality of the insects.

Kumar *et al*. (2010) studied the insecticidal activity of ethanolic extract of custard apple leaves against rice weevil and found significant knockdown in the concentration one per cent w/v and five per cent w/v tested 23.1 and 11.4 minutes, respectively. The 100 per cent mortality at 39.6 and 14.5 minutes for one per cent w/v and five w/v concentration respectively.

Khalequzzaman and Sultana (2006) conducted the laboratory experiment evaluated the insecticidal properties of custard apple seed extract with petroleum spirit, acetone, ethyl acetone and methanol against raj, CR 1, FSSII and CTC-12 strains red flour beetle and reported that in larval bioassay, highest toxicity was recorded for petroleum spirit extract in raj strain (LD_{50} is 0.03 µg cm^{-2}) and lowest toxicity was in methanol extract in FSS II strain (LD_{50} is 58.697 µg cm^{-2}).

2.2.5.4 Jamun leaf extract

Kanthammal *et al*. (2018) studied novel insecticidal properties of *Syzygium cumini* fabricated silver nanoparticles against mosquitoes and found that silver nanoparticles of jamun as highly effective against the larvae of *Aedes stephensi*, *A. aegypti* and *Culex quinquefasciatus* with LC_{50} value of 14.58, 16.45 and 18.83 µg/ml respectively, and also suggested that, the synthesized silver nanoparticles as a rapid, environmentally safer bio pesticide to be used in synergy with *S. cumini* to control mosquito vectors.

2.2.5.5 Eucalyptus leaf extract

Ganeshwari *et al*. (2019) investigated bio-efficacy of essential oils and insecticides against yellow stem borer under field conditions at Research cum Instructional Farm of IGKV, Raipur during 2017-18 and reported that eucalyptus oil with 17.99 per cent mean dead heart and 27.47 per cent white ear head, where as in control 36.00 and 55.68 per cent respectively.

Sharma and Gupta (2009) studied antifeedant effects of aqueous extracts of some plant extracts on *Pieris brassicae* (Linn.) and reported that, the treatment with aqueous extract of eucalyptus recorded 15.8 per cent mortality of *P. brassicae* and with 50.7 per cent protection to cabbage foliage.

2.2.6 Chilli-Garlic Extract

Pandey *et al.* (2017) studied the effect of different plant products against rice leaf folder population in rice ecosystem and reported that among different plant products chilli garlic solution found to be effective treatment with the minimum leaf damage per cent (2.45 %) and with the 36.53 per cent reduction over control.

Baidoo and Mochaiah (2016) conducted experiment of the effectiveness on garlic (*Allium sativum* L.) in the management of major pests of cabbage (*Brassica oleracea* L.) and revealed that garlic treated plot showed 42.05 per cent reduction of aphids, where as in control plot aphid population increased by

15.29 per cent and 31 per cent reduction of diamond back moth, 10.76 per cent of cabbage semi looper reduction and 41.69 per cent of cabbage head borer reduction was noticed.

Pandey *et al*. (2017) evaluated the different plant products like neem oil, karanj oil, NSKE, karanj seed powder extract, chilli garlic solution, chilli solution and chemical chlorantraniliprole on rice leaf folder's population. They reported that chlorantraniliprole 18.5 % SC with least damage per cent (1.10 mean leaf damage per cent per five hills), among different plant products karanj oil followed by chilli garlic solution were found to be most effective treatments with minimum 2.26 and 2.45 mean leaf damage per cent respectively.

Minh *et al*. (2014) evaluated the efficiency of garlic and chili combination solution for control of insect pests of cabbage crop and reported that the chilli-garlic-soap combination @ 0.1 per cent was found most effective in reducing the cabbage insect pests *viz*., diamond back moth (62.03 %), case worms (56.55 %) and flea bettle (88.16 %).

Pahla *et al.* (2014) evaluated the effectiveness of botanicals spray in controlling aphids on rape (*Brassica napus* L.) and reported reduction of aphid population of 50.03 per cent, 45.08 per cent, 17.99 per cent, 14.8 per cent and 72.03 per cent in 10 grams, 7.5 grams, 5 grams, 2.5 grams of each garlic and chilli treated plots and dimethoate treated plots respectively. Treatment with 10 grams of garlic and 10 grams of chilli had recorded highest yield followed by 7.5 grams of each garlic and chilli treated plot with yield of 68.2 t/ha and 62.6 t/ha respectively when compared to control (54.3 t/ha).

Mallapur and Lingappa (2005) conducted field trials for three years (2000-2001 to 2002-2003) on the evaluation of indigenous materials against chilli pests at University of Agricultural Sciences, Dharwad and reported that the least leaf curl index was recorded in chilli garlic kerosene + nimbicidene at 0.5 per cent concentration against both thrips and mites with 0.4 and 0.8 leaf curl index respectively and also reported that highest pod yield was obtained in

garlic-chilli kerosene extract + nimbecidine treated plot (10.6 q/ha) followed by insecticide treated (9.9 q/ha) and garlic-chilli kerosene extract treated plot (9.5 q/ha).

Ravichandran *et al*. (2014) conducted experiment on management of rice insect-pests by organic approaches during *kharif* 2011 at Agricultural Research Station, Gangavathi and reported that among various organic treatments against pests, garlic chilli kerosene extract @ 10 ml/l recorded with 13.37, 10.30, 10.22 and 11.40 numbers of brown plant hopper per hill and 9.33, 6.63, 7.71 and 9.75 number of WBPH per hill and 10.04, 10.10, 6.43, and 7.65 per cent of leaf folder damage per hill when compared to the untreated control with 14.18, 14.5, 15.65 and 18.48 number of brown plant hopper per hill and 10.00, 10.48, 11.67 and 12.98 number of WBPH per hill and 10.58, 10.61, 12.36 and 16.85 per cent of leaf folder damage per hill at 1 DAS, 3 DAS, 7 DAS and 14 DAS respectively.

Santhosh *et al*. (2009) evaluated the indigenous components against pod borer complex of soybean and stated that, among all treatments chilli garlic kerosene extract at 5 per cent concentration recorded 36.70 per cent pod damage and 31.12 per cent reduction over control, where as in untreated control 53.07 per cent pod damage was recorded.

2.2.7 Datura Leaf Extract

Ritesh kumar *et al.* (2017) evaluated the efficacy of different plant extracts against *Mythemna separata* in Oats crop, revealed that, datura green leaf extracts @ 5 per cent recorded mean per cent mortality of 28.47 per cent when compared to the untreated control with 5.93 per cent mortality. And also reported 79.17 per cent increased yield over control.

EI-Massad *et al.* (2012) studied the insecticidal potentiality of datura leaf extracts against cluster bug at 2, 3, 5 and 7 days intervals and found 6.7, 16.7, 20.0 and 20.0 per cent mortality, respectively.

Abbasipour *et al*. (2011) evaluated the insecticidal activity of extract of *Datura stramonium* against *Callosobruchus maculatus* in a laboratory experiments and reported that the mortality of pest increased with increase in concentration and exposure time. And also reported the probit analysis for lethal concentration to kill 50 per cent of the population as 1680 ppm and 16058 ppm, for 24 and 48 hours, respectively.

George *et al*. (2008) studied the insecticidal activity of eight plant extracts and found that the plant extracts of *Datura innoxia* with 100 per cent motality on fourth instar mosquito larvae and 30 to 40 per cent mortality on white fly.

Ali *et al*. (2012) evaluated the potential of datura leaf extracts against khapra beetle and rice weevil and reported that, the maximum datura leaf extract concentration (2.5 %) caused the lowest survival rates with 67.5 per cent for *T. granarium* and 55 per cent for *S. oryzae*.

Jawalkar *et al*. (2016) studied the insecticidal property of datura seed extracts against rice weevil in stored wheat grain and reported that Soxhlet's extracted extracts of *D. stramonium* seed in ethanol, chloroform and acetone were very effective to control the pest while extracts in methanol and n-hexane gave poor results. The probit analysis of data demonstrated that LD_{10}, LD_{50} and LD_{90} values for ethanol, chloroform and acetone extracts was LD_{10} is 2.962, 3.080, 0.4752 ml/kg, LD_{50} is 8.594, 7.379, 1.185 ml/Kg and LD_{90} is 24.94, 17.67, 2.957 ml/kg respectively for 96 hours and these results suggest that the mortality increased with increase in concentration as well as exposure time.

2.2.8 Flubendiamide 480 SC

Chaudhari *et al.* (2017) screened newer insecticides against major insect pests of rice and reported that flubendiamide 480 SC @ 50 ml/ha was recorded 2.34 per cent leaf damage, where as in control 3.75 per cent leaf damage was noticed. In case of flubendiamide 240 % with thiocloprid 240 % @ 250 ml/ha recorded least damage of 2.13 per cent.

Rashid *et al.* (2013) studied efficacy of karuz (cartaphydrochloride 4G) and belt (flubendiamide 48 SC) against rice leaf folder and reported 4.02 and 1.77 per cent leaf damage respectively.

Kulagod *et al.* (2011) studied insecticides against rice leaf folder and revealed that flubendiamide 480 SC @ 0.2 ml/l with lower per cent of leaf damage of 4.66, 5.11 and 5.34 at 5, 10 and 15 DAS respectively compared to other chemicals like thiodicarb, cartaphydrochloride, novaluron and chlorpyriphos. And also reported with grain yield of 52.10 q/ha in flubendiamide treated plot where as in control 36.60 q/ha yield was recorded.

Rajkumar (2010) reported that flubendiamide @ 0.2 ml/l found highly effective in managing rice leaf folder with 73.56 per cent population reduction over control.

Sandhu and Dhaliwal (2016) evaluated the efficacy of different chemical insecticides against major insect pests of rice in Punjab and found that Fame (flubendiamide 480 SC) @ 50 ml/ha with significantly lower per cent of damaged leaves (1.47 %) with more grain yield of 66.25 q/ha followed by marktraizo and sutathion.

Karthikeyan (2017) evaluated the efficacy of new insecticides against major pests of rice and reported flubendiamide 20 % WDG with least per cent incidence of rice leaf folder of about 6.2 per cent when compared to control (12.6 %).

Sridhar and Sharma (2015) evaluated the flubendiamide 20 WG against the major lepidopteran defoliator of soybean and reported that flubendiamide 20 WG was most effective with better incremental cost benefit ratio of 3.11, 3.15 and 1.88 at 50, 60 and 120 g a.i./ha and reduction of lepidopteran pests of soybean significantly.

Flubendiamide @ 0.2 ml/l and indoxacarb @ 1 ml/l were highly effective against rice leaf folder with 3.60 and 5.62 per cent leaf damage, respectively (DRR 2010).

Misra (2008) conducted experiment on rice leaf folder management by new insecticides in field during wet seasons (2004-05) and reported that 60.56 per cent reduction of damage due to leaf folder over control in flubendiamide treated plot.

Flubendiamide 20 WDG @ 25 and 50 g a.i./ha recorded 0.61 and 0.44 damaged leaves per hill by leaf folder on 7^{th} day after spray, 0.45 and 0.24 damaged leaves per hill on 14^{th} day after spray, respectively and was superior to chlorpyriphos 20 EC @ 500 g a.i./ha, which recorded 2.41 and 4.81 damaged leaves per hill, respectively on 7^{th} and 14^{th} day after spray (Javaregowda and Krishna Naik 2005).

Chapter – III

Material and Methods

Chapter III

MATERIAL AND METHODS

The present entomological research entitled **"Screening of rice entries for resistance against rice leaf folder, *Cnaphalocrocis medinalis* (Guenee) and its management with ecofriendly products"** was carried out during *kharif*, 2018 in southern block of Agricultural College Farm, Agricultural College, Bapatla. Detailed information on different materials utilized and various methods employed in conducting the experiment during the course of investigation are presented in this chapter.

All the packages of practices like land preparation, nursery raising, transplanting, manures and fertilizers application, weeding and irrigation were followed in raising the rice crop as per ANGRAU recommendation during the experimental period except the plant protection measures.

3.1 RAISING OF RICE NURSERY AND MAIN FIELD REPARATION

Both for screening of rice entries and evaluation of the efficacy of ecofriendly products against rice leaf folder, the nursery and the main field were prepared simultaneously.

The nursery of test variety BPT-5204 (Samba Masuri) and all the test rice entries were raised in floriculture block, Agricultural College Farm, Bapatla. Seeds of all 42 genotypes and BPT-5204 were sown on 30.07.2018 on well prepared raised beds (Plate 1.a and 1.b). The main field layout in field number 49 of southern block for both evaluating the efficacy of ecofriendly products and screening of rice entries were formulated separately. After onset of monsoon, initially the main field was ploughed twice with tractor drawn cultivator. Stubbles, weeds and other left over plant debris were removed. Puddling was done for two times with the tractor with cage wheels after stagnating the water in the field, and then levelling was done thoroughly with the leveling plank.

3.2 SCREENING OF RICE ENTRIES AGAINST RICE LEAF FOLDER, *C. medinalis* (Guenee)

Forty (40) rice entries (table 3.1) along with susceptible check TN-1 and resistant check W-1263 were collected from the Agricultural Research Station, Bapatla, and were sown in lines on well prepared raised beds. All the recommended agronomic practices were adopted during the experimentation as per ANGRAU recommendations.

3.2.1 Layout and Transplanting

The experiment was laid out in randomized block design (RBD), each variety was transplanted in two rows of two meter length (Fig. 3.1). A total of 42 entries were transplanted in three replications. Transplanting was done on 30.08.2018 with 30 days old seedlings in an area of 201.6 metres. Line planting was adopted with a spacing of 20×15 cm (20 cm between the rows and 15 cm between plants) with the help of marked rope. Two to three seedlings were planted per hill and gap filling was done after one week to get uniform population.

3.2.2 Nylon Net Coverage for Screening Area

Twenty five days after transplanting three replications were covered with the nylon net after destruction of the other pests and natural enemies present over there. The main aim of covering with net was to get the complete expression of infestation by the rice leaf folder under controlled conditions and to avoid the influence of other pest and natural enemies on leaf folder under the particular area. Leaf folder adults were collected from the neighboring field and nearby farmers fields and were released in to the netted area. One hundred adults were released twice at 40 DAT and 60 DAT inside the net and entries were subjected to ‘No’ choice test.

Another set of same entries were transplanted in three replications in same measured area and they were subjected to natural field condition.

Table 3.1. List of entries screened for resistance against rice leaf folder

Treatment number	Entries name	Treatment number	Entries name
1	BPT 2270	22	BPT 2938
2	BPT 2601	23	BPT 2946
3	BPT 2787	24	BPT 2947
4	BPT 2795	25	BPT 2949
5	BPT 2798	26	BPT 2956
6	BPT 2808	27	BPT 2958
7	BPT 2845	28	BPT 3018
8	BPT 2849	29	BPT 3025
9	BPT 2850	30	BPT 3031
10	BPT 2855	31	BPT 3034
11	BPT 2856	32	BPT 3036
12	BPT 2858	33	BPT 3038
13	BPT 2861	34	BPT3041
14	BPT 2863	35	BPT 3042
15	BPT 2865	36	BPT 3049
16	BPT 2871	37	BPT 3058
17	BPT 2874	38	BPT 3059
18	BPT 2875	39	BPT 3060
19	BPT 2932	40	BPT 5204
20	BPT 2935	41	W-1263
21	BPT 2936	42	TN-1

R1 T1	IRRIGATION CHANNEL	R2 T42	IRRIGATION CHANNEL	R3 T21
R1 T2		R2 T41		R3 T20
R1 T3		R2 T40		R3 T19
R1 T4		R2 T39		R3 T18
R1 T5		R2 T38		R3 T17
R1 T6		R2 T37		R3 T16
R1 T7		R2 T36		R3 T15
R1 T8		R2 T35		R3 T14
R1 T9		R2 T34		R3 T13
R1 T10		R2 T33		R3 T12
R1 T11		R2 T32		R3 T9
R1 T12		R2 T31		R3 T10
R1 T13		R2 T30		R3 T11
R1 T14		R2 T29		R3 T8
R1 T15		R2 T28		R3 T7
R1 T16		R2 T27		R3 T6
R1 T17		R2 T26		R3 T5
R1 T18		R2 T25		R3 T4
R1 T19		R2 T24		R3 T3
R1 T20		R2 T23		R3 T2
R1 T21		R2 T22		R3 T1
R1 T22		R2 T21		R3 T42
R1 T23		R2 T20		R3 T41
R1 T24		R2 T19		R3 T40
R1 T25		R2 T18		R3 T39
R1 T26		R2 T17		R3 T38
R1 T27		R2 T16		R3 T37
R1 T28		R2 T15		R3 T36
R1 T29		R2 T14		R3 T35
R1 T30		R2 T13		R3 T34
R1 T31		R2 T12		R3 T33
R1 T32		R2 T11		R3 T22
R1 T33		R2 T10		R3 T31
R1 T34		R2 T9		R3 T30
R1 T35		R2 T8		R3 T29
R1 T36		R2 T7		R3 T28
R1 T37		R2 T6		R3 T27
R1 T38		R2 T5		R3 T26
R1 T39		R2 T4		R3 T25
R1 T40		R2 T3		R3 T24
R1 T41		R2 T2		R3 T23
R1 T42		R2 T1		R3 T32

Figure 3.1. Field layout of screening trial for both natural and controlled conditions

Plate 1. General view of screening trial on rice entries against rice leaf folder under controlled condition

3.2.3 Agronomic Practices

Agronomic practices like manures and fertilizer application, weeding and irrigation were same for both screening of rice entries and ecofriendly product evaluation trials except insect pest management measures.

3.2.4 Manure and Fertilizer Application

Recommended dose of manure @ 5 tonnes/ha was applied 30 day prior to planting into main field and it was mixed well with the soil by ploughing. Recommended dose of urea, single super phosphate and murate of potash was applied @ 120:60:60 kg of NPK/ha. Nitrogen was applied in three split doses, one at puddling stage as a basal dose, second dose at tillering stage and last dose at panicle initiation stage. At the time of puddling, entire recommended dose of phosphorus was applied at once as a basal dose. While split dose of potash was applied once at puddling stage as a basal dose and then second split as top dressing at panicle initiation stage.

3.2.5 Irrigation

Upto tillering stage, 2 cm depth of water was maintained in the experimental field. Then from post tillering stage to maturity stage the level of water was increased to 5 cm. Finally 10 days prior to harvesting field was completely dried.

3.2.6 Weeding

Weeding was done manually at 15, 30 and 45 DAT and whenever necessary.

3.2.7 Data Collection

Collection of data on total number of leaves and number of damaged leaves by rice leaf folder larvae was started from 40 DAT onwards at ten days interval *i.e.*, ten days after release of adults into the net. Data was collected from each entry in ten randomly selected hills in both natural and controlled conditions.

As per International Rice Research Institute, Phillipines (IRRI)'s standard evaluation system (2002), leaf damage is considered for determining the percentage of damage. By using the below mentioned formula the per cent leaf damage was calculated

$$\text{Per cent leaf damage} = \frac{\text{Number of damaged leaves per hill}}{\text{Total number of leaves per hill}} \times 100$$

As suggested in International Rice Research Institute, Phillipines (IRRI)'s standard evaluation system (2002), the per cent leaf damage was calculated by taking the count of damaged leaves and total leaves per hill and scoring was given asmentioned below (Table 3.2).

Table 3.2. Scoring scale of rice leaf folder damage used in experiment

Leaf folder damage (%)	Scale	Status of variety
0	0	Highly resistant
1−10	1	Resistant
11−20	3	Moderately resistant
21−35	5	Moderately susceptible
36−50	7	Susceptible
51−100	9	Highly susceptible

3.3 EVALUATION OF EFFICACY OF ECOFRIENDLY PRODUCTS AGAINST RICE LEAF FOLDER, *C. medinalis*

3.3.1 Layout of Experiment and Transplanting

The experiment was laid out in Randomized Block Design (RBD) (Fig. 3.2 and plate 4). A total of three replications with 15 treatments were maintained in a total area of 1394 m² and each plot size was 25 m² (5 m× 5 m). Thirty days old seedlings of BPT-5204 rice variety were transplanted on 30.08.2018. Line planting was adopted with a spacing of 20×15 cm (20 cm between the rows and 15 cm within the rows) with the help of marked rope. Two to three seedlings were planted per hill and gap filling was done after one week to get uniform population.

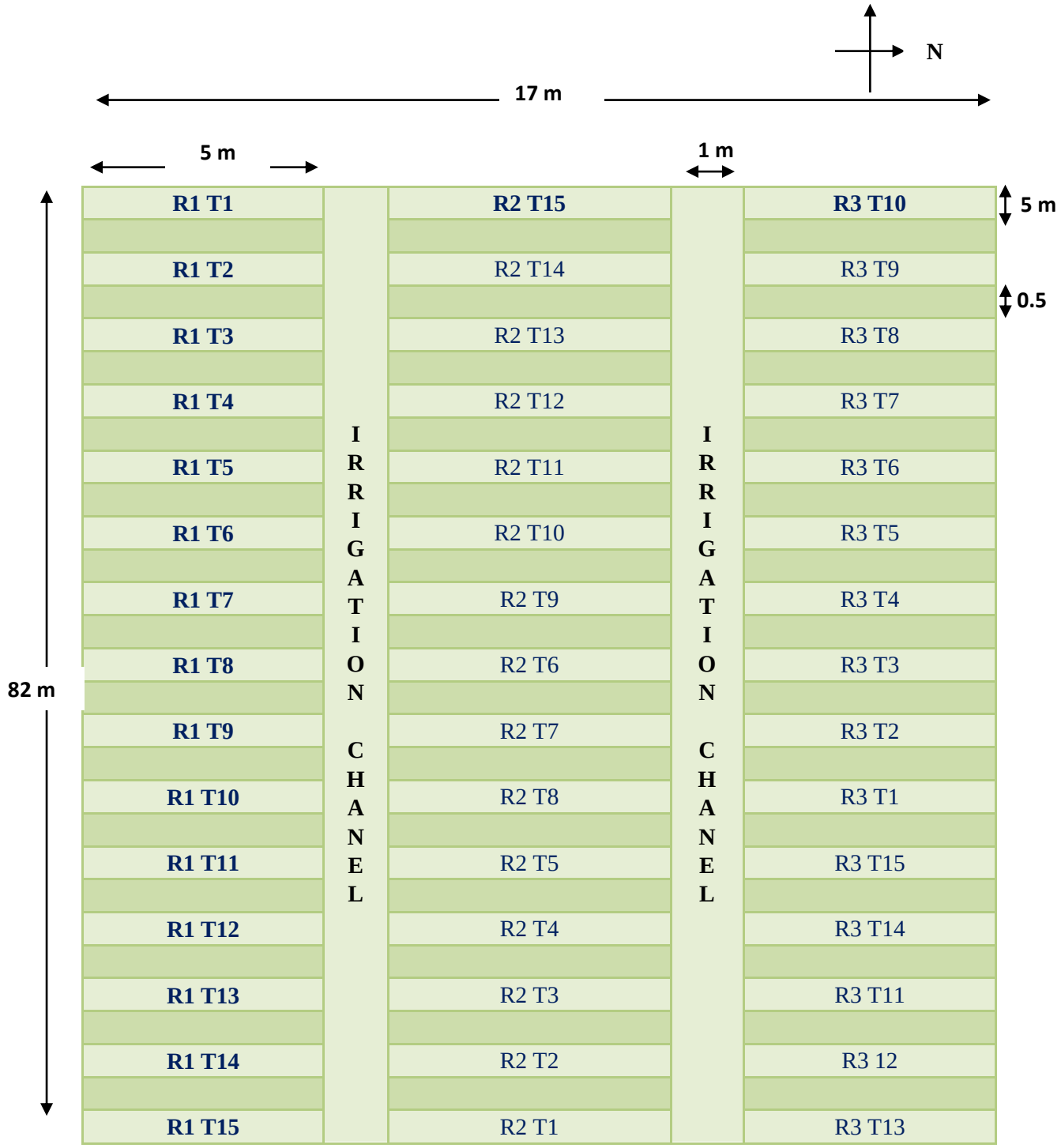

Figure 3.2. Field layout of trial on evaluation of ecofriendly products against rice leaf folder, *C. medinalis.*

Plate 2. General view of trial on ecofriendly products evaluation against rice leaf folder, *C. medinalis*

3.3.2 Preparation of Extracts of Plant Products and Application

All the raw materials required for the organic insecticide preparation were collected locally and extracts were prepared (table 3.3 and Plate 3). The procedures for preparation of extracts are discussed below.

3.3.2.1 Neemastram

Materials required:

Neem leaves	: 1 kg
Cow urine	: 1 litre
Cow dung	: 200 grams
Water	: 2 litres

Method of preparation

In a plastic drum one kg of grinded neem leaves paste along with two litres of water was mixed. Added one litre of cow urine and 200 grams of cow dung to this content and mixed thoroughly. Then the content was kept for 48 hours and it was stirred two to three times per day. After 48 hours the extract was filtered with the help of muslin cloth and the solution was collected in a clean plastic bottle. Neemastram solution was applied at two different doses *i.e.,* 25 ml/l and 50 ml/l of water.

3.3.2.2 Brahmastram

Materials required:

Cow urine	:	1 litre
Neem leaves	:	300 grams
Custard apple leaves	:	200 grams
Papaya leaves	:	200 grams
Pongamia leaves	:	200 grams
Castor leaves	:	200 grams

Method of preparation

All the above five types of leaves were weighed and grinded separately into paste. In a mud pot one litre of cow urine was taken and added all five types of grinded leaves paste. Then the content was boiled for about two hours and then kept for cooling for about 48 hours. After 48 hours the content was filtered and the solution was collected and used for spraying. Brahmastram solution was applied at two different doses *i,e.*, 25 ml/l and 50 ml/l of water.

3.3.2.3 Agnastram

Materials required:

Cow urine	:	1 litre
Tobacco leaves	:	100 grams
Neem leaves	:	500 grams
Green chilli	:	50 grams
Garlic	:	50 grams
Water	:	1 litre

Method of preparation

In a mud pot one litre of cow urine was taken and added separately grinded neem leaves, tobacco leaves, chilli and garlic paste. Then the content was boiled for two hours and kept for cooling. After 48 hours the extract was filtered and solution was used for spraying. Agnastram solution was sprayed at two different doses *i.e.,* 25 ml/l and 50 ml/l of water.

3.3.2.4 Neem seed kernel extract

Materials required:

Neem seeds	:	1 kilo grams
Soap powder	:	20 grams
Water	:	20 litres

Method of preparation

One kg of neem seed kernels were powdered and taken in a muslin cloth and it was tied tightly then this muslin cloth with powder was soaked in twenty litres of water in a container and it was kept for overnight. Next day the content in the muslin cloth was squeezed and added 200 grams of soap powder. Finally the solution was collected and used for spraying.

3.3.2.5 Panchapatra extract

Materials required:

Neem leaves	:	100 grams
Pongamia leaves	:	100 grams
Custard apple leaves	:	100 grams
Eucalyptus leaves	:	100 grams
Jamun leaves	:	100 grams
Soap powder	:	20 grams
Water	:	20 litres

Method of preparation

In a mud pot, measured quantities of all five types of leaves were soaked in one litre of water over night. Then next day it was boiled for about two hours (till the content become 500 ml) in a medium flame with stirring. After 24 hours it was filtered and added 20 grams of soap powder and finally the solution was diluted by adding 20 lts of water and used for spraying.

The solution was sprayed at two different doses *i.e.*, 25 ml/l and 50 ml/l of water.

3.3.2.6 Chilli garlic extract

Materials required:

Chilli	:	300 grams
Garlic	:	50 grams
Kerosene	:	25 ml
Soap powder	:	10 grams
Water	:	1 litre

Method of preparation

300 grams of green chillis were grinded and added to one litre of water and kept it for overnight. In another container 50 grams of grinded garlic was mixed with 25 ml of kerosene and kept it for overnight. Next day these two solutions were filtered separately and mixed together along with 10 grams of soap powder solution and used for spraying.

The solution was sprayed at different doses *i.e.,* 25 ml/l and 50 ml/l of water.

3.3.2.7 Datura leaf extract

Materials required:

Datura leaves	:	500 grams
Water	:	23 litres

Method of preparation

Half kilogram of datura leaves were crushed and it was added to three litres of water then it was boiled for half an hour and it was filtered then added 20 litres of water to dilute it. Then it was used for spraying.

This extract was used for spraying at two different doses *i.e.,* 25 ml/l and 50 ml/l of water.

3.3.2.8 Flubendiamide 480 SC

Flubendiamide is an insecticide of a newer chemical class, phthalic acid diamides recommended for the management of lepidopteran pests of paddy by Directorate of Plant Protection, Quarantine and Storage, CIB&RC. It has larvicidal activity by disrupting calcium ion balance and rapid cessation of feeding. The insecticide is selective in action against wide range of lepidopteran insect pests. A measured quantity 0.2 ml (0.048 g a.i/lt) of chemical was mixed with one litre of water and sprayed.

Knapsack sprayer was used to impose the treatment. The appliances which were used for spraying were thoroughly cleaned and rinsed with water before each treatment. During the cropping season three sprays were given, first spray was given on the basis of economic threshold level (ETL) (10 % leaf damge at vegetative stage and 5 % flag leaf damage at flowering stage) and remaining two sprays were given at ten days interval (schedule spray) subsequently (plate 4).

3.4.4 Data Collection

As per International Rice Research Institute, Phillipines (IRRI)'s standard evaluation system (2002), leaf damage is considered for determining the percentage of damage. Observations were recorded on the per cent leaf damage by leaf folder in 10 randomly selected hills from each plot of each replication leaving the border rows. Data was recorded by counting the number of leaves damaged by leaf folder and total number of leaves present in the selected hills at one day before spraying (DBS) and 3, 7 days after spraying (DAS).

The per cent leaf folder damage and the per cent reduction of leaf damage over untreated control (by using Modified Abbott's formula) were calculated by using the following formulae

$$\text{Per cent leaf folder damage} = \frac{\text{Number of damaged leaves per hill}}{\text{Total number of leaves per hill}} \times 100$$

Per cent reduction of leaf damage =

$$\left(1-\left(\frac{post\ treatment\ leaf\ damage}{pre\ treatment\ leaf\ damage\ in\ treatment}\times\frac{pre\ treatment\ leaf\ damage}{post\ treatment\ leaf\ damage\ in\ untreated\ control}\right)\right)\times 100$$

Per cent increase of yield over control= $\frac{Yield\ in\ treatment-Yield\ in\ control}{Yield\ in\ control}\times 100$

3.4.5 Cost Benefit Ratio (ICBR)

The ratio between extra benefit obtained from enhanced yield and the extra cost incurred for each treatment were expressed as cost benefit ratio.

3.4.6 Yield

The net plots were harvested replication wise and yield per plot was recorded and expressed as kg/net plot based on which yield per hectare was calculated.

3.5 STATISTICAL ANALYSIS

The per cent leaf folder damage in each observation was transformed to the corresponding Arc sine values and subjected to ANOVA. The yield data in each treatment were recorded separately and subjected to statistical analysis (Gomez & Gomez, 1984) to test the significance of mean yield in different treatments. The per cent increase in yield over untreated check in various treatments was calculated**.** The per cent reduction of leaf folder damage over control (untreated) was calculated by using modified Abbott's formula followed by Flemming and Retnakaran (1985).

Table 3.3. The particulars of different ecofriendly products used in the experiment

Insecticide (Treatments)	Ingredients used	Dosage
T_1: Neemasthram	Cow dung-200 grams + cow urine-1 litre + neem leaves-1 kg+water-2 litre.	25 ml/l
T_2: Neemasthram	Cow dung-200 grams + cow urine-1 litre + neem leaves-1 kg+water-2 litre.	50 ml/l
T_3: Brahmsthram	Cow urine-1 litre + neem leaves-300 g + custard apple leaves-200 g + pongamia leaves-200 g + papaya leaves-200 g + castor leaves-200 g.	25 ml/l
T_4: Brahmsthram	Cow urine-1 litre + neem leaves-300 g + custard apple leaves-200 g + pongamia leaves-200 g + papaya leaves-200 g + castor leaves-200 g.	50 ml/l
T_5: Agnasthram	Cow urine-1 litre + tobacco leaves-100 g + garlic-50 g + green chili-50 g + neem leaves-500 g water-1 litre.	25 ml/l
T_6: Agnasthram	Cow urine-1 litre + tobacco leaves-100 g + garlic-50 g + green chili-50 g + neem leaves-500 g water-1 litre.	50 ml/l
T_7: NSKE	1 kg neem seed kernel powder in 20 litres water	5 %
T_8: Panchapatra extract	Neem leaves-100 g + pongamia leaves-100 g + custard apple leaves-100 g + eucalyptus leaves-100 g + jamun leaves-100 g + soap powder- 20 g + water-20 litres.	25 ml/l
T_9: Panchapatra extract	Neem leaves-100 g + pongamia leaves-100 g + custard apple leaves-100 g + eucalyptus leaves-100 g + jamun leaves-100 g + soap powder- 20 g + water-20 litres.	50 ml/l
T_{10}: Chilli and Garlic extract	Green chilli-300 g + garlic-50 g + kerosene-25 ml + 100 g soap powder.	25 ml/l
T_{11}: Chilli and Garlic extract	Green chilli-300 g + garlic-50 g + kerosene-25 ml + 100 g soap powder.	50 ml/l
T_{12}: Datura leaf extract	500 g datura leaves + 23 litres of water.	25 ml/l
T_{13}: Datura leaf extract	500 g datura leaves + 23 litres of water.	50 ml/l
T_{14}: Chemical control Flubendiamide 480 SC	N2-[1,1-Dimethyl-2-[methylsulfonyl]-3-iod-n-[2methyl-4-[1,2,2,2-tetrafluoro-1-(trifluoromethyl) ethyl]phenyl]-1,2-benzenedicarboxamide	0.2 ml/l
T_{15}: Untreated control	-	-

Plate 3. Preparation of ecofriendly products for spraying

Plate 4. Application of ecofriendly products in management trial against rice leaf folder, *C. medinalis*

Plate 5.a: Larvae of rice leaf folder, *C. medinalis*

Plate 5.b: Leaf damage by rice leaf folder, *C. medinalis*

Chapter – IV

Results and Discussion

Chapter IV

RESULTS AND DISCUSSION

The present study on "Screening of rice entries against rice leaf folder, *Cnaphalocrocis medinalis* (Guenee) and its management by ecofriendly products" was carried out under Department of Entomology, Agricultural College, Bapatla, Andhra Pradesh during *kharif* 2018. The results pertaining to the investigation were presented here under.

4.1 SCREENING OF RICE ENTRIES AGAINST RICE LEAF FOLDER, *Cnaphalocrocis medinalis*

Totally 42 rice entries including susceptible check (TN-1) were screened against rice leaf folder, *C. medinalis* and data on infestation was recorded at ten days intervals after 40 days after transplanting both in natural and controlled conditions. The analysis of variance on leaf infestation was showed highly significant among the rice entries and results were presented (Table 4.1, 4.2 and Fig. 4.1, 4.2).

4.1.1 Per cent Leaf Damage under Controlled Condition

4.1.1.1 Observation at 40 Days after Transplanting

The data revealed that, seven entries (BPT 2863, BPT 2874, BPT 2958, BPT 3031, BPT 3036, BPT 3041 and BPT 3060) recorded damage rating between 11.51 to 17.12, thirty four entries (BPT 2270, BPT 2601, BPT 2787, BPT 2795, BPT 2798, BPT 2808, BPT 2845, BPT 2849, BPT 2850, BPT 2855, BPT 2856, BPT 2858, BPT 2861, BPT 2865, BPT 2871, BPT 2875, BPT 2932, BPT 2935, BPT 2936, BPT 2938, BPT 2946, BPT 2947, BPT 2949, BPT 2956, BPT 3018, BPT 3025, BPT 3034, BPT 3038, BPT 3042, BPT 3049, BPT 3058, BPT 3059, BPT 5204 and W-1263) recorded below ten per cent and susceptible check TN-1 recorded 28.08 per cent leaf damage.

Table. 4.1. Susceptibility-Resistance rating of different rice entries against rice leaf folder, *Cnaphalocrocis medinalis* under controlled condition, *kharif* 2018

S. No.	Rice entries	LEAF FOLDER DAMAGE (%)								S/R Ratio	Damage Rating
		40 DAT	50 DAT	60 DAT	70 DAT	80 DAT	90 DAT	100 DAT	Mean		
1	BPT 2270	3.53 (12.04)	12.55 (20.83)	11.56 (20.05)	21.18 (26.65)	18.18 (24.78)	17.37 (24.25)	10.11 (18.86)	13.49 (26.58)	MR	3
2	BPT 2601	6.44 (15.44)	26.58 (29.72)	27.32 (30.12)	31.75 (32.39)	29.56 (31.29)	26.14 (29.48)	15.69 (23.12)	23.35 (30.14)	MS	5
3	BPT 2787	4.57 (13.35)	18.20 (24.80)	17.17 (24.12)	23.20 (27.84)	22.13 (27.22)	19.46 (25.60)	12.93 (21.12)	16.81 (27.98)	MR	3
4	BPT 2795	5.89 (14.85)	24.76 (28.72)	24.30 (28.47)	27.40 (30.16)	27.24 (30.08)	21.18 (26.65)	12.51 (20.80)	20.47 (29.23)	MR	3
5	BPT 2798	6.40 (15.40)	27.59 (30.26)	27.11 (30.01)	28.41 (30.69)	29.21 (31.11)	20.25 (26.08)	14.35 (22.17)	21.90 (29.70)	MS	5
6	BPT 2808	6.92 (15.93)	30.41 (31.72)	29.92 (31.47)	29.42 (31.22)	31.19 (32.11)	22.23 (27.28)	14.51 (22.28)	23.51 (30.18)	MS	5
7	BPT 2845	7.44 (16.44)	33.24 (33.12)	32.73 (32.87)	30.43 (31.73)	33.17 (33.09)	24.56 (28.62)	16.33 (23.56)	25.41 (30.74)	MS	5
8	BPT 2849	7.96 (16.94)	36.06 (34.46)	35.54 (34.22)	31.44 (32.24)	35.14 (34.03)	19.60 (25.69)	11.12 (19.70)	25.27 (30.57)	MS	5
9	BPT 2850	8.48 (17.42)	38.89 (35.75)	38.34 (35.51)	32.45 (32.74)	37.12 (34.95)	24.89 (28.80)	13.15 (21.28)	27.62 (31.25)	MS	5
10	BPT 2855	9.00 (17.89)	41.71 (37.00)	41.15 (36.76)	33.46 (33.23)	39.09 (35.84)	21.39 (26.78)	16.53 (23.69)	28.91 (31.60)	MS	5
11	BPT 2856	9.52 (18.35)	44.54 (38.21)	43.96 (37.96)	34.47 (33.71)	41.07 (36.72)	17.07 (24.06)	9.67 (18.48)	28.61 (31.33)	MS	5
12	BPT 2858	5.41 (14.33)	29.09 (31.05)	30.50 (31.77)	37.24 (35.01)	43.23 (37.65)	33.09 (33.05)	19.67 (25.73)	28.32 (31.41)	MS	5
13	BPT 2861	9.61 (18.43)	32.84 (32.93)	25.02 (28.87)	34.10 (33.54)	26.27 (29.55)	27.81 (30.38)	17.55 (24.37)	24.74 (30.63)	MS	5
14	BPT 2863	14.01 (21.92)	15.06 (22.68)	14.59 (22.34)	21.47 (26.83)	21.40 (26.78)	19.47 (25.60)	10.18 (18.92)	16.60 (28.06)	MR	3
15	BPT 2865	1.68 (9.27)	21.47 (26.82)	21.78 (27.01)	28.27 (30.62)	37.93 (35.32)	23.62 (28.08)	18.38 (24.91)	21.88 (29.41)	MS	5
16	BPT 2871	7.54 (16.53)	22.81 (27.61)	19.10 (25.37)	25.58 (29.18)	21.43 (26.80)	21.28 (26.71)	12.11 (20.48)	18.55 (28.67)	MR	3
17	BPT 2874	17.12 (24.09)	38.44 (35.55)	42.79 (37.46)	49.43 (40.21)	52.32 (41.34)	37.04 (34.91)	29.39 (31.20)	38.07 (33.95)	S	7
18	BPT 2875	0.95 (7.90)	20.69 (26.35)	19.31 (25.51)	24.48 (28.57)	23.96 (28.28)	21.39 (26.78)	18.57 (25.03)	18.48 (28.33)	MR	3
19	BPT 2932	5.22 (14.11)	18.17 (24.77)	15.10 (22.70)	22.18 (27.25)	20.15 (26.03)	16.87 (23.92)	13.05 (21.21)	15.82 (27.64)	MR	3
20	BPT 2935	3.00 (11.32)	15.37 (22.90)	17.61 (24.41)	19.45 (25.59)	21.80 (27.02)	23.58 (28.06)	20.42 (26.19)	17.32 (28.09)	MR	3
21	BPT 2936	7.71 (16.70)	22.10 (27.20)	22.49 (27.43)	37.46 (35.11)	29.56 (31.29)	23.32 (27.91)	14.30 (22.13)	22.42 (29.85)	MS	5
22	BPT 2938	2.14 (10.03)	10.45 (19.14)	11.54 (20.03)	16.43 (23.63)	16.57 (23.72)	15.51 (23.00)	10.08 (18.83)	11.82 (25.79)	MR	3
23	BPT 2946	3.82 (12.43)	11.42 (19.94)	11.61 (20.09)	17.14 (24.10)	15.78 (23.18)	15.32 (22.86)	9.00 (17.90)	12.01 (25.98)	MR	3
24	BPT 2947	2.60 (10.74)	10.64 (19.31)	15.18 (22.76)	18.37 (24.90)	19.19 (25.43)	20.61 (26.31)	16.77 (23.85)	14.77 (27.08)	MR	3
25	BPT 2949	10.35 (19.06)	10.35 (19.06)	13.28 (21.38)	19.73 (25.77)	21.22 (26.68)	16.66 (23.78)	9.83 (18.62)	14.49 (27.17)	MR	3

S. No.	Rice entries	LEAF FOLDER DAMAGE (%)								S/R Ratio	Damage Rating
		40 DAT	50 DAT	60 DAT	70 DAT	80 DAT	90 DAT	100 DAT	Mean		
26	BPT 2956	8.29 (17.24)	32.65 (32.83)	28.52 (30.75)	32.22 (32.62)	40.69 (36.55)	30.35 (31.69)	27.13 (30.02)	28.55 (31.64)	MS	5
27	BPT 2958	11.51 (20.01)	19.90 (25.87)	18.21 (24.81)	22.19 (27.26)	23.66 (28.10)	21.92 (27.09)	14.67 (22.40)	18.87 (28.90)	MR	3
28	BPT 3018	9.30 (18.16)	17.11 (24.08)	20.22 (26.07)	29.52 (31.27)	22.31 (27.32)	26.10 (29.46)	20.52 (26.25)	20.73 (29.46)	MR	3
29	BPT 3025	8.35 (17.30)	23.86 (28.22)	21.88 (27.07)	26.19 (29.51)	25.49 (29.13)	22.89 (27.66)	18.60 (25.05)	21.04 (29.56)	MS	5
30	BPT 3031	12.62 (20.88)	21.98 (27.13)	22.96 (27.70)	26.43 (29.64)	30.54 (31.79)	24.41 (28.53)	22.85 (27.64)	23.11 (30.28)	MS	5
31	BPT 3034	0.83 (7.64)	5.26 (14.16)	9.58 (18.40)	10.86 (19.49)	13.54 (21.58)	15.06 (22.67)	16.97 (23.99)	10.30 (24.85)	R	1
32	BPT3036	13.80 (21.77)	38.67 (35.65)	32.72 (32.87)	39.87 (36.19)	40.53 (36.48)	37.45 (95.10)	21.88 (27.07)	32.13 (32.60)	MS	5
33	BPT 3038	6.56 (15.56)	37.31 (35.04)	38.71 (35.67)	47.87 (39.58)	43.29 (37.68)	36.56 (34.69)	27.70 (30.32)	34.00 (32.83)	MS	5
34	BPT 3041	16.43 (23.63)	23.45 (27.98)	23.96 (28.27)	36.75 (34.78)	27.36 (30.14)	24.05 (28.33)	20.90 (26.49)	24.70 (30.75)	MS	5
35	BPT3042	9.02 (17.91)	9.12 (18.00)	12.27 (20.61)	19.31 (25.51)	23.94 (28.26)	12.69 (20.94)	6.38 (15.37)	13.25 (26.51)	MR	3
36	BPT 3049	10.61 (19.28)	41.53 (36.92)	38.62 (35.63)	42.87 (37.50)	46.86 (39.17)	33.07 (33.04)	29.61 (31.32)	34.74 (33.13)	MS	5
37	BPT 3058	7.44 (16.44)	44.45 (38.17)	42.44 (37.31)	47.40 (39.39)	61.82 (44.88)	38.50 (35.58)	24.65 (28.66)	38.10 (33.65)	S	7
38	BPT 3059	2.40 (10.43)	65.40 (46.15)	53.89 (41.95)	65.60 (46.22)	65.97 (46.35)	53.27 (41.71)	33.86 (33.42)	48.63 (35.37)	S	7
39	BPT 3060	16.11 (23.41)	19.12 (25.38)	20.98 (26.53)	24.70 (28.69)	31.20 (32.12)	21.07 (26.59)	20.78 (26.41)	21.99 (29.96)	MS	5
40	BPT 5204	10.52 (19.21)	20.87 (26.47)	19.00 (25.31)	30.94 (31.99)	23.70 (28.13)	21.65 (26.94)	20.98 (26.53)	21.10 (29.61)	MS	5
41	W 1263	0.00 (5.66)	3.85 (12.46)	5.79 (14.74)	8.72 (17.64)	9.78 (18.58)	8.94 (17.84)	7.07 (16.07)	6.31 (22.43)	R	1
42	TN 1	28.08 (30.52)	39.49 (36.02)	48.89 (39.99)	57.98 (43.49)	68.24 (47.13)	61.87 (44.90)	55.60 (42.60)	51.45 (36.54)	HS	9
	Mean	16.33	28.34	28.39	31.04	31.52	28.27	24.14			
	SEM	0.89	1.13	1.08	1.33	1.10	1.16	1.05	0.45		
	CD (P=0.05)	2.49	3.19	3.05	3.75	3.09	3.25	2.97	1.24		
	CV (%)	17.13	12.91	12.31	13.38	10.95	12.37	13.22	11.60		

Figures in parenthesis are arc sine transformed values

DAT: days after transplanting, S/R: Susceptibility- Resistant, R: resistant, MR: Moderately resistant, MS: Moderately Susceptible, S: Susceptible and HS: Highly Susceptible

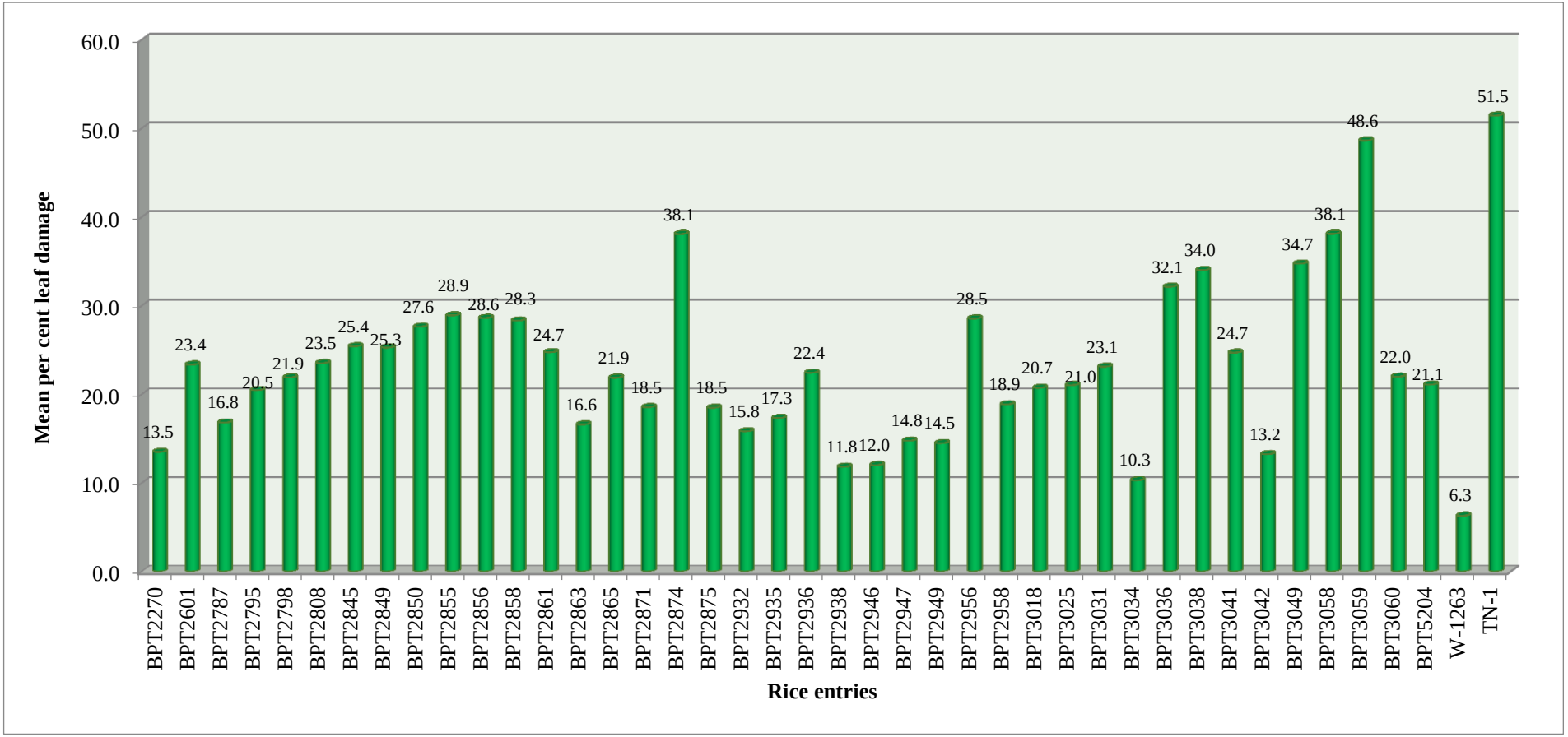

Fig. 4.1. Per cent leaf damage by rice leaf folder, *Cnaphalocrocis medinalis* in different rice entries under controlled condition, *kharif* 2018

4.1.1.2 Observation at 50 days after transplanting

The results revealed that, six entries (BPT 2938, BPT 2947, BPT 2949, BPT 3034, BPT 3042 and W-1263) recorded damage ranging between 3.85 to 10.64 per cent, eleven entries (BPT 2270, BPT 2787, BPT 2863, BPT 2875, BPT 2932, BPT 2935, BPT 2946, BPT 2958, BPT 3018, BPT 3060) recorded between 11.42 to 20.87 per cent leaf damage, fourteen entries (BPT 2601, BPT 2795, BPT 2798, BPT 2808, BPT 2845, BPT 2858, BPT 2861, BPT 2865, BPT 2871, BPT 2936, BPT 2956, BPT 3025, BPT 3031 and BPT 3041) were between 21.47 to 33.24 per cent leaf damage, ten entries (BPT 2849, BPT 2850, BPT 2855, BPT 2856, BPT 2874, BPT 3036, BPT 3038, BPT 3049, BPT 3058 and TN-1) were between 36.06 to 44.54 per cent and remaining one entry (BPT 3059) with 65.40 per cent leaf damage.

4.1.1.3 Observation at 60 days after transplanting

The observations at 60 days after planting revealed that two entries BPT 3034 and W-1263 recorded 9.58 and 5.79 per cent leaf damage respectively, sixteen entries (BPT 2270, BPT 2787, BPT 2863, BPT 2871, BPT 2875, BPT 2932, BPT 2935, BPT 2938, BPT 2946, BPT 2947, BPT 2949, BPT 2958, BPT 3018, BPT 3042, BPT 3060 and BPT 5204) recorded damage ranging between 11.54 to 20.98 per cent leaf damage, fifteen entries (BPT 2601, BPT 2795, BPT 2798, BPT 2808, BPT 2845, BPT 2849, BPT 2858, BPT 2861, BPT 2865, BPT 2936, BPT 2956, BPT 3025, BPT 3031, BPT 3036 and BPT 3041) were between 21.78 to 35.54 per cent damage, seven entries (BPT 2850, BPT 2855, BPT 2856, BPT 2874, BPT 3038, BPT 3049, BPT 3058 and susceptible check TN-1) were between 38.34 to 48.89 per cent damage and one entry BPT 3059 with 53.89 per cent damage.

4.1.1.4 Observation at 70 days after transplanting

The data revealed that, two entries *i.e.,* W-1263 and BPT 3034 recorded leaf folder damage of 8.72 and 10.86 respectively, six entries (BPT 2935, BPT 2938, BPT 2946, BPT 2947, BPT 2949 and BPT 3042) recorded per cent leaf

damage ranging between 16.43 to 19.73, twenty four entries (BPT 2270, BPT 2601, BPT 2787, BPT 2795, BPT 2798, BPT 2808, BPT 2845, BPT 2849, BPT 2850, BPT 2855, BPT 2856, BPT 2861, BPT 2863, BPT 2865, BPT 2871, BPT 2875, BPT 2932, BPT 2956, BPT 2958, BPT 3018, BPT 3025, BPT 3031, BPT 3060 and BPT 5204) recorded per cent leaf damage ranging between 21.18 to 34.47, eight entries (BPT 2858, BPT 2874, BPT 2936, BPT 3036, BPT 3038, BPT 3041, BPT 3049 and BPT 3058) recorded damage between 36.75 to 49.43 per cent and remaining two entries *viz.*,susceptible check TN-1 and BPT 3059 recorded 57.98 and 65.60 per cent leaf damage.

4.1.1.5 Observation at 80 days after transplanting

The results revealed that, seven entries (W-1263, BPT 2270, BPT 2932, BPT 2938, BPT 2946, BPT 2947 and BPT 3034) recorded damage ranging between 9.78 to 20.15 per cent, twenty two entries (BPT 2601, BPT 2787, BPT 2795, BPT 2798, BPT 2808, BPT 2845, BPT 2849, BPT 2861, BPT 2863, BPT 2871, BPT 2875, BPT 2935, BPT 2936, BPT 2949, BPT 2958, BPT 3018, BPT 3025, BPT 3031, BPT 3041, BPT 3042, BPT 3060 and BPT 5204) were between 21.40 to 35.14 per cent leaf damage, nine entries (BPT 2850, BPT 2855, BPT 2856, BPT 2858, BPT 2865, BPT 2956, BPT 3036 and BPT 3049) were between 37.12 to 46.86 per cent leaf damage. Whereas BPT 3058, BPT 3059 and TN-1 recorded 61.82, 65.97 and 68.24 per cent damage respectively.

4.1.1.6 Observation at 90 days after transplanting

The data revealed that fourteen entries (W-1263, BPT 2270, BPT 2787, BPT 2798, BPT 2849, BPT 2856, BPT 2863, BPT 2932, BPT 2938, BPT 2946, BPT 2947, BPT 2949, BPT 3034 and BPT 3042) recorded damage ranging between 8.94 to 20.61 per cent, twenty two entries (BPT 2601, BPT 2795, BPT 2808, BPT 2845, BPT 2850, BPT 2855, BPT 2858, BPT 2861, BPT 2865, BPT 2871, BPT 2875, BPT 2935, BPT 2936, BPT 2956, BPT 2958, BPT 3018, BPT 3025, BPT 3031, BPT 3041, BPT 3049, BPT 3060 and BPT 5204) recorded leaf damage between 21.07 to 33.09 per cent, four entries (BPT 2874, BPT 3036,

BPT 3038 and BPT 3058) recorded leaf damage between 36.56 to 38.50 per cent and whereas BPT 3059 and susceptible check TN-1 recorded 53.27 and 61.87 per cent damage respectively.

4.1.1.7 Observation at 100 days after transplanting

The data revealed that eight entries (BPT 2270, BPT 2856, BPT 2863, BPT 2938, BPT 2946, BPT 2949, BPT 3042 and W-1263) recorded damage ranging between 6.38 to 10.18 per cent, twenty five entries (BPT 2601, BPT 2787, BPT 2795, BPT 2798, BPT 2808, BPT 2845, BPT 2849, BPT 2850, BPT 2855, BPT 2858, BPT 2861, BPT 2865, BPT 2871, BPT 2875, BPT 2932, BPT 2935, BPT 2936, BPT 2958, BPT 3018, BPT 3025, BPT 3034, BPT 3041 and BPT 5204) recorded leaf damage between 11.12 to 20.98 per cent, eight entries (BPT 2874, BPT 2956, BPT 3031, BPT 3036, BPT 3038, BPT 3049, BPT 3058 and BPT 3059) were between 21.88 to 33.86 per cent damage and susceptible check TN-1 recorded 55.60 per cent leaf damage.

4.1.1.8 Mean per cent leaf folder damage under controlled condition

Among 42 entries screened under controlled conditions 15 entries namely BPT 2938 (11.82 %), BPT 2946 (12.01%), BPT 3042 (13.25 %) BPT 2270 (13.49 %), BPT 2949 (14.49 %), BPT 2947 (14.77 %), BPT 2932 (15.82 %), BPT 2863 (16..60 %), BPT 2787 (16.81 %), BPT 2935 (17.32 %), BPT 2875 (18.48 %), BPT 2871 (18.55 %), BPT 2958 (18.87 %), BPT 2795 (20.47 %) and BPT 3018 (20.73 %) showed moderately resistant to rice leaf folder with the damage rating of 3. Twenty one entries *viz.*, BPT 3025 (21.04 %), BPT 5204 (21.10 %), BPT 2865 (21.88 %), BPT 2798 (21.90 %), BPT 3060 (21.99 %), BPT 2936 (22.42 %), BPT 3031 (23.11 %), BPT 2601 (23.35 %), BPT 2808 (23.51 %), BPT 3041 (24.70 %), BPT 2861 (24.74 %), BPT 2849 (25.27 %), BPT 2845 (25.41 %), BPT 2850 (27.62 %), BPT 2858 (28.32 %), BPT 2956 (28.55 %), BPT 2856 (28.61 %), BPT 2855 (28.91 %), BPT 3036 (32.13 %), BPT 3038 (34.00 %) and BPT 3049 (34.74 %), showed moderately susceptibility to rice leaf folder with damage rating of 5. Remaining three entries *viz.*, BPT

2874, BPT 3058 and BPT 3059 with 38.07, 38.10 and 48.63 per cent leaf damage respectively were showed susceptibility to rice leaf folder with damage rating of 7 and W-1263 (6.31 %) and BPT 3034 (10.30 %) recorded with damage rating of 1 (resistant), whereas susceptible check TN-1 (51.45 %) with damage rating 9 (highly susceptible).

4.1.2 Per cent Leaf Damage under Natural Condition

4.1.2.1 Observation at 40 days after transplanting

The data revealed that twenty six entries (BPT 2270, BPT 2601, BPT 2787, BPT 2795, BPT 2798, BPT 2808, BPT 2845, BPT 2849, BPT 2850, BPT 2855, BPT 2856, BPT 2858, BPT 2865, BPT 2871, BPT 2875, BPT 2932, BPT 2935, BPT 2936, BPT 2938, BPT 2946, BPT 2947, BPT 3034, BPT 3038, 3058, BPT 3059 and W-1263) recorded damage rating between 0.76 to 10.91 per cent, fifteen entries (BPT 2861, BPT 2863, BPT 2949, BPT 2956, BPT 2958, BPT 3018, BPT 3025, BPT 3031, BPT 3036, BPT 3041, BPT 3042, BPT 3049, BPT 3060 and BPT 5204) were between damage ranging of 11.29 to 20.12 per cent and TN-1 with 22.08 per cent leaf damage.

4.1.2.2 Observation at 50 days after transplanting

The results on per cent leaf damage by leaf folder at 50 days after transplanting revealed that twelve entries (BPT 2270, BPT 2795, BPT 2855, BPT 2856, BPT 2861, BPT 2874, BPT 2938, BPT 2946, BPT 2949, BPT 3034, BPT 3042 and W-1263) recorded leaf damage between 1.52 to 10.94 per cent, twenty four entries (BPT 2787, BPT 2798, BPT 2808, BPT 2845, BPT 2849, BPT 2850, BPT 2858, BPT 2863, BPT 2865, BPT 2871, BPT 2875, BPT 2932, BPT 2935, BPT 2936, BPT 2947, BPT 2956, BPT 2958, BPT 3018, BPT 3025, BPT 3031, BPT 3038, BPT 3058, BPT 3059 and BPT 5204) recorded between 11.37 to 19.57 per cent damage and remaining six entries (BPT 2601, BPT 3036, BPT 3041, BPT 3049, BPT 3060 and susceptible check TN-1) between 21.25 to 29.72 per cent leaf damage.

4.1.2.3 Observation at 60 days after transplanting

The data revealed that fifteen entries (BPT 2787, BPT 2795, BPT 2798, BPT 2808, BPT 2855, BPT 2856, BPT 2865, BPT 2875, BPT 2935, BPT 2938, BPT 2946, BPT 2947, BPT 3034, BPT 3059 and W-1263) recorded leaf damage between 4.05 to 10.70 per cent, twenty five entries (BPT 2270, BPT 2601, BPT 2845, BPT 2849, BPT 2850, BPT 2858, BPT 2861, BPT 2863, BPT 2871, BPT 2874, BPT 2932, BPT 2936, BPT 2949, BPT 2956, BPT 2958, BPT 3018, BPT 3025, BPT 3031, BPT 3038, BPT 3041, BPT 3042, BPT 3049, BPT 3058, BPT 3060 and BPT 5204) between 11.31 to 20.48 per cent damage and remaining two entries *viz.,* BPT 3036 and TN-1 were recorded per cent leaf damage of 25.10 and 33.20 respectively.

4.1.2.4 Observation at 70 days after transplanting

The results revealed that seven entries (BPT 2795, BPT 2798, BPT 2938, BPT 2946, BPT 2947, BPT 3034 and W-1263) recorded damage due to leaf folder between 7.55 to 10.66 per cent, twenty nine entries (BPT 2270, BPT 2601, BPT 2787, BPT 2808, BPT 2845, BPT 2849, BPT 2850, BPT 2855, BPT 2856, BPT 2858, BPT 2861, BPT 2863, BPT 2865, BPT 2871, BPT 2875, BPT 2932, BPT 2935, BPT 2936, BPT 2949, BPT 2956, BPT 2958, BPT 3018, BPT 3025, BPT 3031, BPT 3038, BPT 3042, BPT 3058, BPT 3059 and BPT 5204) between 11.06 to 20.45 per cent damage, five entries (BPT 2874, BPT 3036, BPT 3041, BPT 3049 and BPT 3060) between 21.90 to 25.44 per cent damage and remaining susceptible check TN-1 recorded 37.64 per cent leaf damage.

4.1.2.5 Observation at 80 days after transplanting

The observation revealed that twenty four entries (BPT 2270, BPT 2601, BPT 2845, BPT 2849, BPT 2850, BPT 2858, BPT 2861, BPT 2863, BPT 2871, BPT 2874, BPT 2932, BPT 2936, BPT 2949, BPT 2958, BPT 3018, BPT 3025, BPT 3031, BPT 3036, BPT 3038, BPT 3042, BPT 3049, BPT 3058, BPT 3060 and BPT 5204) recorded leaf damage rating between 21.06 to 32.90 per cent, fifteen entries (BPT 2787, BPT 2795, BPT 2798, BPT 2808, BPT 2855, BPT

2856, BPT 2865, BPT 2875, BPT 2935, BPT 2938, BPT 2946, BPT 2947, BPT 2956, BPT 3034 and BPT 3059) recorded between 11.44 to 20.80 per cent leaf damage due to leaf folder and W-1263 recorded 9.29 per cent, BPT 3041 and susceptible check TN-1 recorded 37.98 and 41.97 per cent leaf damage respectively.

4.1.2.6 Observation at 90 days after transplanting

The data revealed that twenty eight entries (BPT 2270, BPT 2601, BPT 2787, BPT 2845, BPT 2849, BPT 2850, BPT 2856, BPT 2858, BPT 2861, BPT 2863, BPT 2865, BPT 2871, BPT 2874, BPT2936, BPT 2949, BPT 2956, BPT 2958, BPT 3018, BPT 3025, BPT 3031, BPT 3038, BPT 3041, BPT 3042, BPT 3049, BPT 3058, BPT 3059, BPT 3060 and BPT 5204) were between 21.06 to 34.39 per cent leaf damage caused by leaf folder, ten entries (BPT 2795, BPT 2798, BPT 2808, BPT 2855, BPT 2875, BPT 2932, BPT 2935, BPT 2938, BPT 2946 and BPT 2947) were between 16.72 to 20.83 per cent leaf damage and W-1263, BPT 3036 and susceptible check TN-1 recorded 9.84, 40.95 and 46.56 per cent leaf damage respectively.

4.1.2.7 Observation at 100 days after transplanting

The data revealed that thirty three entries (BPT 2270, BPT 2601, BPT 2787, BPT 2795, BPT 2808, BPT 2845, BPT 2849, BPT 2850, BPT 2855, BPT 2856, BPT 2858, BPT 2861, BPT 2863, BPT 2865, BPT 2871, BPT 2875, BPT 2932, BPT 2935, BPT 2936, BPT 2938, BPT 2946, BPT 2947, BPT 2956, BPT 2958, BPT 3025, BPT 3034, BPT 3038, BPT 3042, BPT 3049, BPT 3058, BPT 3059, BPT 3060 and W-1263) recorded leaf damage between 10.95 to 20.93 per cent, eight entries (BPT 2798, BPT 2874, BPT 2949, BPT 3018, BPT 3031, BPT 3036, BPT 3041 and BPT 5204) were between 21.21 to 25.15 per cent leaf damage and susceptible check TN-1 recorded 43.13 per cent leaf damage.

Table 4.2. Susceptibility-Resistance rating of different rice entries against rice leaf folder, *Cnaphalocrocis medinalis* under natural condition, *kharif* 2018

S. No.	Rice entries	LEAF FOLDER DAMAGE (%)								S/R Rating	Damage Rating
		40 DAT	50 DAT	60 DAT	70 DAT	80 DAT	90 DAT	100 DAT	Mean		
1	BPT 2270	6.53(15.52)	10.79 (19.43)	12.33 (20.66)	12.72 (20.96)	21.93 (27.10)	25.70 (29.24)	16.40 (23.61)	15.20 (22.78)	MR	3
2	BPT 2601	9.44(18.29)	21.29 (26.72)	13.04 (21.20)	18.02 (24.68)	21.94 (27.11)	24.94 (28.82)	18.97 (25.29)	18.23 (24.82)	MR	3
3	BPT 2787	7.57(16.56)	15.39 (22.91)	10.70 (19.35)	14.11 (21.99)	20.24 (26.08)	25.33 (29.04)	17.02 (24.02)	15.76 (23.17)	MR	3
4	BPT 2795	4.48(13.24)	10.40 (19.11)	5.73 (14.67)	10.66 (19.32)	14.70 (22.42)	20.80 (26.42)	16.60 (23.74)	11.91 (20.33)	MR	3
5	BPT 2798	7.17(16.17)	11.42 (19.94)	8.65 (17.58)	8.64 (17.57)	17.55 (24.38)	19.49 (25.62)	21.67 (26.95)	13.51 (21.56)	MR	3
6	BPT 2808	2.40(10.43)	11.68 (20.15)	4.93 (13.78)	11.61 (20.09)	16.60 (23.74)	17.96 (24.64)	18.57 (25.03)	11.96 (20.37)	MR	3
7	BPT 2845	9.87(18.66)	14.80 (22.49)	13.13 (21.27)	15.06 (22.68)	24.36 (28.50)	24.47 (28.56)	17.29 (24.20)	17.00 (24.01)	MR	3
8	BPT 2849	9.04(17.93)	15.79 (23.19)	12.56 (20.83)	15.55 (23.02)	21.80 (27.02)	23.88 (28.23)	17.93 (24.62)	16.65 (23.77)	MR	3
9	BPT 2850	10.91(19.52)	19.07 (25.35)	13.13 (21.27)	17.32 (24.22)	26.69 (29.78)	27.62 (30.28)	19.33 (25.52)	19.15 (25.40)	MR	3
10	BPT 2855	7.47(16.46)	10.53 (19.21)	8.56 (17.49)	12.51 (20.80)	16.18 (23.46)	18.22 (24.81)	17.51 (24.35)	13.00 (21.17)	MR	3
11	BPT 2856	3.97(12.61)	9.20 (18.07)	8.64 (17.57)	12.04 (20.43)	19.94 (25.90)	22.27 (27.30)	15.57 (23.03)	13.09 (21.24)	MR	3
12	BPT 2858	8.41(17.36)	14.26 (22.10)	11.53 (20.03)	17.11 (24.08)	23.62 (28.08)	28.67 (30.83)	16.51 (23.68)	17.16 (24.11)	MR	3
13	BPT 2861	12.61(20.87)	10.94 (19.55)	16.25 (23.50)	15.99 (23.33)	23.88 (28.23)	21.77 (27.01)	16.07 (23.38)	16.79 (23.87)	MR	3
14	BPT 2863	17.01(24.01)	14.51 (22.29)	15.90 (23.27)	18.76 (25.15)	25.41 (29.09)	31.26 (32.15)	20.78 (26.41)	20.52 (26.25)	MR	3
15	BPT 2865	4.56(13.34)	14.20 (22.06)	7.79 (16.78)	11.89 (20.31)	16.92 (23.96)	22.17 (27.24)	16.35 (23.57)	13.41 (21.48)	MR	3
16	BPT 2871	10.54(19.22)	18.54 (25.02)	16.07 (23.38)	16.82 (23.89)	23.10 (27.78)	21.06 (26.58)	20.93 (26.50)	18.15 (24.76)	MR	3
17	BPT 2874	20.12(26.01)	10.16 (18.90)	16.19 (23.46)	23.60 (28.07)	28.87 (30.93)	33.44 (33.22)	25.15 (28.94)	22.50 (27.44)	MS	5
18	BPT 2875	2.93(11.21)	15.55 (23.02)	7.64 (16.63)	11.08 (19.66)	16.36 (23.58)	19.80 (25.81)	12.18 (20.54)	12.22 (20.57)	MR	3
19	BPT 2932	8.22(17.18)	15.71 (23.13)	12.28 (20.62)	13.60 (21.62)	21.06 (26.58)	20.44 (26.20)	16.41 (23.61)	15.39 (22.91)	MR	3
20	BPT 2935	6.00(14.97)	11.37 (19.90)	7.56 (16.55)	11.06 (19.65)	14.01(21.92)	16.72 (23.82)	16.82 (23.89)	11.93 (20.35)	MR	3
21	BPT 2936	10.71(19.37)	17.57 (24.39)	11.31 (19.85)	15.14 (22.73)	27.34 (30.13)	24.81 (28.75)	16.00 (23.33)	17.55 (24.38)	MR	3
22	BPT 2938	0.86 (7.71)	7.62 (16.62)	5.50 (14.43)	10.15 (18.90)	15.18 (22.76)	18.89 (25.24)	11.07 (19.66)	9.90 (18.68)	R	1
23	BPT 2946	6.82(15.83)	8.28 (17.23)	7.48 (16.47)	9.27(18.13)	14.67 (22.40)	20.83 (26.44)	17.22 (24.15)	12.08 (20.46)	MR	3
24	BPT 2947	5.60(14.54)	11.87 (20.30)	9.30 (18.16)	7.94 (16.92)	13.90 (21.84)	19.43 (25.58)	19.22 (25.45)	12.47 (20.76)	MR	3

Sl. No.	Rice entries	LEAF FOLDER DAMAGE (%)								S/R Rating	Damage Rating
		40 DAT	50 DAT	60 DAT	70 DAT	80 DAT	90 DAT	100 DAT	Mean		
	BPT 2949	13.35(21.43)	10.69 (19.34)	13.20 (21.33)	19.02 (25.32)	25.18 (28.96)	28.22 (30.60)	21.21 (26.67)	18.70 (25.11)	MR	3
26	BPT 2956	11.29 (19.83)	18.75 (25.15)	14.41 (22.21)	16.97 (23.99)	20.80(26.42)	30.45 (31.74)	16.50 (23.67)	18.45 (24.96)	MR	3
27	BPT 2958	14.51 (22.28)	16.03 (23.36)	18.64 (25.08)	19.61 (25.69)	23.38 (27.95)	25.75 (29.27)	20.67 (26.34)	19.80 (25.81)	MR	3
28	BPT 3018	12.30 (20.64)	18.54 (25.01)	12.91 (21.11)	18.04 (24.69)	27.06 (29.98)	25.60 (29.19)	21.41 (26.79)	19.41 (25.57)	MR	3
29	BPT 3025	11.35 (19.88)	18.02 (24.68)	18.05 (24.70)	20.04 (25.96)	24.46 (28.55)	27.35 (30.14)	16.56 (23.71)	19.40 (25.56)	MR	3
30	BPT 3031	15.62 (23.07)	14.44 (22.23)	15.90 (23.26)	20.45 (26.21)	23.69 (28.12)	32.19 (32.61)	22.83 (27.63)	20.73 (26.38)	MR	3
31	BPT 3034	2.68 (10.86)	4.56 (13.34)	4.86 (13.69)	7.55 (16.54)	11.44 (19.95)	19.59 (25.68)	15.05 (22.67)	9.39 (18.24)	R	1
32	BPT 3036	18.47 (24.97)	24.16 (28.39)	25.10 (28.92)	25.44 (29.10)	32.90 (32.96)	40.95 (36.67)	23.66 (28.11)	27.24 (30.08)	MS	5
33	BPT 3038	9.56 (18.39)	18.09 (24.72)	13.44 (21.50)	16.12 (23.41)	23.32 (27.91)	24.46 (28.56)	17.79 (24.53)	17.54 (24.37)	MR	3
34	BPT 3041	20.10 (25.99)	23.48 (28.00)	20.48 (26.23)	24.06 (28.33)	37.98 (35.34)	30.46 (31.75)	24.58 (28.63)	25.88 (29.34)	MS	5
35	BPT 3042	12.02 (20.42)	7.96 (16.93)	13.09 (21.24)	18.63 (25.07)	26.45 (29.65)	34.39 (33.68)	19.57 (25.66)	18.87 (25.23)	MR	3
36	BPT 3049	14.95(22.60)	26.32 (29.58)	19.67 (25.73)	22.12 (27.21)	25.96 (29.39)	28.94 (30.97)	19.71 (25.75)	22.52 (27.45)	MS	5
37	BPT 3058	10.44 (19.14)	19.57 (25.67)	15.07 (22.68)	18.73 (25.14)	23.70 (28.12)	33.31 (33.15)	19.61 (25.69)	20.06 (25.97)	MR	3
38	BPT 3059	5.40 (14.31)	17.27 (24.19)	9.57 (18.40)	12.54 (20.82)	19.67 (25.73)	24.70 (28.69)	16.56 (23.71)	15.10 (22.71)	MR	3
39	BPT 3060	19.11 (25.38)	21.25 (26.70)	17.16 (24.11)	21.90 (27.08)	25.37 (29.06)	33.37 (33.19)	19.38 (25.55)	22.51 (27.44)	MS	5
40	BPT 5204	12.52 (20.81)	13.56 (21.59)	16.39 (23.60)	20.16 (26.03)	23.95 (28.27)	26.77 (29.82)	24.94 (28.82)	19.75(25.78)	MR	3
41	W 1263	0.76 (7.50)	1.52 (8.97)	4.05 (12.72)	9.65 (18.46)	9.29 (18.15)	9.84 (18.63)	10.95(19.56)	6.58(15.58)	R	1
42	TN 1	22.08 (27.19)	29.72 (31.37)	33.20(33.10)	37.64 (35.19)	41.97(37.11)	46.56 (39.05)	43.13 (37.61)	36.33 (34.59)	S	7
	Mean	18.14	22.15	20.68	23.15	27.01	28.93	25.11	23.60		
	SEM	0.87	1.14	1.02	0.81	0.90	1.06	0.87	0.27		
	CD (P=0.05)	2.46	3.22	2.88	2.26	2.53	2.99	2.45	0.74		
	CV (%)	14.57	15.63	14.94	10.47	10.02	11.06	10.46	7.93		

Figures in parenthesis are arc sine transformed values.

DAT: days after transplanting**,** S/R: Susceptibility- Resistant, R: resistant, MR: Moderately resistant, MS: Moderately Susceptible, S: Susceptible and HS: Highly Susceptible

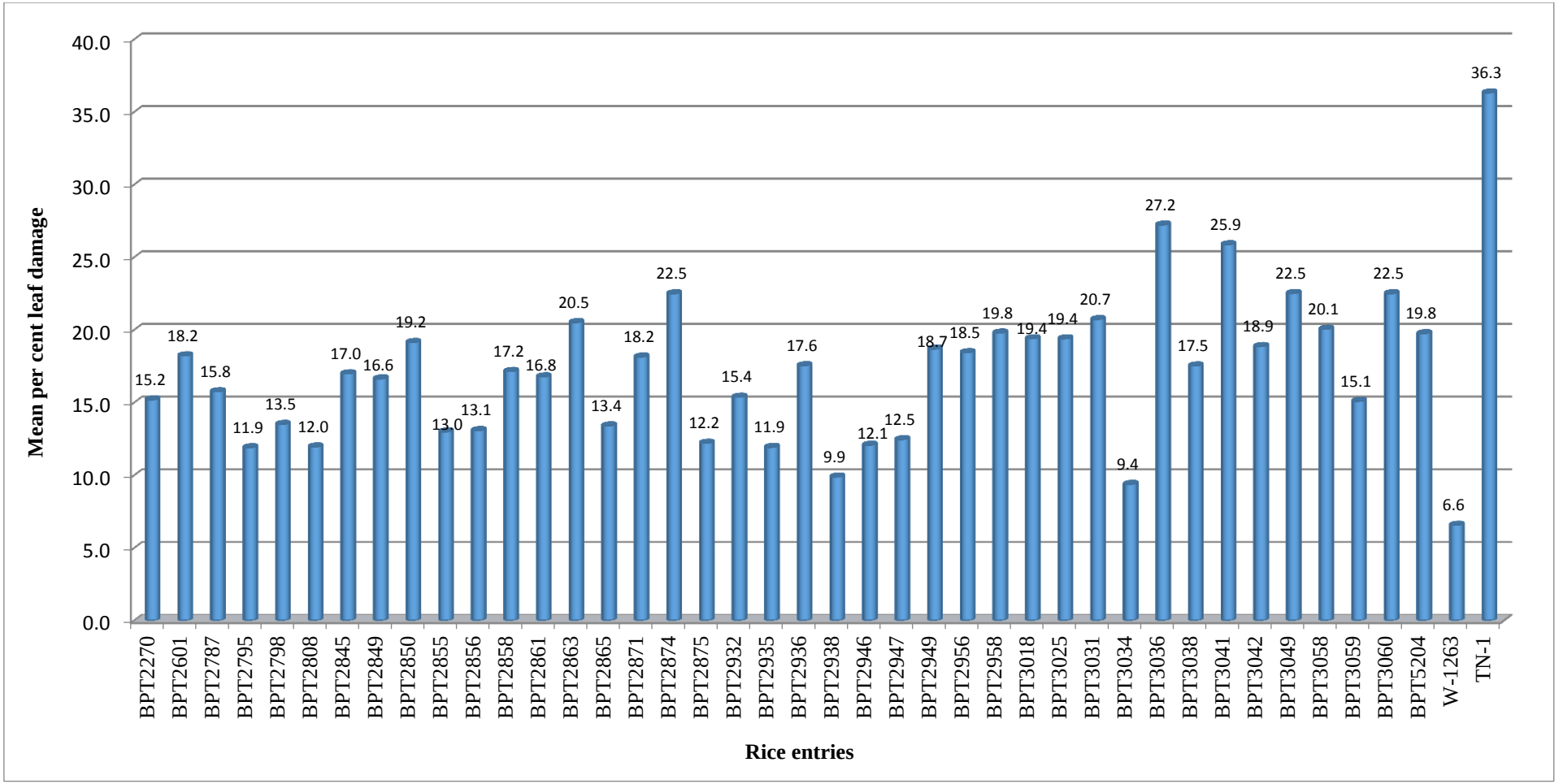

Fig. 4.2. Per cent leaf damage by rice leaf folder, *Cnaphalocrocis medinalis* in different rice entries under natural condition, *kharif* 2018

4.1.2.8 Mean per cent leaf folder damage under natural condition

Among 42 entries the per cent leaf damage by rice leaf folder was least in entries W-1263, BPT 3034 and BPT 2938 with 6.58, 9.39 and 9.90 per cent leaf damage respectively. These entries showed resistant to rice leaf folder with damage rating one. Thirty three entries namely BPT 2795 (11.91 %), BPT 2935 (11.93 %), BPT 2808 (11.96 %), BPT 2946 (12.08 %), BPT 2875 (12.22 %), BPT 2947 (12.47 %), BPT 2855 (13.00 %), BPT 2856 (13.09 %), BPT 2865 (13.41 %), BPT 2798 (13.51 %), BPT 3059 (15.10 %), BPT 2270 (15.20 %), BPT 2932 (15.39 %), BPT 2787 (15.76 %), BPT 2849 (16.65 %), BPT 2861 (16.79 %), BPT 2845 (17.00 %), BPT 2858 (17.16 %), BPT 3038 (17.54 %), BPT 2936 (17.55 %), BPT 2871 (18.15 %), BPT 2601 (18.23 %), BPT 2956 (18.45 %), BPT 2949 (18.70 %), BPT 3042 (18.87 %), BPT 2850 (19.15 %), BPT 3025 (19.40 %), BPT 3018 (19.41 %), BPT 5204 (19.75 %), BPT 2958 (19.80 %), BPT 3058 (20.06 %), BPT 2863 (20.52 %) and BPT 3031 (20.73 %) showed moderately resistant with damage rating 3.

Remaining five entries namely BPT 2874 (22.50 %), BPT 3060 (22.51 %), BPT 3049 (22.52 %), BPT 3041 (25.88 %) and BPT 3036 (27.24 %), showed moderately susceptible with damage rating of 5 and where as susceptible check, TN-1 (36.33 %) showed susceptible with the damage rating of 7 to rice leaf folder.

Among Forty two rice entries screened, fifteen entries were come under a rating 3 (moderately resistant), twenty one entries under rating 5 (moderately susceptible), three entreis were under rating 7 (susceptible), two entries under damage rating 1 (resistant) and one entry (susceptible check) under damage rating 9 (highly susceptible) under controlled condition. In case of natural condition, thirty three entries were come under a rating 3 (moderately resistant), five entries under rating 5 (moderately susceptible) three entreis were under rating 1 (resistant) and one entry (susceptible check) under damage rating7 (susceptible).

These findings were in accordance with Sarao and Mahal (2012), who reported that among 66 lines over the two years, 18 lines with 6.21 to 9.99 per cent leaf damage at vegetative stage and six lines with 8.77 to 12.25 per cent leaf damage at reproductive stage. Similarly Chintalapati *et al*. (2017) also reported that out of 50 rice genotypes, six genotypes come under rating 1 (resistant), ten genotypes under rating 3 (moderately resistant) and remaining 32 genotypes under rating 7 (susceptible) for leaf folder. These finding also in accordance with Ahmad *et al*. (2016), who reported that among 26 rice entries, variety PK-8893-4-1-3-1come under rating 3 (moderately resistant), seven entries under rating 5 (moderately susceptible), eleven entries under rating 7 (susceptible) and seven entries under rating 9 (highly susceptible) for rice leaf folder under green house condition.

4.2 EVALUATION OF ECOFRIENDLY PRODUCTS AGAINST RICE LEAF FOLDER, *C. medinalis*

The field experiment was conducted to evaluate the efficacy of seven ecofriendly products, neemastram, brahmastram, agnastram, panchapatra extract, chilli garlic extract and datura leaf extract each at two doses *i.e.*, 25 ml and 50 ml/l and neem seed kernel extract at 5 per cent and one insecticidal check *i.e.*, flubendiamide 480 SC @ 0.2 ml/l in total of fifteen treatments against rice leaf folder *C. medinalis* during *kharif* 2018.

The results obtained were presented and discussed with suitable literature here under. A total of three sprays were given at 10 days interval from 45 days after transplanting.

4.2.1 First Spray

The data pertaining to the efficacy of the treatments after the first spray was presented in the table 4.3 and Fig. 4.3.

At 45 DAT the per cent leaf damage varied between 11.49 to 14.85 (pretreatment count) and there was no significant difference among the treatments.

4.2.1.1 Three days after spraying

The data at 3 days after treatment revealed that, least per cent damage of 8.08 was recorded in the chemical control *i.e.,* flubendiamide 480 SC @ 0.2 ml/land it was on par with neem seed kernel extract at 5 per cent (9.02 %) and superior over other treatments.

The next best treatment was brahmastram at 50 ml/l (10.97 %) and it was followed by and chilli garlic extract at 50 ml/l (11.06 %) and these treatments were on par with each other. The next best treatment was agnastram at 50 ml/l (11.79 %) and it was followed by neemastram at 50 ml/l (12.27 %) and these two treatments were on par with each other statistically and also on par with panchapatra extract at 50 ml/l (12.57 %) and chilli garlic extract at 25 ml/l (13.17 %).

Highest leaf folder damage of 17.60 per cent was recorded in neemastam at 25 ml/l and it was statistically on par with untreated control, agnastram at 25 ml/l, panchapatra extract at 25 ml/l, datura leaf extract at 25 ml/l, brahmastram at 25 ml/l and datura leaf extract at 50 ml/l recorded 15.53, 15.96, 14.96, 14.56 and 14.41 per cent leaf damage due to leaf folder respectively.

4.2.1.2 Seven days after spraying

At 7 days after spraying, the least per cent leaf damage of 7.75 was recorded in the chemical control *i.e.,* flubendiamide 480 SC @ 0.2 ml/l and it was followed by the treatment neem seed kernel extract at 5 per cent (8.02 %) and both were statistically on par with each other and also on par with chilli garlic extract at 50 ml/l (8.73 %), brahmastram at 50 ml/l (9.29 %), agnastram at 50 ml/l (9.45 %) and chilli garlic extract at 25 ml/l (9.95 %).

The next best treatment was agnastram at 25 ml/l (10.25 %) followed by panchapatra extract at 50 ml/l (10.57 %), neemastram at 50 ml/l (11.18 %) and datura leaf extract at 25 ml/l (12.62 %). These treatments were on par with each other statistically. The next effective treatment was brahmastram 25 ml/l (13.74 %) and it was followed by panchapatra extract at 25 ml/l with 14.76 per cent leaf damage.

Among ecofriendly products the highest leaf folder damage was recorded in datura leaf extract at 50 ml/l with 16.23 per cent leaf folder damage and it is statistically on par with neemastram at 25 ml/l (15.93 %) and all the treatments were statistically superior over untreated control which recorded 19.21 per cent leaf folder damage.

4.2.1.3 Mean per cent leaf damage in first spray

The mean per cent damage by leaf folder after first spray was varied between 7.91 to 17.37 per cent. The least per cent leaf folder damage was recorded in chemical control *i.e.,* flubendiamide 480 SC @ 0.2 ml/l with 7.91 per cent leaf damage and it was followed by neem seed kernel extract at 5 per cent (8.52 %) and both the treatments were statistically on par with each other and also superior over other treatments.

The next best treatment was chilli garlic extract at 50 ml/l with 9.90 per cent leaf damage it was followed by brahmastram at 50 ml/l, agnastram at 50 ml/l, chilli garlic extract at 25 ml/l, panchapatra extract at 50 ml/l and neemastram at 50 ml/l with 10.13, 10.62, 11.56, 11.57 and 11.72 per cent leaf folder damage respectively. And these treatments were on par with each other. Agnastram at 25 ml/l with 13.10 per cent leaf damage was on par with datura leaf extract at 25 ml/l (13.79 %).

The highest leaf foder damage of 17.37 per cent was recorded in untreated control and it was statistically on par with neemastram at 25 ml/l, datura leaf extract at 50 ml/l, panchapatra extract at 25 ml/l and brahmastram at 25 ml/l with 16.76, 15.40, 15.13 and 14.07 per cent leaf folder damage respectively.

4.2.1.4 Per cent reduction over control in first spray

The per cent reduction over control varied between 0.50 to 54.33 and 15.20 to 61.57 at 3 days and 7 days after first spray respectively in different treatments. The mean per cent reduction over control in first spray was varies between 10.71 to 59.16 per cent.

The highest mean per cent reduction over control was recorded in chemical control *i.e.,* flubendiamide 480 SC @ 0.2 ml/l with 59.16 per cent and it was followed by neem seed kernel extract at 5 per cent and brahmastram at 50 ml/l with 57.95 and 45.47 per cent respectively and these treatments were on par with each other.

The next best treatment was agnastram at 50 ml/l with mean per cent reduction over control of 43.22 and it was followed by chilli garlic extract at 25 ml/l, chilli garlic extract at 50 ml/l, neemastram at 50 ml/l and panchapatra extract at 50 ml/l with the mean per cent reduction over control of 42.55, 38.45, 37.58 and 37.09 respectively and these treatments were on par with each other. Agnastram at 25 ml/l and brahmastram at 25 ml/l recorded 32.31 and 26.64 per cent reduction over control.

The least mean per cent reduction over control was recorded in treatment neemastram at 25 ml/l with 10.71 per cent and it was followed by datura leaf extract at 50 ml/l with 14.26 per cent mean reduction over control both the treatments were on par with each other and also with treatment panchapatra extract at 25 ml/l which recorded 15.52 mean per cent reduction over control.

Table 4.3. Efficacy of ecofriendly products after first spray against rice leaf folder, *C. medinalis* in BPT 5204 rice variety, *kharif* 2018

Tr. No.	Treatments Treatments	Dose @ ml/l	Leaf folder damage (%)				Per cent reduction over control		
			Pre treatment	Post treatment			3 DAS	7 DAS	Mean
				3 DAS	7 DAS	Mean			
T1	Neemasthram	25	13.36 (21.44)	17.60 (24.40)^{g}	15.93 (23.28)^{e}	16.76 (23.85)^{gh}	0.50 (6.92)	20.92 (26.50)	10.71 (19.36)^{e}
T2	Neemasthram	50	13.36 (21.45)	12.27 (20.61)^{cde}	11.18 (19.74)^{c}	11.72 (20.18)^{cde}	30.63 (31.83)	44.54 (38.20)	37.58 (35.16)^{bc}
T3	Bhramsthram	25	13.63 (21.64)	14.41 (22.21)^{def}	13.74 (21.73)^{de}	14.07 (21.97)^{f}	20.15 (26.02)	33.14 (33.07)	26.64 (29.76)^{cd}
T4	Bhramsthram	50	13.24 (21.36)	10.97 (19.57)^{bc}	9.29 (18.15)^{ab}	10.13 (18.87)^{bc}	37.45 (35.10)	53.50 (41.80)	45.47 (38.60)^{ab}
T5	Agnisthram	25	13.66 (21.67)	15.96 (23.31)^{fg}	10.25 (18.98)^{bc}	13.10 (21.15)^{de}	14.36 (22.18)	50.27 (40.54)	32.31 (32.67)^{cd}
T6	Agnisthram	50	13.36 (21.44)	11.79 (20.23)^{cd}	9.45 (18.29)^{ab}	10.62 (19.29)^{c}	33.36 (33.18)	53.08 (41.64)	43.22 (37.65)^{b}
T7	NSKE	5 %	14.85 (22.53)	9.02 (17.91)^{ab}	8.02 (16.99)^{a}	8.52 (17.45)^{a}	54.33 (42.12)	61.57 (44.79)	57.95 (43.48)^{a}
T8	Panchapatra extract	25	12.69 (20.94)	15.49 (22.98)^{efg}	14.76 (22.46)^{e}	15.13 (22.72)^{fg}	8.17 (17.14)	22.87 (27.65)	15.52 (23.00)^{e}
T9	Panchapatra extract	50	13.12 (21.26)	12.57 (20.85)^{cde}	10.57 (19.25)^{bc}	11.57 (20.06)^{cd}	27.61 (30.28)	46.56 (39.05)	37.09 (34.94)^{bc}
T10	Chilli and Garlic extract	25	14.40 (22.21)	13.17 (21.30)^{cdef}	9.95 (18.73)^{ab}	11.56 (20.05)^{cd}	30.93 (31.98)	54.18 (42.06)	42.55 (37.36)^{b}
T11	Chilli and Garlic extract	50	11.49 (20.00)	11.06 (19.65)^{bc}	8.73 (17.65)^{ab}	9.90 (18.68)^{ab}	27.28 (30.10)	49.63 (40.29)	38.45 (35.56)^{b}
T12	Datura leaf extract	25	13.09 (21.24)	14.96 (22.60)^{efg}	12.62 (20.89)^{cd}	13.79 (21.76)^{f}	13.66 (21.66)	36.03 (34.45)	24.84 (28.77)^{d}
T13	Datura leaf extract	50	12.69 (20.94)	14.56 (22.32)^{def}	16.23 (23.49)^{e}	15.40 (22.91)^{gh}	13.32 (21.41)	15.20 (22.77)	14.26 (22.10)^{e}
T14	Flubendiamide 480 SC	0.2 (0.048 g a.i./l)	13.37 (21.45)	8.08 (17.05)^{a}	7.75 (16.73)^{a}	7.91 (16.89)^{a}	54.13 (42.04)	64.20 (45.73)	59.16 (43.92)^{a}
T15	Untreated control	-	12.74 (20.98)	15.53 (23.01)^{efg}	19.21 (25.44)^{f}	17.37 (24.26)^{h}			
	SEm			0.77	0.74	0.55			1.86
	CD (P=0.05)		NS	2.23	2.15	1.67			5.70
	CV (%)			10.91	11.11	5.32			11.47

Figures in parentheses are arc sine transformed values

Valves with similar alphabets in each column do not vary significantly at 5 per cent level

DAS: days after spraying, NS: Non-significant

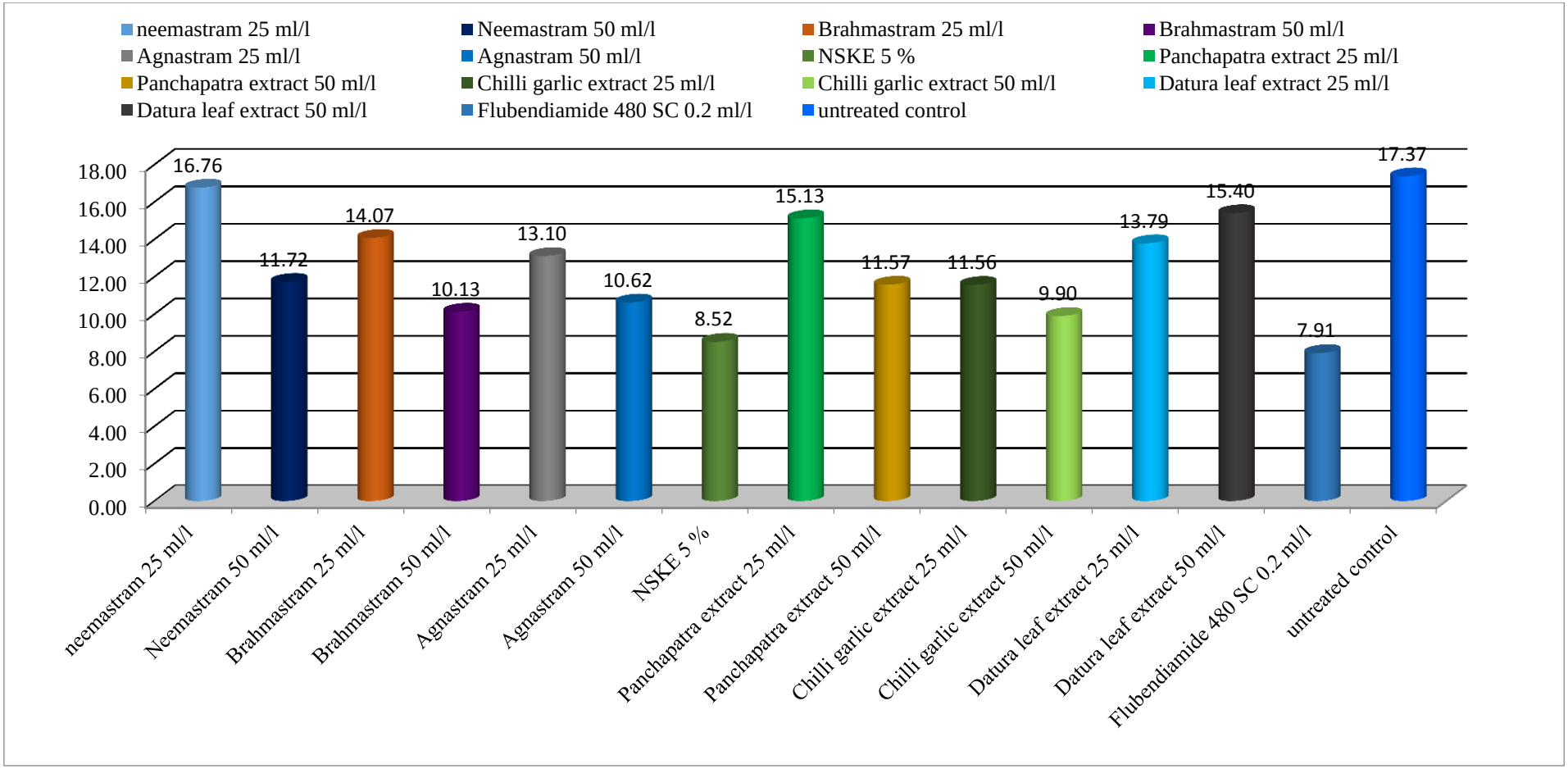

Fig. 4.3. Efficacy of ecofriendly products after first spray against rice leaf folder, *C. medinalis*, *kharif* 2018

4.2.2 Second Spray

The data pertaining to the efficacy of the treatments after the second spray was presented in the table 4.4 and fig. 4.4.

At 55 days after transplanting the per cent leaf damage varied between 9.29 to 19.20 (pretreatment count) and there was a significant difference among the treatments.

4.2.2.1 Three days after spray

The data at three days after second spray revealed that, least per cent damage of 7.41 was recorded in the chemical control *i,e.,* flubendiamide 480 SC @ 0.2 ml/l and it was followed by the agnastram treatment at 50 ml/l (7.95 %) and neem seed kernel extract at 5 per cent (8.10 %) and these treatments were on par with each other statistically. The next best treatment was agnastram at 25 ml/l with 8.79 per cent leaf damage and it was followed by brahmastram at 50 ml/l, chilli garlic extract at 25 ml/l and brahmastram 25 ml/l with 9.80, 9.95 and 11.07 per cent leaf damage respectively and these treatments were on par with each other. The next best treatment was neemastram at 50 ml/l which recorded 10.84 per cent leaf damage and it was followed by panchapatra extract at 50 ml/l (10.91 %) and chilli garlic extract at 50 ml/l (11.06 %).

Among the ecofriendly product treatments, highest leaf folder damage of 17.02 per cent was recorded in neemastam at 25 ml/l and it was statistically on par with datura leaf extract at 50 ml/l, panchapatra extract at 25 ml/l and datura leaf extract at 25 ml/l with 16.90, 16.76 and 13.62 per cent leaf damage due to leaf folder respectively.

All the ecofriendly products were superior over untreated control, which was recorded highest per cent leaf folder damage (20.53 %).

4.2.2.2 Seven days after spraying

At 7 days after spraying, the least per cent leaf damage of 6.08 was recorded in the chemical control *i.e.,* flubendiamide 480 SC @ 0.2 ml/l and it was followed by the treatment neem seed kernel extract at 5 per cent (6.77 %), agnastram at 50 ml/l (7.62 %) brahmastram at 50 ml/l (7.68 %), chilli garlic extract at 50 ml/l (7.82 %), chilli garlic extract at 25 ml/l (8.39 %) and agnastram at 25 ml/l (8.79 %) and these treatments were on par with each other and superior over the other treatments. The next best treatment was brahmastram at 25 ml/l with 8.74 per cent leaf damage and it was followed by neemastram at 50 ml/l (9.84 %), panchapatra extract at 50 ml/l (10.57 %) and neemastram at 25 ml/l (11.83 %).

Among ecofriendly products the highest leaf folder damage was recorded in panchapatra extract at 25 ml/l with 14.76 per cent leaf folder damage and it was statistically on par with datura leaf extract at 50 ml/l and datura leaf extract at 25 ml/l with 14.23 and 12.96 per cent leaf damage respectively.

All the treatments were superior over untreated control, which recorded 25.65 per cent leaf folder damage.

4.2.2.3 Mean per cent leaf damage

The mean per cent damage by leaf folder after second spray varied between 6.74 to 23.09 per cent and the least per cent leaf folder damage was recorded in chemical control *i.e.,* flubendiamide 480 SC @ 0.2 ml/l with 6.74 per cent and it was followed by treatment neem seed kernel extract at 5 per cent (7.44%) and agnastram at 50 ml/l (7.79 %) and these treatments were statistically on par with each other and also superior over other treatments. The next best treatment was brahmastram at 50 ml/l with 8.74 per cent leaf damage and it was followed by agnastram 25 ml/l, chilli garlic extract at 25 ml/l, chilli garlic extract at 50 ml/l and brahmastram at 25 ml/l with 8.79, 9.17, 9.44 and 9.91 per cent leaf folder damage respectively. And these treatments were on par with each other and also with neemastram at 50 ml/l (10.34 %) and panchapatra extract at 50 ml/l (10.74 %).

Among ecofriendly products the highest leaf folder damage was recorded in panchapatra extract at 25 ml/l with 15.76 per cent leaf folder damage and it is statistically on par with datura leaf extract at 50 ml/l, neemastram at 25 ml/l and datura leaf extract at 25 ml/l with 15.56, 14.42 and 13.29 per cent leaf damage respectively.

All the ecofriendly products were superior over control, which recorded 23.09 per cent leaf damage respectively.

4.2.2.4 Mean per cent reduction over control

The per cent reduction over control was varied between 10.20 to 35.72 and 32.12 to 49.87 at 3 days and 7 days after second spray respectively. The mean per cent reduction over control in second spray varied between 21.49 to 42.80 per cent. The highest mean per cent reduction (42.80) over control was recorded in chemical control *i.e.*, flubendiamide 480 SC @ 0.2 ml/l and it was superior over all other ecofriendly products treated plots. The next best treatment was neem seed kernel extract at 5 per cent with 34.16 mean per cent reduction over control and it was followed by neemastram at 25 ml/l, chilli garlic extract at 50 ml/l, chilli garlic extract at 25 ml/l, agnastram at 50 ml/l, agnastram 25 ml/l, neemastram at 50 ml/l, brahmastram at 25 ml/l and brahmastram at 50 ml/l with 32.56, 30.80, 29.35, 29.25, 28.53, 28.11, 27.05 and 26.92 per cent respectively and these treatments were on par with each other.

The least mean per cent reduction of 21.49 over control was recorded in treatment datura leaf extract at 25 ml/l and it was followed by panchapatra extract at 50 ml/l, datura leaf extract at 50 ml/l and panchapatra extract at 25 ml/l with 22.24, 24.10 and 24.77 per cent mean reduction over control and they were on par with each other.

Table 4.4. Efficacy of ecofriendly products after second spray against rice leaf *C. medinalis* in BPT 5204 rice variety, *kharif* 2018

Tr. No.	Treatments Treatments	Dose @ ml/l	Leaf folder damage (%)				Per cent reduction over control		
			Pre treatment	Post treatment			3 DAS	7 DAS	Mean
				3 DAS	7 DAS	Mean			
T1	Neemasthram	25	18.38 (24.92)	17.01 (24.02)^{f}	11.83 (20.27)^{def}	14.42 (22.14)^{fg}	13.43 (21.50)	51.69 (41.10)	32.56 (32.79)^{c}
T2	Neemasthram	50	12.18 (20.54)	10.84 (19.47)^{bcde}	9.84 (18.63)^{bcd}	10.34 (19.05)^{d}	16.73 (23.83)	39.48 (36.02)	28.11 (30.54)^{cd}
T3	Bhramsthram	25	15.41 (22.92)	11.07 (19.66)^{de}	8.74 (17.65)^{bc}	9.91 (18.66)^{d}	13.99 (21.91)	40.11 (36.30)	27.05 (29.97)^{cde}
T4	Bhramsthram	50	10.20 (18.94)	9.80 (18.59)^{abcd}	7.68 (16.67)^{ab}	8.74 (17.63)^{bcd}	10.20 (18.94)	43.64 (37.83)	26.92 (29.91)^{cde}
T5	Agnisthram	25	10.79 (19.43)	8.79 (17.70)^{abcd}	8.79 (17.70)^{bc}	8.79 (17.70)^{bcd}	18.05 (24.70)	39.02 (35.81)	28.53 (30.76)^{cd}
T6	Agnisthram	50	9.29 (18.15)	7.95 (16.93)^{ab}	7.62 (16.61)^{ab}	7.79 (16.77)^{abc}	19.92 (25.88)	38.57 (35.61)	29.25 (31.13)^{cd}
T7	NSKE	5 %	9.71 (18.52)	8.10 (17.07)^{abc}	6.77 (15.77)^{ab}	7.44 (16.42)^{ab}	21.99 (27.14)	46.33 (38.95)	34.16 (33.57)^{b}
T8	Panchapatra extract	25	17.76 (24.51)	16.76 (23.85)^{f}	14.76 (22.46)^{f}	15.76 (23.16)^{g}	11.76 (20.21)	37.78 (35.25)	24.77 (28.73)^{de}
T9	Panchapatra extract	50	11.57 (20.06)	10.91 (19.53)^{cde}	10.57 (19.24)^{cde}	10.74 (19.39)^{e}	11.88 (20.31)	32.61 (32.81)	22.24 (27.28)^{e}
T10	Chilli and Garlic extract	25	10.95 (19.56)	9.95 (18.73)^{abcd}	8.39 (17.34)^{bc}	9.17 (18.03)^{cd}	15.03 (22.66)	43.67 (37.84)	29.35 (31.18)^{c}
T11	Chilli and Garlic extract	50	12.74 (20.97)	11.06 (19.65)^{de}	7.82 (16.81)^{ab}	9.44 (18.23)^{cd}	18.79 (25.17)	42.81 (37.47)	30.80 (31.92)^{c}
T12	Datura leaf extract	25	14.29 (22.13)	13.62 (21.64)^{ef}	12.96 (21.14)^{ef}	13.29 (21.39)^{f}	10.86 (19.48)	32.12 (32.58)	21.49 (26.84)^{e}
T13	Datura leaf extract	50	17.90 (24.60)	16.90 (23.94)^{f}	14.23 (22.08)^{f}	15.56 (23.01)^{fg}	11.72 (20.18)	36.47 (34.65)	24.10 (28.35)^{de}
T14	Flubendiamide 480 SC	0.2	10.78 (19.42)	7.41 (16.40)^{a}	6.08 (15.06)^{a}	6.74 (15.73)^{a}	35.72 (34.30)	49.87 (40.38)	42.80 (37.47)^{a}
T15	Untreated control	-	19.20 (25.43)	20.53 (26.26)^{g}	25.65 (29.22)^{g}	23.09 (27.74)^{h}	-	-	-
	SEm		0.85	0.880	0.75	0.53			1.22
	CD (P=0.05)		2.46	2.56	2.18	1.62			3.73
	CV (%)		11.99	13.19	11.86	5.42			8.15

Figures in parentheses are arc sine transformed values

Valves with similar alphabets in each column do not vary significantly at 5 per cent level

DAS: days after spraying

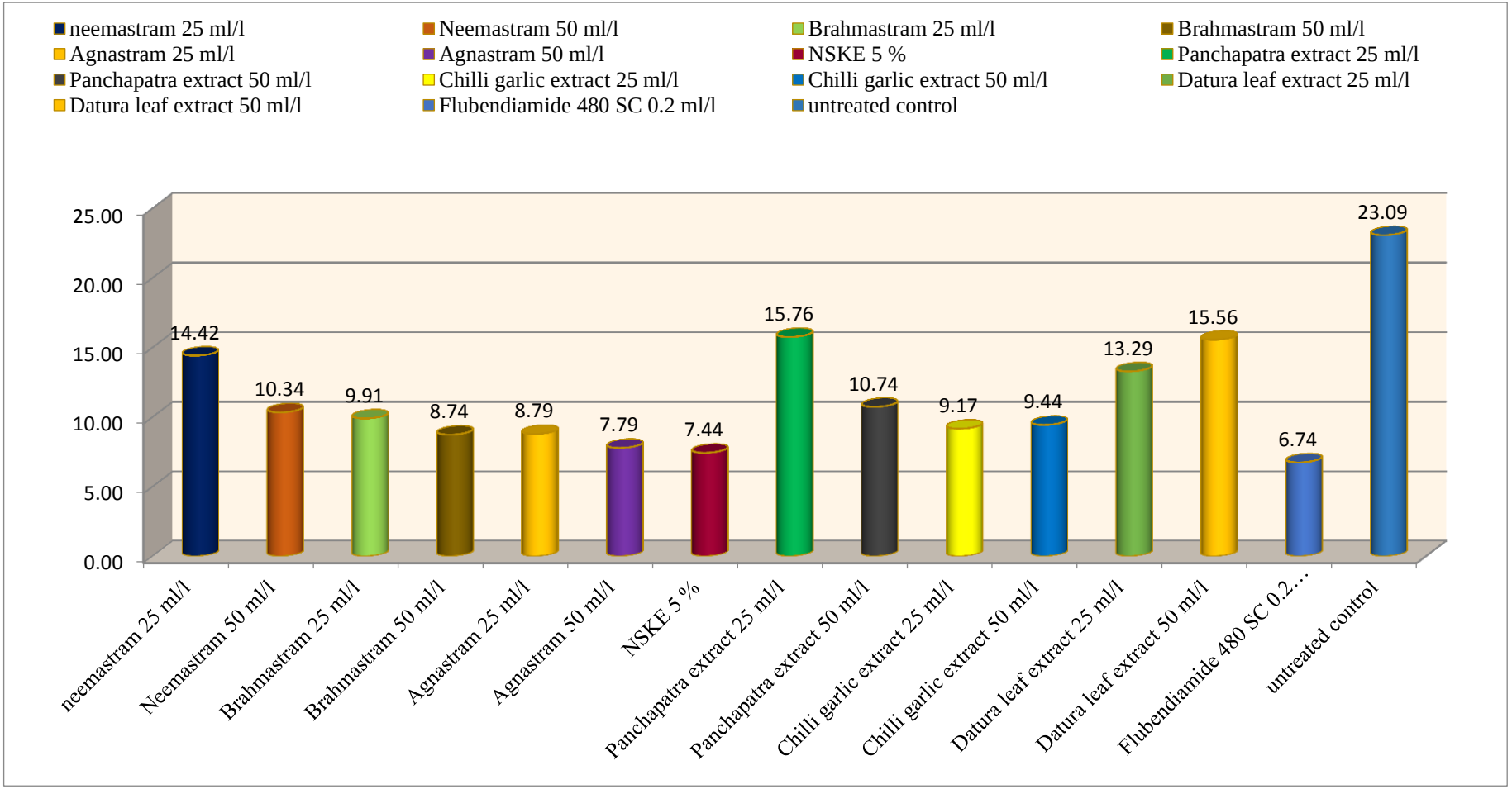

Fig. 4.4. Efficacy of ecofriendly products after second spray against rice leaf folder, *C. medinalis, kharif* 2018

4.2.3 Third Spray

The data pertaining to the efficacy of the treatments after the third spray were presented in the table 4.5 and fig 4.5.

At 65 days after transplanting the per cent leaf damage varied between 14.97 to 29.92 (pretreatment count) and there was a significant difference among ecofriendly products treatments.

4.2.3.1 Three days after spraying

The data at 3 days after spraying in third spray revealed that, least per cent damage of 5.08 was recorded in the chemical control *i.e.,* flubendiamide 480 SC @ 0.2 ml/l and it was followed by the treatments neem seed kernel extract at 5 per cent (6.60 %) and brahmastram at 50 ml/l (7.28 %) and these treatments were on par with each other and also superior over other treatments. The next best treatment was chilli garlic extract at 50 ml/l, which recorded 7.76 per cent leaf damage and it was followed by agnastram at 50 ml/l, chilli garlic extract at 25 ml/l, brahmastram at 25 ml/l, neemstram at 50 ml/l and agnastram at 25 ml/l with 8.01, 9.06, 9.07, 9.51 and 10.12 per cent leaf damage and these treatments were on par with each other statistically.

Among ecofriendly products the highest leaf folder damage was recorded in datura leaf extract at 50 ml/l with 19.56 per cent leaf folder damage and it was followed by neemastram at 25 ml/l, datura leaf extract at 25 ml/l, panchapatra extract at 25 ml/l and panchapatra extract at 50 ml/l with 15.22, 14.56, 14.09 and 13.24 per cent leaf damage due to leaf folder respectively.

All the ecofriendly product treatments were superior over untreated control, which was recorded 26.98 per cent leaf folder damage.

4.2.3.2 Seven days after spraying

At 7 days after spraying, the least per cent leaf damage of 3.41 was recorded in the chemical control *i.e.,* flubendiamide 480 SC @ 0.2 ml/l and it was followed by neem seed kernel extract at 5 per cent (4.93 %). Both the

treatments were on par with each other and also superior over other treatments. The next best treatment was brahmastram at 50 ml/l with 5.95 per cent leaf damage and it was followed by chilli garlic extract at 50 ml/l, agnastram at 50 ml/l, chilli garlic extract at 25 ml/l and brahmastram at 25 ml/l with 6.10, 6.34, 6.39 and 7.74 per cent leaf damage respectively and these treatments were on par with each other. The next best treatment was neemastram at 50 ml/l with 8.18 per cent damage and it was followed by agnastram 25 ml/l (8.45 %) and panchapatra extract at 50 ml/l (8.57 %). These treatments were on par with each other statistically. Among ecofriendly products the highest leaf folder damage was recorded in datura leaf extract at 25 ml/l with 11.62 per cent leaf folder damage and it was followed by datura leaf extract at 50 ml/l (11.16 %), panchapatra extract at 25 ml/l (11.09 %) and neemastram at 25 ml/l (10.55 %). These treatments were on par with each other.

All the ecofriendly products were superior over untreated control, which recorded 18.39 per cent leaf folder damage.

4.2.3.3 Mean per cent leaf damage

The mean per cent damage by leaf folder after third spray was varied between 4.25 to 22.68 per cent and the least per cent leaf folder damage was recorded in chemical control *i.e.,* flubendiamide 480 SC @ 0.2 ml/l with 4.25 per cent leaf damage and it was followed by treatment neem seed kernel extract at 5 per cent (5.77 %) and both the treatments were statistically on par with each other and also superior over other treatments. The next best treatment was brahmastram at 50 ml/l with 6.61 per cent leaf damage and followed by chilli garlic extract at 50 ml/l, agnastram 50 ml/l and chilli garlic extract at 25 ml/l with 6.93, 7.17 and 7.72 per cent leaf folder damage respectively. And these treatments were on par with each other and also with brahmastram at 25 ml/l, neemastram at 50 ml/l and agnastram 25 ml/l with 8.41, 8.84 and 9.29 per cent leaf folder damage respectively.

Table. 4.5. Efficacy of ecofriendly products after third spray against rice leaf folder, *C. medinalis* in BPT 5204 rice variety, *kharif* 2018

Tr. No.	Treatments	Dose @ ml/l	Leaf folder damage (%)				Per cent reduction over control		
			Pre treatment	Post treatment			3 DAS	7 DAS	Mean
				3 DAS	7 DAS	Mean			
T1	Neemasthram	25	22.16 (27.24)	15.22 (22.79)^{d}	10.55 (19.23)^{g}	12.88 (21.08)^{gh}	23.84 (28.21)	22.53 (27.45)	23.19 (27.83)^{e}
T2	Neemasthram	50	18.91 (25.25)	9.51 (18.34)^{c}	8.18 (17.14)^{def}	8.84 (17.75)^{e}	44.23 (38.08)	28.84 (30.92)	36.54 (34.68)^{cd}
T3	Bhramsthram	25	19.36 (25.54)	9.07 (17.96)^{bc}	7.74 (16.73)^{cdef}	8.41 (17.35)^{de}	48.03 (39.65)	34.21 (33.59)	41.12 (36.74)^{bcd}
T4	Bhramsthram	50	17.54 (24.37)	7.28 (16.28)^{abc}	5.95 (14.91)^{bc}	6.61 (15.61)^{bc}	53.97 (41.98)	44.20 (38.06)	49.09 (40.07)^{abc}
T5	Agnisthram	25	18.77 (25.16)	10.12 (18.87)^{cd}	8.45 (17.40)^{ef}	9.29 (18.15)^{ef}	40.21 (36.34)	25.88 (29.34)	33.05 (33.03)^{cde}
T6	Agnisthram	50	17.42 (24.29)	8.01 (16.98)^{bc}	6.34 (15.33)^{bcd}	7.17 (16.18)^{bcd}	49.02 (40.04)	40.10 (36.29)	44.56 (38.21)^{bcd}
T7	NSKE	5 %	16.15 (23.44)	6.60 (15.60)^{ab}	4.93 (13.78)^{ab}	5.77 (14.72)^{ab}	54.69 (42.26)	49.74 (40.33)	52.21 (41.30)^{ab}
T8	Panchapatra extract	25	22.07 (27.18)	14.09 (21.98)^{d}	11.09 (19.68)^{g}	12.59 (20.86)^{gh}	29.20 (31.10)	17.30 (24.20)	23.25 (27.87)^{e}
T9	Panchapatra extract	50	20.03 (25.95)	13.24 (21.35)^{d}	8.57 (17.51)^{f}	10.91 (19.53)^{fg}	26.71 (29.80)	29.57 (31.29)	28.14 (30.55)^{de}
T10	Chilli and Garlic extract	25	18.47 (24.97)	9.06 (17.94)^{bc}	6.39 (15.38)^{bcde}	7.72 (16.71)^{cde}	45.63 (38.66)	43.07 (37.58)	44.35 (38.12)^{bcd}
T11	Chilli and Garlic extract	50	17.24 (24.17)	7.76 (16.75)^{bc}	6.10 (15.07)^{bcd}	6.93 (15.93)^{bcd}	50.07 (40.46)	41.81 (37.04)	45.94 (38.79)^{bc}
T12	Datura leaf extract	25	23.56 (28.05)	14.56 (22.32)^{d}	11.62 (20.10)^{g}	13.09 (21.24)^{h}	31.46 (32.25)	18.80 (25.18	25.13 (28.93)^{e}
T13	Datura leaf extract	50	22.96 (27.70)	19.56 (25.66)^{e}	11.16 (19.73)^{g}	15.36 (22.89)^{i}	5.53 (14.46)	20.06 (25.97)	12.80 (21.02)^{f}
T14	Flubendiamide 480 SC	0.2 (0.048 g a.i./l)	14.97 (22.61)	5.08 (13.95)^{a}	3.41 (11.89)^{a}	4.25 (12.96)^{a}	62.39 (45.09)	62.49 (45.13)	62.44 (45.11)^{a}
T15	Untreated control	-	29.92 (31.47)	26.98 (29.94)^{f}	18.39 (24.92)^{h}	22.68 (27.54)^{j}	-	-	-
	SEm		0.72	0.94	0.71	0.51			1.76
	CD (P=0.05)		8.38	14.35	12.41	5.48			5.39
	CV (%)		2.09	2.72	2.06	1.54			10.28

Figures in parentheses are arc sine transformed values

Valves with similar alphabets in each column do not vary significantly at 5 per cent level

DAS: days after spraying

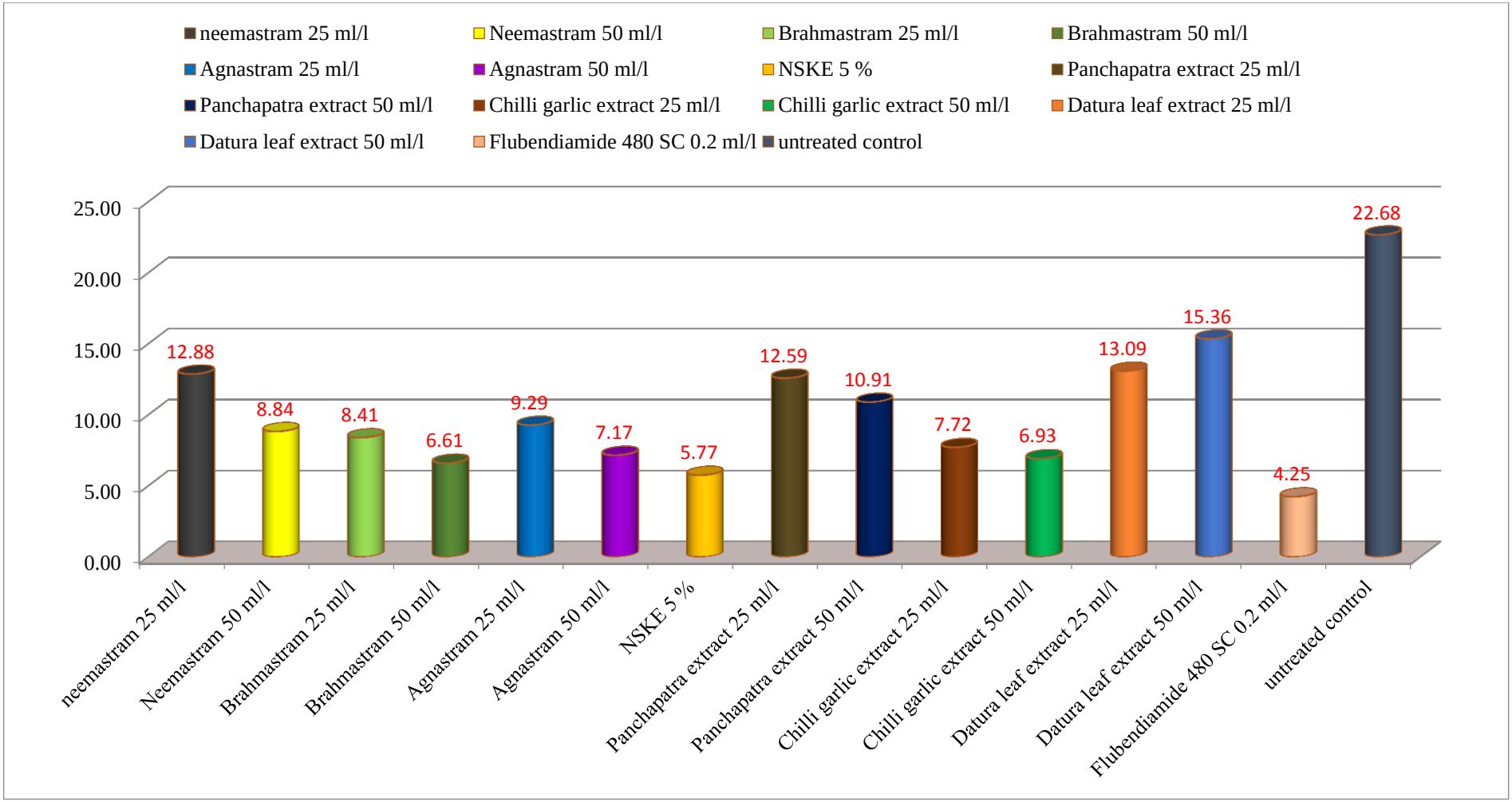

Fig. 4.5. Efficacy of ecofriendly products after third spray against rice leaf folder, *C. medinalis*, *kharif* 2018.

The highest leaf foder damage of 15.36 per cent was recorded in datura leaf extract at 50 ml/l and followed by datura leaf extract at 25 ml/l, neemastram at 25 ml/l, panchapatra extract at 25 ml/l and panchapatra extract 50 ml/l with 13.09, 12.88, 12.59 and 10.91 per cent leaf folder damage respectively.

All the ecofriendly product treatments are superior over control, which recorded 22.68 per cent leaf folder damage.

4.2.3.4 Per cent reduction over control

The per cent reduction over control varied between 5.53 to 62.39 and 17.30 to 62.49 at 3 days and 7 days after third spray respectively. The mean per cent reduction over control in third spray varied between 12.80 to 62.44 per cent. The highest mean per cent reduction over control was recorded in chemical control *i.e.,* flubendiamide 480 SC @ 0.2 ml/l with 62.44 per cent and it was followed by neem seed kernel extract at 5 per cent (52.21 %) and both were on par with each other statistically. The next best treatment was brahmastram at 50 ml/l with 49.09 per cent damage and followed by chilli garlic extract at 50 ml/l (45.94 %), agnastram at 50 ml/l (44.56 %), chilli garlic extract at 25 ml/l (44.35 %) and brahmastram at 25 ml/l (41.12 %). The next best treatment was neemastram at 50 ml/l with 36.54 per cent and followed by agnastram at 25 ml/l (33.05 %) and panchapatra extract at 50 ml/l (28.14 %) and these treatments were on par with each other.

The least per cent reduction over control was recorded in datura leaf extract at 50 ml/l with 12.80 per cent and next least per cent reduction over control was recorded in neemastram at 25 ml/l (23.19 %), panchapatra extract at 25 ml/l (23.25 %) and datura leaf extract at 25 ml/l (25.13 %), these treatments were on par with each other.

4.2.4 Mean Efficacy of Three Sprays on Per cent Leaf Damage

Pooled data of three sprays on mean per cent leaf damage by rice leaf folder was presented in table. 4.6 and fig. 4.6.

The mean per cent damage by leaf folder after three sprays was varied between 6.30 to 21.05 per cent and the least per cent leaf folder damage was recorded in chemical control *i.e.*, flubendiamide 480 SC @ 0.2 ml/l with 6.30 per cent and it shows superiority over other ecofriendly product treatment. Among ecofriendly products treatment neem seed kernel extract at 5 per cent concentration recorded 7.24 per cent leaf damage and it was followed by brahmastram at 50 ml/l with 8.34 per cent leaf damage and both the treatments were statistically on par with each other and also superior over other treatments. The next best treatment was chilli garlic extract at 50 ml/l with 8.42 per cent leaf damage and it was followed by agnastram 50 ml/l and chilli garlic extract at 25 ml/l lt with 8.53 and 9.48 per cent leaf folder damage respectively and these treatments were on par with each other and also with neemastram at 50 ml/l and agnastram 25 ml/l with 10.30 and 10.50 per cent leaf folder damage respectively. The next effective treatment was panchapatra extract 50 ml/l with 11.08 per cent leaf folder damage and it was followed by brahmastram at 25 ml/l with 11.67 per cent leaf folder damage and these two were on par with each other.

Among ecofriendly products treatments the highest leaf foder damage of 15.44 per cent was recorded in datura leaf extract at 50 ml/l and it was followed by neemastram at 25 ml/l, panchapatra extract at 25 ml/l and datura leaf extract at 25 ml/l with 15.07, 14.38 and 13.39 per cent leaf folder damage respectively.

All the ecofriendly product treatments were superior over control, which recorded 21.05 per cent leaf folder damage.

Table. 4.6. Mean efficacy of ecofriendly products on per cent leaf damage after three sprays against rice leaf folder, *C. medinalis, kharif* 2018

Tr. No.	Treatments Treatments	Dose @ ml/l	Mean per cent leaf damage			Pooled mean
			1 spray	2 spray	3 spray	
T1	Neemasthram	25	16.76 (23.85)^{gh}	14.42 (22.14)^{fg}	12.88 (21.08)^{gh}	15.07 (22.66)^{f}
T2	Neemasthram	50	11.72 (20.18)^{cde}	10.34 (19.05)^{d}	8.84 (17.75)^{e}	10.30 (19.00)^{de}
T3	Bhramsthram	25	14.07 (21.97)^{f}	9.91 (18.66)^{d}	8.41 (17.35)^{de}	11.67 (20.05)^{e}
T4	Bhramsthram	50	10.13 (18.87)^{bc}	8.74 (17.63)^{bcd}	6.61 (15.61)^{bc}	8.34 (17.24)bc
T5	Agnisthram	25	13.10 (21.15)^{de}	8.79 (17.70)^{bcd}	9.29 (18.15)^{ef}	10.50 (19.13)^{de}
T6	Agnisthram	50	10.62 (19.29)^{c}	7.79 (16.77)^{abc}	7.17 (16.18)^{bcd}	8.53 (17.41)^{c}
T7	NSKE	5 %	8.52 (17.45)^{a}	7.44 (16.42)^{ab}	5.77 (14.72)^{ab}	7.24 (16.20)^{b}
T8	Panchapatra extract	25	15.13 (22.72)^{fg}	15.76 (23.16)^{g}	12.59 (20.86)^{gh}	14.38 (22.17)^{f}
T9	Panchapatra extract	50	11.57 (20.06)^{cd}	10.74 (19.39)^{e}	10.91 (19.53)^{fg}	11.08 (19.66)^{e}
T10	Chilli and Garlic extract	25	11.56 (20.05)^{cd}	9.17 (18.03)^{cd}	7.72 (16.71)^{cde}	9.48 (18.27)^{cd}
T11	Chilli and Garlic extract	50	9.90 (18.68)^{ab}	9.44 (18.23)^{cd}	6.93 (15.93)^{bcd}	8.42 (17.33)^{c}
T12	Datura leaf extract	25	13.79 (21.76)^{f}	13.29 (21.39)^{f}	13.09 (21.24)^{h}	13.39 (21.46)^{f}
T13	Datura leaf extract	50	15.40 (22.91)^{gh}	15.56 (23.01)^{fg}	15.36 (22.89)^{i}	15.44 (22.94)^{f}
T14	Flubendiamide 480 SC	0.2 (0.048 g a.i./l)	7.91 (16.89)^{a}	6.74 (15.73)^{a}	4.25 (12.96)^{a}	6.30 (15.20)^{a}
T15	Untreated control	-	17.37 (24.26)^{h}	23.09 (27.74)^{h}	22.68 (27.54)^{j}	21.05 (26.52)^{g}
	SEm		0.55	0.53	0.51	0.37
	CD (P=0.05)		1.67	1.62	1.54	1.07
	CV (%)		5.32	5.42	5.48	5.63

Figures in parentheses are arc sine transformed values

Valves with similar alphabets in each column do not vary significantly at 5 per cent level

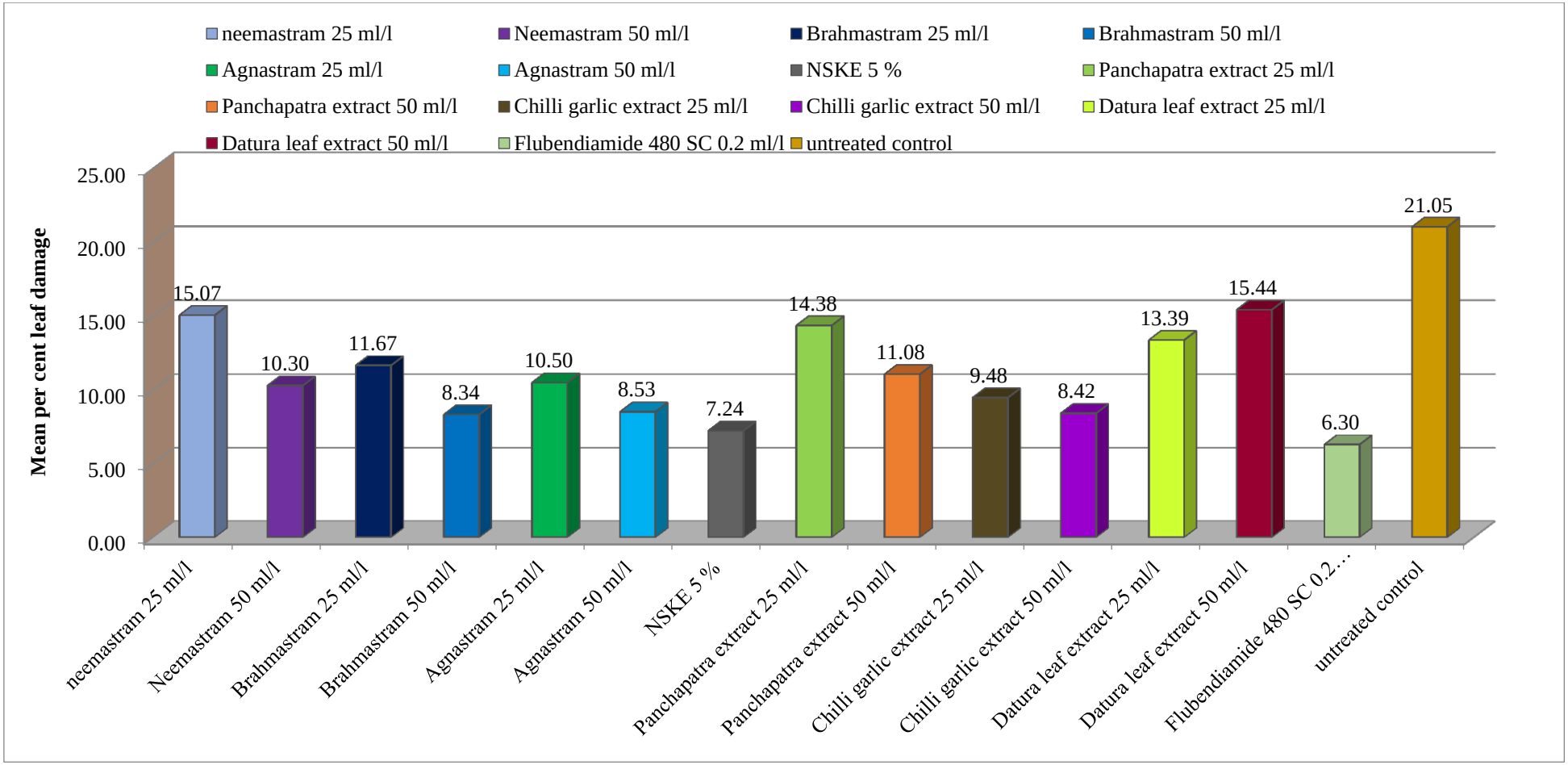

Fig. 4.6. Mean efficacy of ecofriendly products on per cent leaf damage after three sprays against rice leaf folder, *C. medinalis*, *kharif* 2018.

4.2.5 Mean Efficacy of Three Spray and Mean Per cent Reduction over Control

Pooled data of three sprays on mean per cent reduction of rice leaf folder over control was presented in table. 4.7 and fig. 4.7.

Among all the treatments the highest mean per cent reduction over control was recorded in chemical control *i.e.*, flubendiamide 480 SC @ 0.2 ml/l with 54.40 mean per cent and followed by NSKE at 5 per cent (48.51 %) and both were statistically on par with each other. The next best treatment was brahmastram at 50 ml/l (40.49 %) and followed by agnastram at 50 ml/l (39.01 %), chilli garlic extract at 25 ml/l (38.75 %), chilli garlic extract at 50 ml/l (38.40 %) and neemastram at 50 ml/l (34.08 %). All these were on par with each other statistically and also on par with agnastram at 25 ml/l (31.30 %).

The treatment panchapatra extract at 50 ml/l was recorded with 29.16 per cent reduction and followed by datura leaf extract at 25 ml/l (23.82 %). The least per cent reduction over control was recorded in datura leaf extract at 50 ml/l (17.05 %) and it was on par with panchapatra extract at 25 ml/l (21.18 %) and neemastram at 25 ml/l (22.15 %).

The present results regarding superiority of flubendiamide was confirmed with the findings of Kulagod *et al*. (2011), who reported lower per cent of 4.80, 5.31 and 5.52 per cent leaf damage at 5 day, 10 days and 15 days after spraying with flubendiamide 480 SC @ 0.2 ml/l. Similarly Karthikeyan (2017) also recorded that 4.3 per cent leaf damage at 65 days after transplanting with flubendiamide 20 % WDG at 125 grams. Rajkumar (2010) also reported that flubendiamide 480 SC @ 0.2 ml/l as highly effective in managing rice leaf folder with 73.56 per cent reduction over control. These results were also accordance with the finding of Chaudhari *et al*. (2017), who reported that flubendiamide 480 SC at 50 ml/ha with least per cent leaf damage of 2.3. These findings also in accordance with the findings of Javaregowda and Krishna Nail (2005), who reported that flubendiamide 20 WDG at 25 and 50 gram a.i./ha with 0.61 and 0.44 damaged leaves per hill by leaf folder after 7 days after spraying respectively.

Table 4.7. Mean efficacy of ecofriendly products on per cent reduction over control after three sprays against damage of rice leaf folder during *kharif* 2018

Tr. No.	Treatments Treatments	Dose @ ml/l	Mean per cent reduction over control			Pooled mean
			1 spray	2 spray	3 spray	
T1	Neemasthram	25	10.71 (19.36)^{e}	32.56 (32.79)^{c}	23.19 (27.83)^{e}	22.15 (27.23)^{ef}
T2	Neemasthram	50	37.58 (35.16)^{bc}	28.11 (30.54)^{cd}	36.54 (34.68)^{cd}	34.08 (33.52)^{bcd}
T3	Bhramsthram	25	26.64 (29.76)^{cd}	27.05 (29.97)^{cde}	41.12 (36.74)^{bcd}	31.60 (32.32)^{cd}
T4	Bhramsthram	50	45.47 (38.60)^{ab}	26.92 (29.91)^{cde}	49.09 (40.07)^{abc}	40.49 (36.47)^{b}
T5	Agnisthram	25	32.31 (32.67)^{cd}	28.53 (30.76)^{cd}	33.05 (33.03)^{cde}	31.30 (32.17)^{cd}
T6	Agnisthram	50	43.22 (37.65)^{b}	29.25 (31.13)^{cd}	44.56 (38.21)^{bcd}	39.01 (35.81)^{bc}
T7	NSKE	5 %	57.95 (43.48)^{a}	34.16 (33.57)^{b}	52.21 (41.30)^{ab}	48.51 (39.84)^{a}
T8	Panchapatra extract	25	15.52 (23.00)^{e}	24.77 (28.73)^{de}	23.25 (27.87)^{e}	21.18 (26.65)^{ef}
T9	Panchapatra extract	50	37.09 (34.94)^{bc}	22.24 (27.28)^{e}	28.14 (30.55)^{de}	29.16 (31.08)^{de}
T10	Chilli and Garlic extract	25	42.55 (37.36)^{b}	29.35 (31.18)^{c}	44.35 (38.12)^{bcd}	38.75 (35.69)^{bc}
T11	Chilli and Garlic extract	50	38.45 (35.56)^{b}	30.80 (31.92)^{c}	45.94 (38.79)^{bc}	38.40 (35.53)^{bc}
T12	Datura leaf extract	25	24.84 (28.77)^{d}	21.49 (26.84)^{e}	25.13 (28.93)^{e}	23.82 (28.20)^{e}
T13	Datura leaf extract	50	14.26 (22.10)^{e}	24.10 (28.35)^{de}	12.80 (21.02)^{f}	17.05 (24.04)^{f}
T14	Flubendiamide 480 SC	0.2 (0.048 g a.i./l)	59.16 (43.92)^{a}	42.80 (37.47)^{a}	62.44 (45.11)^{a}	54.40 (42.14)^{a}
T15	Untreated control	-		-	-	-
	SEm		1.86	1.22	1.76	1.24
	CD (P=0.05)		5.70	3.73	5.39	3.60
	CV (%)		11.47	8.15	10.28	11.35

Figures in parentheses are arc sine transformed values

Valves with similar alphabets in each column do not vary significantly at 5 per cent level

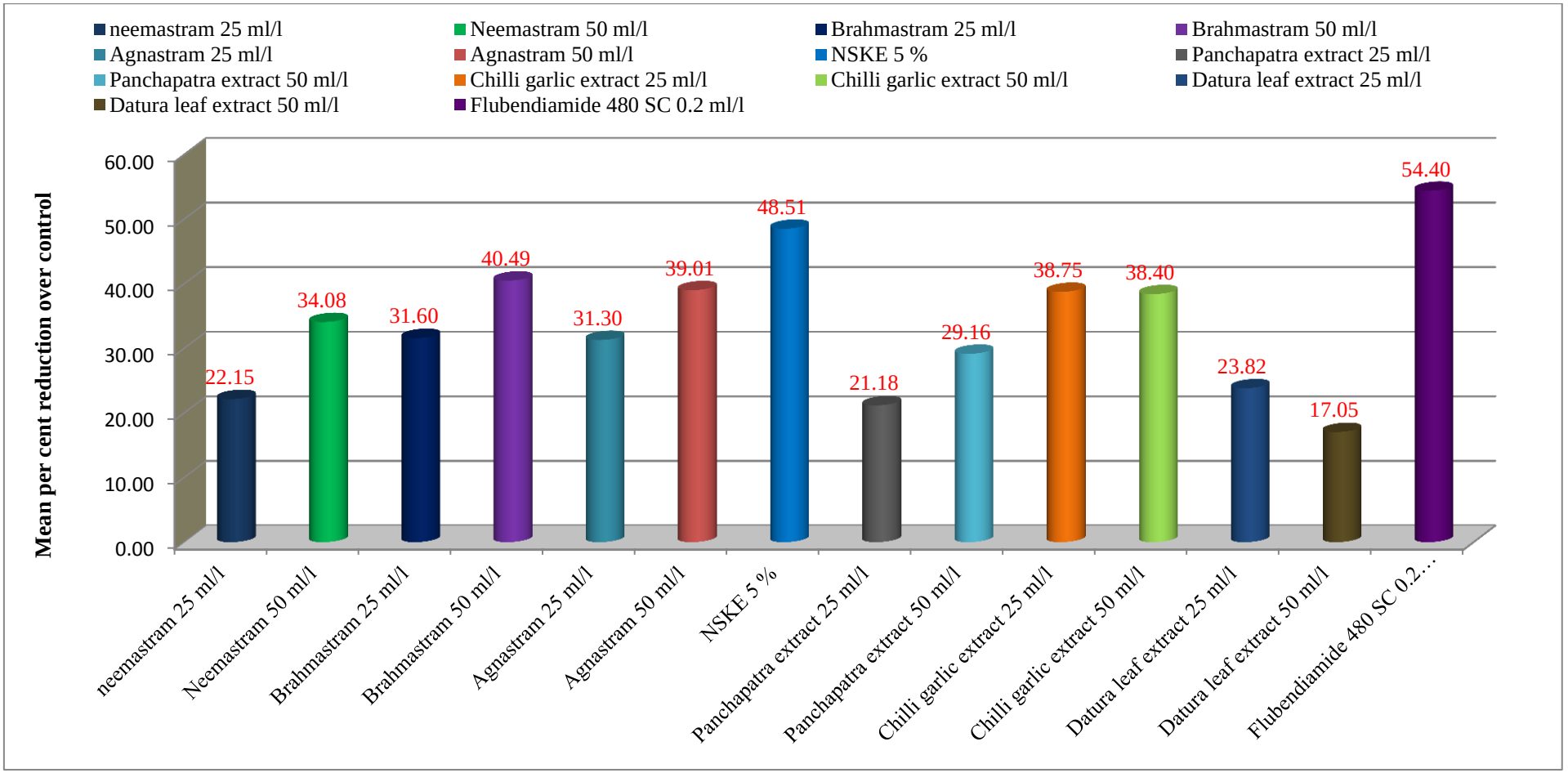

Fig. 4.7. Mean efficacy of ecofriendly products on per cent reduction of rice leaf folder over control after three sprays against rice leaf folder, *C. medinalis*, *kharif* 2018.

The present findings pertaining to neem seed kernel extracts were in accordance with Dey *et al*. (2012), who concluded that neem seed kernel extract at 5 per cent as effective insecticide against rice leaf folder with 71.81 per cent mortality. Arun *et al*. (2000) also reported that neem seed kernel extract with 55.22 and 61.48 per cent mortality at 5.00 and 6.00 per cent concentration.

The literature pertaining to brahmastram in rice crop in leaf folder management was scanty therefore literature regarding to the brahmastram used in other crop pest management were discussed. The results obtained were in accidence with Patel *et al*. (2017), who reported that brahmastram at 20 per cent as effective organic product in managing the pests like aphids, leaf hoppers, thrips and white fly with 2.02, 1.64, 1.48 and 1.39 number of pests per leaf respectively. These findings were also in accordance with the findings of Santhosh *et al*. (2009), who reported that brahmastram at 5 per cent concentration with 28.06 and 47.05 per cent pod damage and per cent reduction over control respectively.

The results pertaining to the chilli garlic extracts against rice leaf folder was in accordance with the findings of Pandey *et al*. (2017), who reported that chilli garlic extracts was an effective treatment with minimum of 2.26 per cent leaf damage. These findings also in accordance with Ravichandran *et al*. (2014), who concluded his results as chilli garlic kerosene extract was effective organic approach with 10.04, 10.10, 6.43 and 7.65 per cent leaf damage at one, three, seven and fourteen days after spraying respectively.

The present studies regarding to agnastram in rice leaf folder management was in accordance with the findings of Ravichandran *et al*. (2014), who reported that agnastram at 30 ml/l with 9.55, 9.61, 5,74 and 4.5 per cent leaf damage at one, three, seven and fourteen days after spraying respectively.

The literature pertaining to neemastram in rice crop in leaf folder management was scanty therefore literature on neemastram used in other crop pest management were discussed. The results were in accordance with the

findings of Patel *et al.* (2017) who reported that neemastram @ 20 per cent recorded with 2.41, 2.11, 1.97 and 1.90 number of pests per leaf in aphids, leaf hoppers, thrips and whitefly respectively. These findings also in accordance with Santhosh *et al.* (2009), who concluded that, neemastra with 37.13 and 31.71 per cent pod damage in 10 and 5 per cent concentration respectively.

As the literature on panchapatra extract is not available, literature on the plant leaves used for preparation of panchapatra extract is here with revied. The results obtained were in accordance with the finding of Reddy *et al.* (2018), who reported that, pongamia leaf extract @ 5.0 and 7.5 per cent concentration with 45.4 and 46.0 per cent mean reduction of plant hoppers with mean grain yield of 4725 and 4425 kg/ha paddy respectively. Akunne *et al*. (2014) concluded that 7.67 and 8.33 mean mortality of rice weevil in neem leaf powder treatment in 5 and 10 grams concentrations respectively. Pareek *et al*. (2018), who reported that custard apple seed extract against pigeon pea pod borer *Helicoverpa armigera* (Hubner) in laboratory and reported that lethal concentration LD_{50} and LC_{90} was found to be 53.24 mg/ml and 107.52 mg/ml respectively.

The literature pertaining to datura leaf extracts in rice crop in leaf folder management was scanty therefore literature regarding datura leaf extracts used in other crop pest management were discussed. The results were in accordance with the findings of Ritesh kumar *et al.* (2017), who reported that datura green leaf extracts @ 5 per cent recorded mean per cent mortality of *Mythimna separata* as 28.47 with 79.17 per cent increase yield over control against in oats crop. Ali *et al*. (2012), who reported that datura leaf extracts against khapra beetle and rice weevil and reported that, datura leaf extract concentration (2.5 %) caused the lowest survival rates in both pests with 67.5 per cent for *T. granarium* and 55 per cent for *S. oryzae*.

4.3 EFFECT OF INSECTICIDAL TREATMENTS ON YIELD OF PADDY AND THEIR COST BENEFIT RATIO

The results regarding influence of ecofriendly product treatments on yield of paddy and cost benefit ratio have been presented in the table 4.8, fig. 4.8 and fig. 4.9.

The data on yield was recorded in plot wise revealed that all the ecofriendly products treatments recorded higher yield significantly than the untreated control. Among all the treatments chemical control *e.i.,* flubendiamide 480 SC @ 0.2 ml/l was recorded the highest yield (4664 Kg/ha) with an increase of 69.30 per cent yield over control and it was superior over all other ecofriendly products treatments. Among the ecofriendly products the treatment neem seed kernel extract at 5 per cent concentration recorded higher yield (4259 Kg/ha) with 54.58 per cent yield increase over control and it was followed by brahmastram at 50 ml/l (3928 Kg/ha) with increase of 42.58 per cent yield over control and these two treatments were statistically on par with each other.

The next treatment with moderately better in recording higher yield was chilli garlic extract at 50 ml/l (3852 Kg/ha) with an increase of 39.82 per cent yield over control and it was followed by agnastram at 50 ml/l (3757 Kg/ha), chilli garlic extract at 25 ml/l (3608 kg/ha), neemastram at 50 ml/l (3505 kg/ha) and agnastram at 25 ml/l (3502 kg/ha) with 36.38, 30.96, 27.21 and 27.10 per cent increased yield over control and these treatments were statistically on par with each other.

The next treatment with moderately lower yield was panchapatra leaf extract at 50 ml/l (3327 kg/ha) with 20.76 per cent increased yield over control and it was followed by brahmastram at 25 ml/l (3240 kg/ha) with increase of 17.60 per cent over control and these two treatments were on par with each other statistically.

The lowest yield was recorded in untreated control (2755 kg/ha) and it was statistically on par with the treatments datura leaf extract at 50 ml/l (2803 kg/ha), neemastram at 25 ml/l (2840 kg/ha), panchapatra extract at 25 ml/l (2888 kg/ha) and datura leaf extract at 25 ml/l (3064 kg/ha) with 1.73, 3.09, 4.83 and 11.23 per cent increased yield over control.

However, the highest cost benefit ratio (CBR) of 1.28 was recorded for chemical control *e.i.,* flubendiamide 480 SC @ 0.2 ml/l followed by neem seed kernel extract at 5 per cent concentration (1.18), chilli garlic extract at 50 ml/l (0.93), brahmastram at 50 ml/l (0.91), chilli garlic extract at 25 ml/l (0.81), panchapatra extract at 50 ml/l (0.74), neemastram at 50 ml/l (0.70), datura leaf extract at 25 ml/l (0.61).

The CBR was lowest for neemastram 25 ml/l (0.38) followed by agnastram at 25 ml/l (0.40), datura leaf extract at 50 ml/l (0.47), agnastram at 50 ml/l (0.50), panchapatra extract at 25 ml/l (0.51) and brahmastram at 25 ml/l (0.58), untreated control (0.58).

Table 4.8. Effect of ecofriendly products treatments on yield of rice and their Cost Benefit Ratio, *kharif* 2018

Tr. No.	Treatments	Dose (ml/l)	Yield/ plot (Kg)	Yield/ ha (Kg)	Yield increased over control	Gross income (Rs)	Net income (Rs)	Total cost (Rs)	CB ratio
T1	Neemasthram	25	7.10	2840	3.09	49700	13615	36085	**0.38**
T2	Neemasthram	50	8.76	3505	27.21	61329	25244	36085	**0.70**
T3	Bhramsthram	25	8.10	3240	17.60	56697	20762	35935	**0.58**
T4	Bhramsthram	50	9.82	3928	42.58	68740	32805	35935	**0.91**
T5	Agnisthram	25	8.75	3502	27.10	61277	17430	43847	**0.40**
T6	Agnisthram	50	9.39	3757	36.38	65753	21906	43847	**0.50**
T7	NSKE	5 %	10.65	4259	54.58	74524	40389	34135	**1.18**
T8	Panchapatra extract	25	7.22	2888	4.83	50540	17155	33385	**0.51**
T9	Panchapatra extract	50	8.32	3327	20.76	58219	24834	33385	**0.74**
T10	Chilli and Garlic extract	25	9.02	3608	30.96	63140	28278	34862	**0.81**
T11	Chilli and Garlic extract	50	9.63	3852	39.82	67410	32548	34862	**0.93**
T12	Datura leaf extract	25	7.66	3064	11.23	53627	20242	33385	**0.61**
T13	Datura leaf extract	50	7.01	2803	1.73	49047	15662	33385	**0.47**
T14	Flubendiamide 480 SC	0.2	11.66	4664	69.30	81620	49995	31625	**1.28**
T15	Untreated control	-	6.89	2755	0.00	48212	17752	30460	**0.58**
	SEM	-	0.33	132.40	-	-	-	-	-
	CD (P=0.05)	-	0.96	383.54	-	-	-	-	-
	CV (%)	-	11.46	11.46	-	-	-	-	-

Values with similar alphabets in each column do not vary significantly at 5 % level.

(Cost of ingredients: Cow urine-Rs.50 per letre, cow dung-Rs.10 per kg, tabacco leaves-Rs.1000 per kg, garlic-Rs. 70/- per kg, chilli-Rs.40 per kg, neem seed kernel-Rs.10 per kg, kerosene-Rs.80 per litre, soap powred-Rs.10 per 100 g, flubendiamide 480 SC-Rs. 180 per 10 ml, sale price of rice-Rs.17.5 per kg; Quantity of spray fluid used-500 letre per hectare; plant protection cost include spray boy charges)

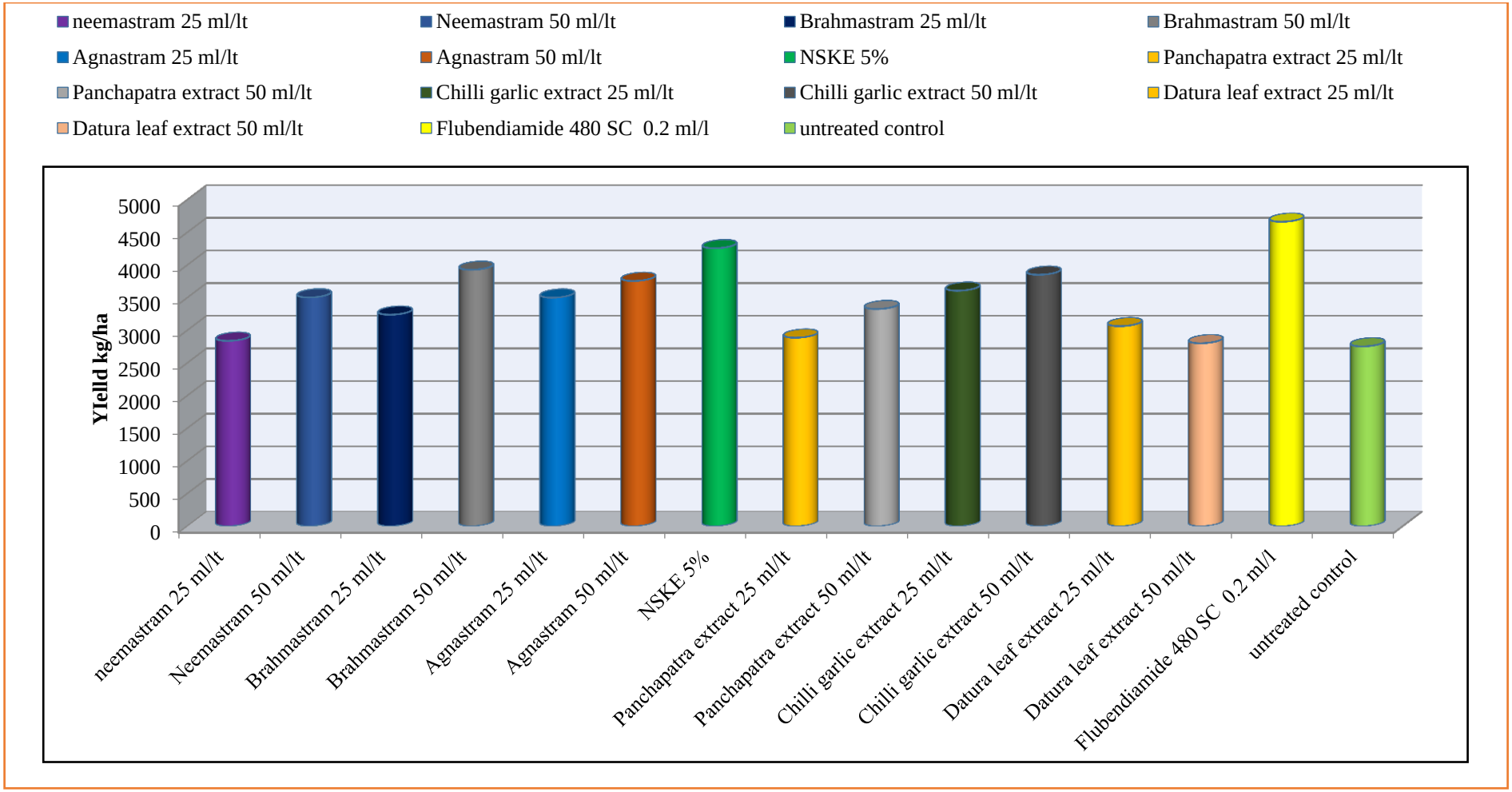

Fig. 4.8. Mean efficacy of ecofriendly products treatments on yield of rice against rice leaf folder, *C. medinalis, kharif* 2018

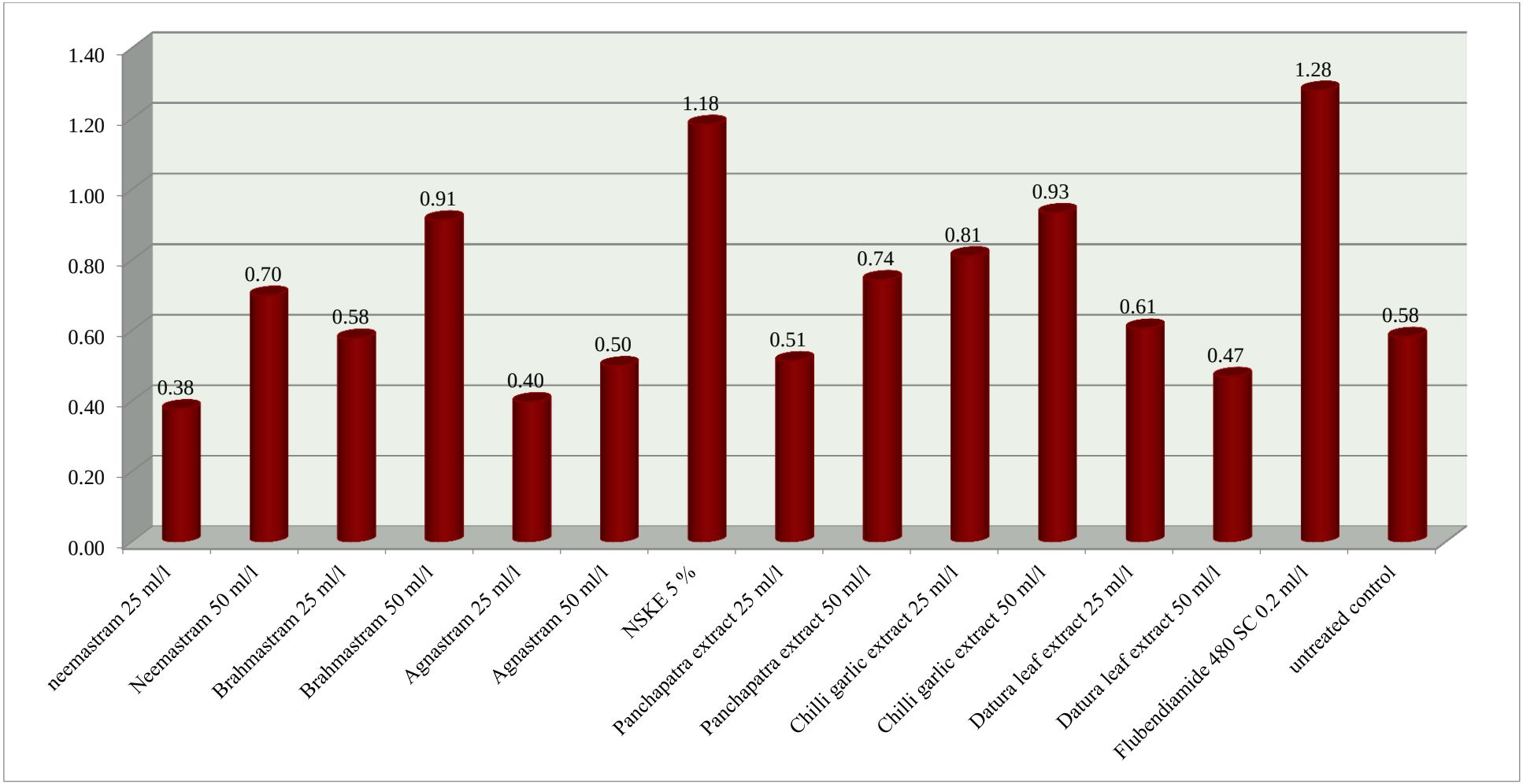

Fig. 4.9. Effect of ecofriendly products treatments on yield of rice and their cost benefit ratio, *kharif* 2018

Chapter – V

Summary and Conclusions

Chapter V

SUMMARY AND CONCLUSIONS

The present investigation on “Screening of rice entries against rice leaf folder *Cnaphalocrocis medinalis* (Guenee) and its management with ecofriendly products” was carried out at Agricultural College Farm, Bapatla, Andhra Pradesh during *kharif* 2018 and the results were precisely summarized in this chapter.

Among forty two different rice entries evaluated for varietal preference by rice leaf folder, *C. medinalis* was analyzed under two conditions *viz.,* controlled condition with the help of nylon net and natural condition during *kharif* 2018. The data was collected from 40 days after transplanting upto 100 days after transplanting at 10 days intervals. The results indicated that forty two entries could record different levels of leaf folder damage.

In controlled condition the mean per cent leaf damage was highest in BPT 3059 (48.63%) and least damge was recorded in W-1263 (6.31 %) and susceptible check (TN-1) recorded 51.45 per cent leaf infestation.

Under controlled condition all the forty two entries recorded different ratings *i.e.,* fifteen entries recorded rating of 3 (moderately resistant), twenty one entries in rating of 5 (moderately susceptible), three entries in rating of 7 (susceptible) two entries with damage rating 1 (resistant) and where as susceptible check (TN-1) recorded damage rating of 9 (Highly susceptible).

Under natural condition the per cent leaf damage recorded between 6.58 to 27.24 with highest leaf infestation by rice leaf folder in BPT 3036 and lowest leaf folder infestation was in W-1263 and susceptible check (TN-1) recorded 36.33 per cent leaf infestation.

Under natural conditions all the forty two entries recorded different ratings *i.e.,* three entries recorded damage rating of 1 (resistant), thirty three entries were in damage rating of 3 (moderately resistant), five entries in rating of 5 (moderately susceptible) and susceptible check (TN-1) recorded damage rating of 7 (susceptible).

The data on the effectiveness of different ecofriendly products (15 treatments) on rice leaf folder during *kharif* 2018 showed that, the most effective treatment was chemical control *i.e.*, flubendiamide 480 SC @0.2 ml/l with 6.30 and 54.40 per cent leaf folder damage and per cent reduction over control respectively and it shows superiority over other ecofriendly product treatment. Among ecofriendly products treatment neem seed kernel extract at 5 per cent concentration recorded 7.24 per cent leaf damage (48.51 % reduction over control) and it was followed by brahmastram at 50 ml/l with 8.34 per cent leaf damage (40.49 % reduction over control), chilli garlic extract at 50 ml/l with 8.42 per cent leaf damage (38.40 % reduction over control), agnastram 50 ml/l with 8.53 per cent leaf folder damage (39.01 % reduction over control), chilli garlic extract at 25 ml/l with 9. 48 per cent leaf folder damage (38.75 % reduction over control). All the ecofriendly products recorded less than 50 per cent reduction of leaf damage over untreated control.

Neemastram at 50 ml/l, agnastram 25 ml/l, panchapatra extract 50 ml/l and brahmastram at 25 ml/l with 10.30, 10.50, 11.08 and 11.67 per cent leaf folder damage and 34.08, 31.30, 29.16 and 31.60 per cent reduction over control respectively. These treatments were superior over untreated control.

Datura leaf extract at 50 ml/l, neemastram at 25 ml/l, panchapatra extract at 25 ml/l and datura leaf extract at 25 ml/l with 15.44, 15.07, 14.38 and 13.39 per cent leaf folder damage and with 17.05, 22.15, 21.18 and 23.82 per cent reduction over control respectively were least effective among all the ecofriendly products treatments, but superior over untreated control.

The mean effect of different ecofriendly products treatments on yield during *kharif* 2018 showed that, the yield was ranged between 2755 to 4664 kg/ha including untreated control. The highest yield was obtained from chemical control *i.e.,* flubendiamide 480 SC @ 0.2 ml/l (4664 kg/ha) with 69.30 per cent superior over control followed by neem seed kernel extract at 5 per cent concentration (4259 kg/ha) with 42.58 per cent yield increased over control. Brahmastram at 50 ml/l (3928 Kg/ha), chilli garlic extract at 50 ml/l (3852 Kg/ha), agnastram at 50 ml/l (3757 Kg/ha), chilli garlic extract at 25 ml/l (3608 kg/ha), neemastram at 50 ml/l (3505 kg/ha), agnastram at 25 ml/l (3502 kg/ha), panchapatra leaf extract at 50 ml/l (3327 kg/ha) and brahmastram at 25 ml/l (3240 kg/ha) recorded only 39.82, 36.38, 30.96, 27.21, 27.10, 20.76 and 17.60 per cent yield increase over control respectively, as these ecofriendly products could not reduce the damage due to rice leaf folder.

Among the ecofriendly products treatments the lower yield was noticed in datura leaf extract at 50 ml/l (2803 kg/ha), neemastram at 25 ml/l (2840 kg/ha), panchapatra extract at 25 ml/l (2888 kg/ha) and datura leaf extract at 25 ml/l (3064 kg/ha) with least per cent increased yield over control of 1.73, 3.09, 4.83 and 11.23 per cent respectively.

The highest cost benefit ratio (CBR) of 1.28 was recorded for chemical control *e.i.,* flubendiamide 480 SC @ 0.2 ml/l followed by neem seed kernel extract at 5 per cent concentration (1.18).

The CBR was less than one in ecofriendly products, which could be due to cost involved in preparation of these products was high when compared with NSKE and flubendiamide. The CBR was 0.93 in Chilli garlic extract at 50 ml/l, 0.91 in brahmastram at 50 ml/l, 0.81 in chilli garlic extract at 25 ml/l, 0.74 in panchapatra extract at 50 ml/l, 0.70 in neemastram at 50 ml/l, 0.61 in datura leaf extract at 25 ml/l. Least CBR was recorded in neemastram 25 ml/l (0.38) followed by agnastram 25 ml/l (0.40), datura leaf extract at 50 ml/l (0.47), agnastram 50 ml/l (0.50), panchapatra extract at 25 ml/l (0.51) and brahmastram at 25 ml/l (0.58), untreated control (0.58).

CONCLUSIONS

- Among forty two different rice entries, the varietal preference of rice leaf folder, *Cnaphalocrocis medinalis* was analyzed under two conditions *viz.*, controlled condition and natural condition during *kharif* 2018. Based on the overall response of 42 entries against rice leaf folder damage during *kharif* 2018 at 40, 50, 60, 70, 80, 90 and 100 days after transplanting, the results indicated that all rice entries recorded different levels of leaf folder damage.

- Under controlled condition, the lowest mean per cent leaf folder damage was recorded in W 1263 (6.31 %) and BPT 3034 (10.30 %) and highest mean per cent leaf damage recorded in BPT 3059 (48.63 %) and where as the susceptible check (TN-1) which recorded 51.45 per cent leaf damage.

- Under natural condition, the lowest mean per cent leaf folder damage was recorded in W 1263 (6.58 %) and BPT 3034 (9.39 %) and highest mean per cent leaf damage recorded in BPT 3036 (25.88 %) when compared to the susceptible check (TN-1) which recorded 36.33 per cent leaf damage.

- In both controlled and natural conditions the entries W 1263 (6.31 and 6.58 %) and BPT 3034 (10.30 and 9.39 %) recorded lowest damage due to rice leaf folder.

- Among all the treatments, after three sprays, the spray with flubendiamide 480 SC @ 0.2 ml/l was found to be most effective with the lowest mean per cent leaf damage (6.30 %) followed by neem seed kernel extract at 5 per cent (7.24 %) with 54.40 and 48.51 per cent reduction over untreated control respectively.

- All other ecofriendly products recorded less than 50 per cent reduction over control. Among them, brahmastram at 50 ml/l recorded 8.34 per cent leaf damage and 40.49 per cent reduction over control followed by chilli garlic extract at 50 ml/l (8.42 %), agnastram at 50 ml/l (8.53 %), chilli

garlic extract at 25 ml/l (9.48 %), neemastram at 50 ml/l (10.30 %), agnastram 25 ml/l (10.50 %), panchapatra extract at 50 ml/l (11.08 %) and brahmastram at 25 ml/l (11.67 %) with 38.40, 39.01, 38.75, 34.08, 31.30, 29.16 and 31.60 per cent reduction over untreated control respectively.

- The highest leaf folder damage was noticed in datura leaf extract at 50 ml/l with 15.44 per cent leaf damage and 17.05 per cent reduction over control followed by neemastram at 25 ml/l, panchapatra extract at 25 ml/l and datura leaf extract at 25 ml/l with 15.07, 14.38 and 13.39 per cent leaf damage and 22.15, 21.18 and 23.82 per cent reduction over control respectively.

- Flubendiamide 480 SC @ 0.2 ml/l was recorded the highest yield (4664 Kg/ha) with an increase of 69.30 per cent yield over control and it was superior over all other ecofriendly products treatments. Among the ecofriendly products only neem seed kernel extract at 5 per cent concentration could record more than 50 per cent increased yield *i.e.,* 54.58 per cent with 4259 kg/ha yield. Where as all other ecofriendly products tested recorded less than 50.00 per cent yield.

- The highest cost benefit ratio (CBR) of 1.28 was recorded for chemical control *e.i.,* flubendiamide 480 SC @0.2 ml/l followed by neem seed kernel extract at 5 per cent concentration (1.18). All other ecofriendly products recorded cost benefit ratio less than one.

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