EFFICACY OF HERBICIDES AND THEIR EFFECT ON YIELD OF TRANSPLANTED AUS RICE

MST. MAHBUBA NARGIS NEELA

DEPARTMENT OF AGRONOMY

SHER-E-BANGLA AGRICULTURAL UNIVERSITY

DHAKA-1207

JUNE, 2016

EFFICACY OF HERBICIDES AND THEIR EFFECT ON YIELD OF TRANSPLANTED AUS RICE

BY

MST. MAHBUBA NARGIS NEELA
Reg. No.: 10-03775

A Thesis
Submitted to the Faculty of Agriculture,
Sher-e-Bangla Agricultural University, Dhaka,
in partial fulfilment of the requirements
for the degree of

MASTER OF SCIENCE
IN
AGRONOMY
SEMESTER: JANUARY-JUNE, 2016
Approved by:

(Dr. Md. Abdullahil Baque)	**(Dr. A. K. M. Ruhul Amin)**
Professor	**Professor**
Supervisor	**Co-Supervisor**

(Prof. Dr. Md. Fazlul Karim)
Chairman
Examination Committee

DEPARTMENT OF AGRONOMY

Sher-E-Bangla Agricultural University

Sher-E-Bangla Nagar, Dhaka-1207

Ref. No.: Date:

CERTIFICATE

*This is to certify that the thesis **entitled "EFFICACY OF HERBICIDES AND THEIR EFFECT ON YIELD OF TRANSPLANTED AUS RICE"** submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree **of MASTER OF SCIENCE (MS) in AGRONOMY**, embodies the results of a piece of bona fide research work carried out by **MST. MAHBUBA NARGIS NEELA**, Registration. No.**10-03775** under my supervision and guidance. No part of this thesis has been submitted for any other degree or diploma.*

I further certify that such help or source of information as has been availed of during the course of this investigation has duly been acknowledged.

Dated:

Dhaka, Bangladesh

(Dr. Md. Abdullahil Baque)
Professor
Supervisor

Dedicated To

My Beloved Parents

ACKNOWLEDGEMENTS

All praises are to the Almighty Allah, the great, the gracious, merciful and supreme sovereign ruler of the universe to complete the research work and thesis successfully for the degree of Master of Science (MS) in Agronomy.

The author expresses the deepest sense of gratitude, cordial respect, sincere appreciation and heartfelt indebtedness to her reverend research supervisor Dr. Md. Abdullahil Baque, Professor, Department of Agronomy, Sher-e-Bangla Agricultural University, Dhaka for his scholastic guidance, innovative suggestion, constant supervision and inspiration, valuable advice and helpful criticism in carrying out the research work and preparation of this manuscript.

The author deems it a proud privilege to acknowledge her gratefulness, and the best regards to her respectable co-supervisor Dr. A. K. M. Ruhul Amin , Professor, Department of Agronomy, Sher-e-Bangla Agricultural University, Dhaka for his valuable advice, constructive criticism and factual comments in upgrading the research work and this documents.

The author would like to express her deepest respect and boundless gratitude to all the respected teachers of the Department of Agronomy, Sher-e-Bangla Agricultural University, Dhaka, for their valuable teaching, sympathetic co-operation, and inspirations throughout the course of her study and research work.

The author feels proud of expressing her sincere appreciation and gratitude to Minister of Science and Technology, The People's Republic of Bangladesh for selecting her as a National Science and Technology (NST) fellow and funding. She expresses deepest respect, gratitude and thanks to her husband Agriculturist Md. Humayun Kabir, from very core of her heart for his codial co-operation, suggestion and moral support. She wishes to extend her cordial gratefulness to Md. Ahsan Habib, Md . Haseur Hossain, and Jannatul Ferdous Moonmoon for their help during experimentation. Special thanks to her friends Fahmida, Milee and Nipa for their support and encouragement to complete ther study.

The author is deeply indebted to her father and grateful to her respectful mother. She expresses thanks to her sister and brother.. The author wants to mention the name of her dear student Dippro and thanks him for giving courage to go ahead in her life. She remembers all her teachers, from primary level to university with due respect for teaching her with care and affection.

Finally the author appreciate the assistance rendered by the staff members of the Department of Agronomy, Agronomy Laboratory and Field Division, Sher-e-Bangla Agricultural University, Dhaka, who have helped during the period of study.

The author

EFFICACY OF HERBICIDES AND THEIR EFFECT ON YIELD OF TRANSPLANTED AUS RICE

ABSTRACT

A field experiment was carried out at the Agronomy Field Laboratory, Sher-e-Bangla Agricultural University, Dhaka, during the period from March-August, 2015 to evaluate the efficacy of herbicides and their effect on yield of transplanted *aus* rice (BRRI dhan 48). This was a single factor experiment with eighteen treatments, namely T_1: Propyrisulfuran (500 ml/ha), T_2: Propyrisulfuran (750 ml/ha), T_3: Propanil (3750 g/ha), T_4: Propyrisulfuran + Propanil (500 ml/ha + 3750g /ha), T_5: Propyrisulfuran + Propanil (500 ml/ha + 2916.7g/ha), T_6: Propyrisulfuran + Propanil (500 ml/ha + 2500 g/ha), T_7: Propyrisulfuran + Propanil (500 ml/ha + 2083.3 g/ha), T_8: Propyrisulfuran + Propanil (500 ml/ha + 1666.7 g/ha), T_9: Propyrisulfuran + Propanil (500 ml/ha + 1250 g/ha), T_{10}: Propyrisulfuran + Propanil (750 ml/ha + 3750 g/ha), T_{11}: Propyrisulfuran + Propanil (750 ml/ha + 3125 g/ha), T_{12}: Propyrisulfuran + Propanil (750 ml/ha + 2500 g/ha), T_{13}: Propyrisulfuran + Propanil (750 ml/ha + 1875 g/ha), T_{14}: Propyrisulfuran + Propanil (500 ml/ha + 900g/ha), T_{15}: Propyrisulfuran + Propanil (750 ml/ha + 900 g/ha), T_{16}: Acetochlor 14% + Bensulfuron methy l 4% (2000 g/ha (premix), $T_{17:}$ Bispyribac sodium + Pyralosulfuran ethyl (150 g/ha + 150 g/ha) and T_{18} (Untreated check). The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Twenty-two different weed species infested the field among which Shusni (*Marsilea quadrifolia*), *Behua* (*Cyperus difformis*) *and Moyurleja* (*Leptochloa chinensis*) dominanted throughout the growing period but controlling *Moyurleja* (*Leptochloa chinensis*) was so hard and could not be controlled till harvesting. Results show that treatment T_9 recorded the lowest weed population at 7, 14, 21, 28 and 45 DAA (days after Application) while the highest weed population was recorded from the control treatment T_{18}. No. of total tillers hill^{-1} (12.87), no. of effective tillers hill^{-1} (11.52), tiller length (.102.40 cm), panicle length (24.03 cm), no. of secondary branches panicle^{-1} (25.07), filled grains panicle^{-1} (118.90), total grains panicle-^{1} (125.4), grain yield (3.8 t ha^{-1}), straw yield (4.64 t ha-1), biological yield (8.4 t ha^{-1}) and harvest index (50.08 %) were obtained highest from T_9 treatment. Whereas, T_{18} (Untreated check) recorded the lowest values in all cases except no. of unfilled grain panicle-^{1}, no. of non effective tiller hill $^{-1}$ (3.17) and 1000 grain weight. It can be concluded from the above results that treatment T_9: Propyrisulfuran + Propanil (500 ml/ha + 1250 g/ha) performed better than other herbicidal treatments.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ACRONYMS

ABBREVIATIONS	ELABORATIONS
%	Percent
@	at the rate of
0C	Degree Celsius
a.i	Active ingredient
Adv.	Advanced
AEZ	Agro-Ecological Zone
Agric.	Agriculture Agricultural
Agril.	Agricultural
Agron .	Agronomy
Anon.	Anonymous
ANOVA	Analysis of Variance
BARI	Bangladesh Agricultural Research Institute
BAU	Bangladesh Agricultural University
BBS	Bangladesh Bureau of Statistics
BRRI	Bangladesh Rice Research Institute
cm	Centimeter
CV	Coefficient of Variation
cv.	Cultivar
DAA	Days After Application
DAS	Days After Sowing
DAT	Days After Transplanting
DBA	Days Before Application
df	Degrees of Freedom
DMRT	Duncan`s Multiple Range Test
EC	Emulsifiable Concentrate
et al.	and others

ABBREVIATIONS	ELABORATIONS
etc.	etcetera
FAO	Food and Agriculture Organization
Fig	Figure
g	Gram
ha^{-1}	Per hectare
HI	Harvest Index
$hill^{-1}$	Per hill
J.	Journal
kg	Kilogram
LSD	Least significance difference
m2	Square meter
No.	Number
NOS	Number of species
NS	Non Significant
$Panicle^{-1}$	Per panicle
PP.	Pages
RCBD	Randomized Complete Block Design
Res.	Research
RH	Relative humidity
SAU	Sher-e-Bangla Agricultural University
Sci.	Science
SRDI	Soil Resource Development Institute
t	Ton
Vol.	Volume
WCE	Weed control efficiency

CHAPTER I

INTRODUCTION

CHAPTER I

INTRODUCTION

Rice (*Oryza sativa L.*) is the staple food for more than two billion people in Asia and for hundreds of millions of people in Africa and Latin America (IRRI, 2006). It contains 6.36-8.13% protein and is the main carbohydrate supplying food in Indian subcontinent. It is also a major part of human diet for the people of Bangladesh and has got a tremendous influence on the economy of this country. It constitutes about 95% of the total food grain production in Bangladesh (Julfiquar *et al.*, 1998).The area covered by rice in our country are 11.26 million hectares and the production is about 29.75million tons, respectively (AIS, 2008). The average yield of rice in Bangladesh is 2.45 t ha^{-1} (BRRI, 2006) which is frustratingly below the highest ranking country China which is 12.9 t ha^{-1} (IRRI, 2001). In 2015-16, aus rice production were21,33,17 metric tons in 9,41,681 hectares; aman rice production was 1,34,83,437 metric tons covering 55,90,340 hectares and boro rice production was 1,89,37,581 metric tons in 47,72,576 hectares of land (BBS, 2017).

Bangladesh is an agrarian based economic country from ancient period as agriculture comprises about 20% of the country's gross domestic product (GDP) and around 45% of the labor force are engaged in this sector (Mondal, 2013). Rice is the staple food of almost all the people of Bangladesh and it has remarkable influence on the economy of Bangladesh. The present population of Bangladesh is about 14.99 crore with growth rate of 1.37%, the population will be 189.85 million within 2030 (Bangladesh Economic Review, 2016). It is estimated that the annual requirement of rice would be 43.6 million metric tons (mmt) by 2030 (Mondal and Chowdhury, 2014). In Bangladesh, rice constitute first position in both area and production. Rice is cultivated here under three distinct seasons namely Aus, Aman and Boro season. It can be grown in irrigated, rainfed and deep water conditions. The area used for rice cultivation were 11.82 million hectares, total production and average yield of rice in our

country in 2015 are 52.23 million tons and 4.42 t ha^{-1}, respectively (FAOSTAT, 2015).

A weed is an unwanted plant having no economic value which grows in cultivated fields, is also the important yield constraint of crops including rice plants. It is a nutrient absorbing competitive plant which grows out of place simultaneously and posses the characteristics of vigorous growth and reproduction, even under adverse conditions. Weeds are also responsible for the uptake and transpiration of appreciable amounts of water and this loss is particularly significant during drought. Most of the weeds possess severe competitive abilities having a serious negative effect on crop production and are responsible for marked losses in crop yield (Mamun *et al*., 1993). Weeds compete with rice plants severely for space, nutrients, air, water and light and thus adversely affecting plant height, leaf architecture, tillering habit, shading ability, growth pattern and crop duration of rice (Miah *et al*.,1990). In Bangladesh, the grain yield reduced by severe weed infestation in aus rice (early summer) is 70.80%, in transplanted aman rice (late summer) is 30-40% and in modern boro rice (winter rice) is 22-36% (Mamun, 1990a). This loss is a severe constraint of crop production for a over populated small country like Bangladesh. So, proper weed management is essential for obtaining higher rice yield in Bangladesh. In a rice field, many varieties of weeds are found. Generally, they are classified into three groups namely, grasses, sedges and broadleaf weeds according to their morphological character. In our country, the traditional methods of weed control practices include preparatory land tillage, hand weeding by hoe and hand pulling. Among them, hand weeding is the most common method practiced by the Bangladeshi farmers (Ahmed *et al*., 1986). Usually two or three hand weeding are normally done for growing a rice crop depending upon the nature of weeds, their intensity of infestation and the crop grown. But due to the unfavorable weather conditions or labour scarcity weed control at the critical period may not be possible by traditional method. However, yield loss due to weeds depends upon some variables like magnitude of weed infestation, type of weed species and time of association with crop

(Moody and De Datta, 1998). Depending on the type of weed flora and their intensity, poor weed control is one of the major factors for yield reduction of rice (Amarjit *et al*., 2005). The traditional methods of weed control in Bangladesh .are time consuming, labor intensive as well as expensive (Chowdhury *et al.,* 1995). Weeds cause severe yield loss of wheat range from 20 to 40% (Ahmed *et al*., 2005). Weed control in transplanted rice by mechanical and cultural methods is expensive (Mitra *et al.,* 2005). On the contrary, chemical weed control is easier and cheaper .So, herbicide could be an excellent alternative to those methods. Hence there are many controversies about using chemical methods as it lead to environmental pollution and has negative impact on public health (Phuong *et al.,* 2005). However, herbicide selectivity and application dose may reduce the pollution in some extent. But the research findings are inadequate to highlight effective chemical use in rice (Bhuiyan *et al*., 2010).

Herbicidal weed control is an effective and economic system of weed management. The commonly used herbicides in rice cultivation in Bangladesh are Acetochlor, Butachlor, Pretilachlor, Ethoxysulfuran, Pyralosulfuron ethyl, Bispyribac sodium, Triasulfuron, Oxadiarzil, Anilphos, Propanil, 2,4-D, etc. Crop-weed competition at early growth stage can be reduced by applying pre-emergence or early post emergence herbicides like Logran, Extra power, Rifit 500 EC and Superhit 500 EC and which are highly selective. Those herbicides can be used in Bangladesh for controlling mono and dicotyledonous weeds in rice fields. In previous researches, it was found that combined use of contact and systemic herbicides generally give better result than using single of them and spraying one time is enough to control weeds in *aus* rice field. Replacement of traditional weeding methods in *aus* rice by herbicides would help to obtain higher crop yield with less costs and reduced labour. Using herbicides at recommended rate, offer good weed suppression and increase rice grain yield (Adigun *et al.,* 2000). Farmers need to apply, herbicides at proper rates in the field. The rate of herbicides application depends on the intensity of

weed infestation, edaphic condition and other climatic factors and it has significant effect on yield and yield components of transplanted *aus* rice.

Considering potential benefit of herbicide for controlling weed in rice, the current research work was undertaken with the view of following objectives:

Objectives of the Research work

The present study will be therefore undertaken-

- To investigate the weed killing efficacy of different herbicides in transplanted aus rice.
- To find out the effect of different herbicides on yield contributing and yield parameters of transplanted aus rice.

CHAPTER II

REVIEW OF LITERATURE

CHAPTER II

REVIEW OF LITERATURE

Weed is considered as one of the most crucial factor which performs a negative influence on the growth and development of the crops since it competes with crop plant for sunlight, water, nutrients and finally reduces the yield drastically. In agronomic point of view, weed management has become a vital issue for modern rice cultivation. Among all weed control methods, application of herbicide is the most effective for controlling weed as well as increasing yield but very often it pollutes the environment. Considering those points, available literature is mentioned below.

2.1 Presence of weed species in rice field

Weed vegetation in crops is the result of cropping, cropping season, topography of land and management practices like time and degree of land preparation, plant spacing, time of planting, fertilizer management, weeding method and intensities.

Hossain (2015) carried out an experiment at Agronomy field of Sher -e-Bangla Agricultural University, Dhaka, during March-August, 2014 in Aus season to find out the "EFFICACY AND RESIDUAL ACTIVITY OF HERBICIDE ON GROWTH AND YIELD OF TRANSPLANTED AUS RICE." He observed that 19 species of weeds named *Marsilea quadrifolia* , *Cyperus deformis* , *Cynodon dactylon*, *Cyperus esculentus* , *Echinochloa crussgalli*, *Monochoria vaginalis* , *Eclipta alba* , *Alternanthera philoxeroides* , *Alternanthera sessilis*, *Ludwigia hyssopifolia*, *Sagittaria guyanensis* , *Leersia hexandra* , *Spilanthes acmella*, *Fimbristylis miliacea*, *Eleucine indica*, *Echinochloa colonum* , *Leptocola sp* , *Commelina benghalensis*, *Sphenoclea zhilanica and Cyperus irria* were present in experimental plot.

An experiment was conducted by Kaes (2015) titled " EVALUATION OF HERBICIDAL EFFICACY AND RESIDUAL ACTIVITY ON DIRECT SEEDED BORO RICE**"** at Agronomy field of Sher -e – Bangla Agricultural

University, Dhaka, during December 2014 to May 2015.He identified 16 weed species in his experimental plot.Those weeds were *Marsilea quadrifolia* , *Cyperus deformis,* , *Leptocola sp* , *Commelina benghalensis, Sphenoclea zhilanica, Cyperus irria* , *Fimbristylis miliacea, Panicum repens, Cynodon dactylon, Alternanthera philoxeroides* ,*Echinochloa crusgalli, Echinochloa colona, Eleucine indica, Alternanthera sessilis, Alternanthera sessilis and Eclipta alba.*

Sharmin (2014) studied that 18 weed species infested the field among *which Cyperus michelianus* and *Cyperus esculentus* at 30 DAT; *Cyperus esculentus, Alternanthera sessile* and *Cyperus difformis* at 60 DAT, *Fimbristylis miliacea*e at 90 DAT were dominated in the experimental plot.

18 commonly growing weed species were identified by Zannat (2014) in aromatic *aman* rice cv. Binadhan-9 and identified weed species lik*e Oxalis corniculate, cyperus michelianus, Cyperus difformis, Panicum repens, Fimbristylis diphylla, Monochoria hastata, Scirpus mucronatus, Echinochloa colonum, Cynodon dactylon, Polygonum orientale, Leersia hexandra, Echinochloa crusgalli, Parapholis incurve, Ludwigina prostrata, and Eclipta alba*.

A field experiment was conducted by Chowdhury (2012) at Sher-e- Bangla Agricultural University Agronomy field during July to December, 2011 to evaluate the performance of aromatic rice varieties under different weed control methods and found twenty three weed species infested the field among which the dominated weed species were *Echinochola crussgali* at 15 DAT, *Cyperus michelianus* at 30 DAT, *Cyperus esculentus* and *Cyperus difformis* at 45 DAT, *Cyperus esculentus* at 60 DAT and *Ludwigia octovalvis* at 75 DAT respectively.

Mamun *et al.* (2011) carried out several experiments to study which weed species are dominant in transplanted rice. They conducted field experiments at Bangladesh Rice Research Institute (BRRI), Gazipur in Aus season, 2010 and

BRRI Rangpur, during Boro season, 2011. They observed that the most dominant weeds were *Cyperus diffornis, Monochoria vaginalis and Echinochloa crus-galli* in the first year and *Cyperus difformis* and *Echinochloa crus-galli* in the next year. In both years *Cyperus diffornis* was the most dominating weed species.

Islam *et al.* (2010) observed that eleven weed species infested the experimental plot. Those belongs to six families and of which *Panicum repens* was the most important weed species and the other dominant species were *Digitaria sanguinalis, Rottboellia protensa, Leersia hexandra, Fimbristylis miliacea, Monochoria hastata,* and *Scirpus mucronatus* in respect of weed density.

Bhuiyan *et al.* (2010) conducted field experiment at two different agroecological zones of Bangladesh. They reported that weed flora in the experimental plots in the two different agroecological zones comprised of the grasses named *Cynodon dactylon, Echinochloa crusgalli, Leptochloa chinensis,* the sedges named *Cyperus difformis , Sicirpus juncoides* and the broadleafs named *Enhvdra fluctuans, Monochoria uginalis, Lindernia anagallis, Marsilea minuta* and *Sphenoclea zeylanica.*

Gowda *et al.* (2009b) recorded *Digitaria sanguinalis, Cynodon dactylon, Panicum repens, Cyperus rotundus, Cyperus iria, Euphorbia hirta, Phyllanthus niruri* and *Commelina benghalensis* as the predominant weed species in aerobic rice fields.

An experiment was carried out by Hasanuzzaman *et al. (*2008) on transplanted Amon rice at the Sher-e-Bangla Agricultural University Farm, Dhaka and observed that *Panicum repens* infested severly among 14 different weed species.

Rahman *et al.* (2007) from his experiment on economic study of levels of herbicide use and hand weeding method in controlling weeds in transplant *aman* rice found that important weed species found to infest the crop were

Angta (*Panicum repens*), Durba (*Cynodon dactylon*), Shama (*Echinochloa crusgalli*) and Panilong (*Ludwigia hyssopifolia*).

Eight field species in transplanted aman rice field, namely *Paspalum scrobiculatum* , *Echinochloa colona* , *Fimbristylis littralis* , *Cvperus iria* , *Alisma plantago* , *Jussieua decurrens* , *Polygonum orientale* and *Sphenocelea zeylanica* were found by Mian *et al*., (2007). They added that among the weed species *Paspalum scrobiculatum* was the most dominating species while *A. plantago* and *J. decurrens* were also dominanted in semi-dwarf modern cultivars (BR11 and BR22) than in traditional tall cultivars (Nizersail and Biroi).

8 commonly growing weed species in *boro* rice *like Echinochloa crusgalli, Marsilea quadrifolia, Scirpus juncoides, Cyperus difformis, Monocoria vaginalis, Leersia hexandra, Lindernia anagalis* and *Fimbristylis miliacea* were listed by Jesmin (2006).

Bahar and Govendra (2004) conducted a field experiment in India to evaluate theweed infestation in transplanted *aman* rice. The infested weeds were identified as *Echinochloa colonum* (30.8%), *E. crusgalli* (15.8%), *Caesulia axillaries* (10.3%), *Isehaemum rugosum* (26.4%), *Commelina diffusa* (7.6%) and others (8.9%). The highest weed density was recorded in the weedy plots at 60 DAT.

Ranasinghe (2003) observed that the dominant weeds were *Monochoria vaginalis* and *Ludwigia octavalvis* in moderate to poor drained soils whereas in well to moderately drained soils *Echinochloa crusgalli, Schaemum rugosum, Leptochloa chinensis, Cyperus iria, Fimbrisrylis miliacea* and *Cyperus difformis* were dominating species.

It was stated by Singh *et al.* (1999) that application of herbicide or hand weeding resulted significant decrease in total number of weeds and their dry matter as compared to weedy check. Maximum weed density and dry weight were recorded with weedy check treatment. Minimum weed density and weed

dry weight were recorded from the crop received weed free treatment up to 60 DAT. Pre-emergence application of Anilofos @ 0.4 kg ha^{-1} supplemented with one hand weeding at 40 DAT was found most effective in controlling density and dry weight of weeds.

2.2 Effect of herbicides

A field research titled "EVALUATION OF HERBICIDAL EFFICACY AND RESIDUAL ACTIVITY ON TRANSPLANTED AROMATIC BORO RICE" was carried out by Moonmoon (2015) at Sher-e-Bangla Agricultural University during December 2014 to May 2015. She observed that combination of propyrisulfuran 380 ml ha^{-1} and propanil 1500 g ha^{-1} gives the best result in weed control during boro season.

Poornima *et al.* (2015) revealed that weed biomass reduced by 96-97% due to application of pyralosulfuron ethyl followed by orthosulfamuron and (butachlor+propanil) compared to non-treated weedy plots. On the other hand, pyrazosulfuron ethyl with one post-emergence herbicide either (butachlor+propanil) or 2, 4-D reduced weed by 91 to 92 %. Butachlor followed by orthosulfamuron followed by (butachlor+propanil) also reduce weed biomass by 91% compared to non-treated control. Only pyrazosulfuron ethyl followed by orthosulfamuron and (butachlor+propanil) achieved yields close to those of the weed-free treatments (5.42-6.04 t ha^{-1}). Among the herbicide treatments in 2014, sole application of butachlor produced low grain yield similar to the non-treated crop (2.76-3.1 vs 3.13 t ha^{-1}) suggesting low activity of this herbicide on weed control in unpuddled soil. The results suggest that pyrazosulfuron ethyl was the most effective pre-emergence herbicide in unpuddled transplanting system especially when applied with orthosulfamuron and / or (butachlor+propanil) or 2, 4 - D as a post-emergence herbicides.

An experiment was carried out by Kumaran *et al.* (2015). He found that Bispyribac sodium 10% SC is highly effective on weed control and their nutrient management in direct seeded low land rice. The experiment was laid out in a Randomized Block Design (RBD) with three replications. The results

revealed that application of bispyribac sodium 10% SC 40 g ha^{-1} during Early Post Emergence (EPOE) recorded higher weed control efficiency and lesser weed density, nutrient uptake at reproductive stage of the crop. Different weed management practices imposed on rice crop did not affect the germination of succeeding green gram.

Ramesha *et al.* (2015) evaluated the bio-efficacy and phytotoxicity of pyrazosulfuron ethyl 10% WP (5, 10, 15 and 20g ha^{-1} as spray) against the weeds in transplanted rice. Spraying Saathi (Market Sample) @ 15g ha^{-1}, Pretilachlor 50% EC @ 500 ml ha^{-1}, hand weeding at 15 and 40 days after planting (weed free check) and a weedy check (untreated check) were also maintained. The dominant weeds were *Echinochloa colona, Panicum repens, Cynodon doctylon, , Leptochloa chinensis, Ludwigia parviflora and Cyperus sp*. Application of pyrazosulfuron ethyl 10% WP at 20 g ha^{-1} was most effective in controlling the associated weeds and increasing the grain yield of rice without any phytotoxic effect.

Ahmed and Chauhan (2014) conducted a field study in the boro season of 2011-12 and aman season of 2012 at Jessore, Bangladesh and observed that among herbicides, pendimethalin, acetachlor + bensulfuranmethyl and oxadiargyl performed very well against grasses than pyrazosulfuron. They also revealed that to control broadleaf weed oxadiargyl (65-85%control) performed better than pendimethalin and acetachlor + bensulfuraonmethyl. Oxadiargyl followed by ethoxysulfuron in the boro season and oxadiargyl followed by a one-time hand weeding in the aman season was suggested as the best combination for controlling weed.

Mallikarjun *et al.* (2014) observed the effect of herbicides on weed control and yield of wet seeded rice which involves three pre-emergent herbicides viz., butachlor, oxyflurofen and anilophos applied as alone and each these followed by two post emergent herbicides 2, 4- sodium salt, bispyribac sodium and one hand weeding at 25 days. The results revealed that sequential application of butachlor and anilophos followed by bispyribac sodium, 2, 4-D sodium salt and

one hand weeding at 25 days was recorded significantly lower weed population and dry weight of weeds viz., monocots, dicots and sedges in equal manner which ultimately indicates that higher weed control efficiency over rest of the treatments except weed free check and hand weeding thrice. further, grain and straw yield of rice was followed the same trend as well influenced by yield parameters like number of panicles/m^2 and number of seeds/panicle ultimately sequential application butachlor and anilophos followed by 2, 4-D sodium salt and bispyribac sodium and one hand weeding at 25 DAS resulted higher grain yield and profitable rice production.

Application of Prechlor 500 EC @ 1.5 L ha^{-1} showed the best performance in reducing weed density and weed dry weight and in increasing weed control efficiency but reduced the grain yield was evaluated by Faruq (2013) .

The highest efficacy of acetochlor on *Chenopodium album, Amaranthus retroflexus, Echinochloa crus-galli* and *Solanum pkysalifolium* was found by Jursik *et al.* (2013) .

Mahajan and Chauhan (2013) stated that the single application of pyrazosulfuron (15 g a.i. $ha^{-1)}$ PRE, pendimethalin (750 g a.i. ha^{-1}) PRE, bispyribac-sodium (25 g a.i. ha-') POST, penoxsulam (25 g a.i. ha^{-1}) POST, and azimsulfuron (20 g a.i. ha-$^{1)}$ POST reduced total weed biomass by 75, 68, 73, 70, and 72%, respectively, compared with the non-treated control at flowering stage of the crop.

A field trial was carried out by Madhukumar *et al*. (2013) during *kharif* 2010-11 at Main Research Station, Hebbal, University of Agricultural Sciences, Bangalore to study "The efficacy of pre and post emergent herbicides on growth and yield of *kharif* aerobic rice". The suggested that sequential application of Cyhalofop-butyl_Bensulfuron at early growth stage followed by Bentazon/MCPA at mid growth stage provided the highest weed control efficacy. They also revealed that sequential application of Pretilachlor/safener

just after seeding followed by Propanil/Thiobencarb at early growth stage also provided satisfactory results in terms of efficacy and economic return.

Chowdhury (2012) conducted a field experiment at Agronomy field of Sher-e-Bangla Agricultural University during July to December, 2011 and revealed that weeds were very effectively controlled by pre-emergence herbicide Sunrice l 50WG . Khaliq *et al.* (2011) evaluated that pendimethalin, Acetochlor and butachlor were effective against jungle rice efficient in controlling purple nutsedge while ethoxysulfuron ethyl was most effective.

Among non-chemical weed management techniques, allelopathy (bioherbicides) is considered as an option for weed suppression by Rahamdad and Khan (2012). The results showed that pre-emergence application of plant water extracts proved to be superior to their post-emergence application in respect of weed control. Pre-emergence application of *Helianthus annuus* and *Phragmites australis* gave 65% and 68% weed control, respectively. Minimum fresh and dry weed biomass of 188 kg ha 1and 94 kg ha respectively was recorded under the pre-emergence application of *Phragmites australis*. Sorghum gave maximum grain yield 5015 kg ha^{-1} while weedy check gave only 2700.6 kg ha^{-1}.The instant results suggest *Helianthus annuus* that and *Phragmites australis* could be successfully incorporated in weed management approaches in wheat.

It was revealed by Ikeda *et al.* (2011) that propyrisulfuron is a novel sulfonylurea rice herbicide and it is very effective in controlling annual and perennial paddy weeds, including Echinochloa spp., sedges and broadleaf weeds and suggested that Propyrisulfuron shows safer profiles for human health and the environment.

Mamun *et al.* (2011) conducted an experiment to find out an effective and economic herbicide to control weeds. Becolor SG, Bouncer 10 WP (Pyrazosulfuron-ethyl), (Butachlor) and Becofit 500 EC (Pretilachlor) were used to control 9 weeds. The highest grain yield (6.96 t ha^{-1}) was obtained from

Surjamoni when treated with Bouncer 10 WP @ 150 g ha^{-1} which was 49% higher than control. The highest grain yield (5.92 t ha^{-1}) was produced by BRRI dhan29 when treated with same treatment which was 37% higher than control.

Meier *et al.* (2011) reported that the addition of propanil with thiobencarb to the first application of imazethapyr provided greater control of red rice and barnyardgrass earlier in the season, thus reducing early competition.

An experiment was conducted by Ali *et al.* (2010) at the Agronomy Farm, Sher-e-Bangla Agricultural University, Dhaka during the period July-December, 2006. He observed that among the weed control treatments Pretilachlor + one hand weeding at 40 DAT performed the best for controlling weeds at 30 DAT (79.53%) and moderate for controlling weeds at 60 DAT (75.65%).

Bari (2010) conducted an experiment with eight herbicides in transplanted wetland rice during aman season to study the effect of weed control and rice yield. The highest grain yield of 4.08 t ha^{-1} was obtained from Butachlor while the lowest grain yield (2.83 + t ha^{-1}) was recorded from the plots receiving MCPA @ 125% of the recommended rate.

Bhuiyan and Ahmed (2010) conducted an experiment during dry season of 2007 in two different agroecological zones of Bangladesh and found that Mefenacet + bensulfuron methyl 53% WP (0 524, 594 and 657 g a.i. ha-1 had highest bioefficacy against broad spectrum of weeds and safety to crop.

It was studied by Bakare (2008) that a formulated mixture of propanil + triclopyr was evaluated at 2, 3 and 4l ha^{-1} along side with a check chemical (OrizoplusR made up of propanil + 2, 4 – D Amine) showed significant difference occurred in the level of weed control. Though propanil + triclopyr controlled weeds; the control level was significantly lower than the check OrizoplusR in each respective application rate. There was no phytotoxic effect of the herbicides on rice, indicating that the hebicides are not injurious to rice

crop. Formulated mixture of propanil + triclopyr is recommended to be applied at 3-4 Lha^{-1} as post-emergence herbicide in lowland rice.

James and Rahman (2009) evaluated that Metolachlor was the most effective in controlling summer grass (*Digitaria sanguinalis*) and rough bristle grass *(Setaria verticillata*).

Shamim *et al.* (2008) reported the methods of crop establishment, time of herbicide application and their interaction significantly influenced the number and dry weight of weeds. The highest number and dry weight of weed were recorded in direct seeded thin row, followed by direct seeded thick row and the lowest in transplanting. Again, the highest number and dry weight of weed were recorded in control and the lowest in herbicide application after 3 days of seeding or transplanting. Weed control efficiency was higher in those receiving early application of herbicide. The highest weed control efficiency was in herbicide application at 3 days after seeding or transplanting. Phytotoxicity of herbicide increased with the earliness of herbicide application and highest phytotoxicity was observed in direct seeded thick row having herbicide application 3 days after sowing.

Propanil is highly effective herbicide for controlling weeds on rice was evaluated by Ronald and Nada (2007). They also revealed that the residual herbicides molinate, thiobencarb and pendiniethalm when mixed with propanil improved control of propanil resistant liarnyardgrass.

Mukherjee and Malty (2007) conducted an experiment in transplanted rice, with Butachlor 1.0 kg ha^{-1} at 3 days after transplanting + almix 20 WP (Chlorimuron7 ethyl + Metsulfuron-methyl) 4.0 g ha^{-1} at 20 days after transplanting registered higher weed control efficiency and grain yield compared with season long weed control weed-free condition.

Ishaya *et al.* (2007) observed that application of pretilachlor + dimethametryne at 2.5 kg a.i. ha^{-1} and piperophos + cinosulfuron at 1.5 kg ha^{-1} effectively controlled weeds.

Hasanuzzaman *et al. (*2007) conducted an experiment at the Agronomy field of Sher-e-Bangla Agricultural University, Dhaka and found that among the pre-emergence herbicides, Sunrice 13.75 WG showed better performance to control weeds in transplanted *aus* rice field.

Jucai *et al.* (2002) revealed that Flumicloracpentyl at 50 g a.i. ha-' plus clethodim at 70 g a i. ha-' suppressed both broad leaved weeds and grass weeds with an increased efficacy of more than 90% during field trials in Taigu, Shanxi province, China.

Achlderon *et al*. (1987) observed selectivity of Rifit (Pretilachlor) in both direct seeded and transplanted rice. The herbicide gave good control of most major broad leaf and sedge weeds of low land rice. He recommended that for optimum efficiency Pretilachlor should be applied @ 20 g ha-1 after 3-5 days of transplanting. .

2.3 Effect on weed population

Weed control efficacy is an important parameter of controlling weeds in crop field. High weed control efficacy ensures proper crop growth and profitable weed control. Weed control efficacy varies with weed control methods.

Hossain (2015) observed that propyrisulfuran @ 380 ml ha^{-1} + propanil @ 1500 g ha^{-1} supress weed best after 28 days of spray.

Sharmin (2014) told that two hand weeding at 20 and 40 DAT showed the highest weed control efficiency 89.90% at 30 DAT, 59.74% at 60 DAT 78.85% at 90 DAT.

Mamun *et al*. (2011) evaluated that application of Bensulfuron methyl + Pretilachlor 6.6% GR @ 652 g a.i ha^{-1} gave more than 80% weed control efficiency in *boro* rice.

Ali *et al.* (2010) carried out an experiment at the Agronomy farm, Sher-e-Bangla Agricultural University, Dhaka during the period July-December, 2006

and observed that among the weed control treatments Pretilachlor + one hand weeding at 40 DAT performed the best for controlling weeds at 30 DAT (79.53%) and moderate for controlling weeds at 60 DAT (75.65%) which ultimately availed to the highest grain yield (3.60 t ha^{-1}).

Bhuiyan *et al*. (2010) evaluated that pre-emergence application of Oxadiargyl 400 SC @ 75 g a.i. ha^{-1} controlled most of the weeds and gave maximum dry weight of weeds which resulted satisfactory weed control efficacy than other herbicide and doses.

Abeysekera *et al*. (2008) suggested that tank mixture of quinchlorac + propanil at a mixture 50 g ha^{-1}+ 1.08 g ha^{-1} a.i foliowed by MCPA effectively controlled *Echinochloa crussgalli ,Digitaria sanguinalis* and *Leptocola sp.*

Kabir *et al.* (2008) found that other than weed free treatment, Butachlor 5G @ 2 kg ha^{-1} applied at 7 DAT along with one hand weeding at 40 DAT gave the best performance under good water management with the highest weed control efficacy (82.57%).

Gealy *et al.* (2003) observed that grain of yields increased and barnyardgrass weed population and biomass decreased with increasing propanil rates.

Jena *et al.* (2002) observed that application of Oxadiazon with hand weeding contributed to the highest weed control efficacy, grain and straw yield and harvest index also,

Chandra *et al.* (1998) found that Butachlor 2.00 kg $ha^{-1,}$ Oxadiazon 0.8 kg ha^{-1}, and Thiobencarb 2.00 kg ha^{-1} provided 80.50, 78.30 and 35.10% weed control, respectively and also told that among the herbicides, Oxadiazon was the most effective herbicidal treatments . The best weed control and crop yield were achieved with Oxadiazon treatment applied 10 DAT.

It was observed by Ahmed *et al.* (1997) that higher weed control efficiency (90.35%) was observed in herbicides with one hand weeding treatment than single herbicides or conventional weed control methods.

Alam *et al.* (1996) stated that weed control efficacy was higher in two hand weeding (90.67%) than the sole dose of Oxadiazon and Cinosulfuron treatments.

2.4 Effect on growth characters

Moonmoon (2015) showed that combination of propyrisulfuron 380 ml ha^{-1} + propanil 1500g ha^{-1} gives highest plant height at 90 days after transplanting.

Madhukumar *et al*. (2013) suggested that pre emergentce application of bensulfuron methyl @ 60 g + pretilachlor @ 600 g a.i ha-1 recorded significantly higher plant height.

Chowdhury (2012) conducted a field experiment at Agronomy field of Sher-e- Bangla Agricultural University during July to December, 2011 and found that the highest plant height was obtained from BRRI dhan37 from the field treated with pre-emergence herticide Sun rice 150 WG .

It was reported by Dhiman (2006) that efficacy of various combination of 2, 4-D axilofos and chlorinuron in controlling weed infesting rice. Application of 500g 2, 4-D ha^{-1} in combination with chlorinuron resulted in the highest control of grasses, sedges and broad level weeds and produced the tallest plants.

Mahadi *et al.* (2006) conducted an experiment during, 2001 and 2002 to evaluate the performance of weeding and some herbicides. The treatments were two hand weeding Butachlor , @ 21 kg ha^{-1} and Cinosulfuron @ 0.06 kg ha-1. All the treatments helped to increase plant vigor, plant height, plant dry matter.

2.5 Effect of herbicides on yield contributing characters of rice

2.5.1 Effective and non effective tillers hill^{-1}

Hossain (2015) evaluated that plot treated with propyrisulfuron 380 ml ha^{-1} + propanil 1500 g ha^{-1} produced the highest number of effective tillers hill^{-1} and weedy check produced the least number of effective tillers hill^{-1}.

Moonmoon (2015) showed that application of propyrisulfuron 380 ml ha^{-1} + propanil 1500g ha^{-1} gives most number of effective tillers per hill^{-1}. She also found that treatment of plot with that combination produced the highest panicle length, highest filled grain panicle^{-1} and lowest unfilled grain panicle^{-1} but using different doses of herbicides have no visible effect in term of 1000 grain weight.

Mahajan and Chauhan (2013) stated that applying Pretilachior alone or combination with Safener and hand weeding produced the lowest weed density, weed dry matter with highest grain yield and number of panicles and panicle length.

Juraimi *et al.* (2011) carried out an experiment titled "EFFICACY, PHYTOTOXICITY AND ECONOMICS OF DIFFERENT HERBICIDES IN AEROBIC RICE" under field conditions in Malaysia during 2010/2011 following a randomized complete block design. Theu reported that Sequential application of Pretilachlor/safener just after seeding followed by Propanil/Thiobencarb at early growth stage provided satisfactory yield.

Chowdhury (2012) observed that weed controlled by Sunrice 150WG gave the highest effective tillers hill^{-1} while highest non effective tillers hill^{-1} was found from no weeding treatment. Besides, he studied that the highest panicle length, filled grains panicle^{-1} and highest 1000 grain weight was recorded from Sunrice 150WP treatment and no weeding treatment gave the highest unfilled grains panicle^{-1} , lowest panicle length, filled grains panicle^{-1} and 1000grain weight.

Abeysekera *et al*. (2008) suggested that tank mixture of quinchlorac + propanil at a mixture 50 g ha^{-1}+ 1.08 g ha^{-1} a.i foliowed by MCPA effectively controlled most of the weeds present in their experimental plot and gives highest yield.

The effects of different weed control treatments in rice as one hand weeding, two hand weeding, three hand weeding, Ronstar, Ronstar + hand weeding were evaluated by Hossain (2000). He observed that yield and yield contributing characters increased with the increase in frequency of hand weeding.

Ganeshwor and Gadadhar (2000) carried out an experiment during kharif season to know the role of herbicides in controlling weeds and improving grain yield in rice. The treatment were 2, 4-D @ sodium salt @ 0.80 kg ai.ha^{-1}. All herbicides were effective in controlling the weeds at 21 DAT. The most effective wee control was exhibited by 20 2, 4-D amine. All herbicides gave higher rice grain yields compared with the weedy control, the 2, 4-D amine gave highest values for grain yield (3.89 t ha^{-1}), total number of spikelets (19.30 m^{-2}), number of grains (18.65 m^{-2}), percentage seed setting (96.6%) and 1000-grain weight (24.69 g).

2.5.2 Effect of herbicides on yield

Kaes (2015) observed that combined application of propyrisulfuron 0.38 L ha^{-1} + propanil 1.5 kg ha^{-1} gives the highest yield.

A field study was carried out by Ahmed and Chauhan (2014) in the boro season of 2011-12 and amon season of 2012 at Jessore, Bangladesh and evaluated that oxadiargyl followed by ethoxysulfuron (4.13 t ha^{-1}) provided 62% higher yield in the boro season while oxadiargyl followed by one-time hand weeding increased 37% yield in aman season.

Nath *et al*. (2014) reported that the highest grain yield was recorded in weed free check treatment followed by two hand weeding treatment which was statistically at par with penoxsulam 25 g ha^{-1}, bispyribac sodium 25 g $ha^{-1}$and

pyrazosulfuron ethyl 20 g ha^{-1}. All the weed control treatments caused significant reduction in uptake of nutrients by weeds over weedy check.

Hossain and Rahman (2013) evaluated the effects of different weed control treatments in rice as one hand weeding, two hand weeding, three hand weeding, Ronstar, Ronstar + hand weeding. He observed that yield and yield contributing characters increased with the increasing in frequency of hand weeding.

Chowdhury (2012) stated that the highest grain yield, straw yield, biological yield and harvest index were obtained from pre-emergence herbicide Sunrice 150WG treated plot.

Khaliq *et al*. (2011) reported that manual weeding gave the highest paddy yield of 4.17 t ha^{-1} and also stated that Bispyribac sodium produced 3.51 t ha^{-1} paddy yield appeared superior to penoxsulam.

An experiment was carried out by Shultana *et al.* (2011) at Bangladesh Rice Research Institute, Gazipur, during winter season 2009 to observe the weed control efficacy of some pre-emergence herbicides in transplanted rice and found that among the evaluated herbicides, Rigid 50 EC (pretilachlor) @ 1 L, Alert 18WP (Bensulfuron +Acetachlor) 400 g, Kildor 5G (Butachlor) @ 25 kg, Bigboss 500EC (Pretilachlor) L1 IL, Rift 500EC (Pretilachlor) @ 1 L, Ravchlor 5G (Butachlor) @ 25 kg, Succour 50EC (Pretilachlor) @1L and Topstar 80WP (Oxadiazon) @ 75 g ha^{-1} produced grain yields above 4.00 t ha^{-1} which were comparable to the standard check; however, weed free plots gave the highest grain yield as anticipated.

It was revealed by Ali *et al*. (2010) that among the weed control treatments Pretilachlor +one hand weeding at 40 DAT performed the best for controlling weeds which ultimately turned to the highest grain yield (3.60 t ha^{-1}).

Bari (2010) found that the highest grain yield (4.08 t ha^{-1}) was obtained from Butachlor, while the lowest (2.83 t ha^{-1}) grain production was recorded from the plots receiving MCPA @ 125% of the recommended rate.

The highest amount of grain (5.22 t ha^{-1}) was harvested under good water management in weed free treatment followed by Butachlor 5G @ 2 kg ha^{-1} and one hand weeding (4.96 t ha^{-1}) under sane water managemen was reported by Kabir *et al*. (2008).

Hoque *et al*. (2003) conducted an experiment to observe the effect of varieties of transplanted aman rice and weeding regimes on weed growth and yield of transplanted aman rice. Five weeding treatments were used in the experiment. The effect of weeding regimes produced significant differences on the weed growth and grain yield of transplant aman rice. The reduction of weed dry matter was similar in both two weeding and three weeding regimes. The highest grain yield was recorded under three weeding conditions (3.95 t ha^{-1}) which was at par with weed free (4.01 t ha^{-1}), but dissimilar to two weeding regimes (3.71 t ha^{-1}).

Jena *et al.* (2002) reported that all weed control treatments reduced weed, density, dry matter and nutrient uptake significantly and increased rice yield and Oxadiazon performed better weed control than Tlilobencarb and the pre-emergence application of Oxadiazon supplemented with hand weeding at 45 DAT recorded the highest weed control efficacy, grain and straw yields and harvest index.

Selvam *et al.* (2001) reported that among the herbicides, Pendimethalin gave the highest grain yield (3773 kg ha^{-1}).

Gogoi *et al.* (2000) revealed that different weed control practices significantly enhanced the rice yield over the control plot (unweeded) in transplanted rice and also repored that combined weed control treatment like Oxadiazon 2.0 L ha^{-1} + 1 hand weeding gave the highest grain yield.

Singh and Kumar (1999) reported that maximum weed dry weight and the lowest grain yield were detected in the unweeded control in the scented rice variety Pusa Basmati-1.

Singh and Singh (1998) observed that more than 60% reduction in grain yield of rice occurred in weedy plots when compared with weed free plots.

Madhu *et al.* (1996) at Bangalore evaluated the effectiveness of four herbicides, Pendimethylin, Butachlor, Anilofos and Oxyfluorfen at 2 application rates during dry and wet seasons in puddled seeded rice field and the results showed that grain and straw yields were higher in the plots treated with Butachlor.

CHAPTER III

MATERIALS AND METHODS

CHAPTER III

MATERIALS AND METHODS

The materials and methods that were used in carrying out the experiment are discussed in the chapter.

3.1 Location of the experimental field

The experiment was carried out at Agronomy research field of Sher-e-Bangla Agricultural University, Sher-e-bangla Nagar, Dhaka during the period from March 2015 to August 2015. The location of the experimental site was at $23^0 46^/$ N latitude and $90^0 22^/$ E longitudes with an elevation of 8.24 meter from sea level.

3.2 Climate of the experimental area

The exerimental area is characterized by subtropical rainfall during the month of May to September and scattered rainfall during the rest of the year. Information regarding average monthly temperature as recorded by Bangladesh Meteorological Department (climate division) during the period of study has been presented in Appendix IIa.

3.3 Soil of the experimental field

Soil of the experimental site belongs to Tejgaon series and its texture is silty clay loam. The area is situated in the Agro-Ecological Zone of Madhupur tract (AEZ No. 28), soil p^H range is 5.8-6.5 and CEC is 25.28. The soil sample was collected from the experimental area and analyzed in the Soil Testing Laboratory, Soil Resources Development Institute (SRDI) of Farmgate, Dhaka and the data have been presented in Appendix IIb.

3.4 Characteristics of test variety

BRRI dhan48 a HYV aus rice variety, was used as the test variety. The variety was developed by Bangladesh Rice Research Institute (BRRI). It was released by National Seed Board in 2008. The average plant height of the variety is about 105 cm and its life cycle is range range from 110-120 days. The grain is

medium-coarse and white in colour. The average grain yield of the variety is 3.5-5.0 t ha^{-1}.

3.5 Description of the herbicide in tabular form

A short description of the herbicides used in the experiment is given in the following page:

Table-1: **Description of the Herbicides used in this Experiment**

Sl. No.	Trade name	Common name	Mode of action	Slectivity	Time of application
01	ZETA-ONE	Propyrisulfuran	Systemic	Broad leaf weeds and sedges in cereals	Post emergrnce
02	Propanil 60WG	Propanil	Contact	Broad leaf weeds and grassweeds in rice	Post emergrnce
03	Chinese herbicide	Acetachlor+ Bensulfuron-methyl	Systemic	Cereals (all types),cotton, green pea ,potato,soybeans and rapeseed, sunflower	Pre or early post emergence for rice
O4	Extra power	Bispyribac sodium	Contact	Narrow Leaf weeds and sedges in rice	Pre or early post emergence
05	Super powder	Pyralosulfuran ethyl	Systemic	Broad leaf weeds and grassweeds in rice	Post emergrnce

3.6 Experimental treatments

The treatments are listed in following table:

Table-2: **List of the Experimental Treatments**

Treat-ments	Active ingredients		Use rate	
	Product 1	Product 2	Product 1	Product 2
T_1	Propyrisulfuran	Propanil	500 ml ha^{-1}	-
T_2	Propyrisulfuran	Propanil	750 ml ha^{-1}	-
T_3	Propyrisulfuran	Propanil	-	3750 g ha^{-1}
T_4	Propyrisulfuran	Propanil	500 ml ha^{-1}	3750g ha^{-1}
T_5	Propyrisulfuran	Propanil	500 ml ha^{-1}	2916.7g ha^{-1}
T_6	Propyrisulfuran	Propanil	500 ml ha^{-1}	2500 g ha^{-1}
T_7	Propyrisulfuran	Propanil	500 ml ha^{-1}	2083.3 g ha^{-1}
T_8	Propyrisulfuran	Propanil	500 ml ha^{-1}	1666.7 g ha^{-1}
T_9	Propyrisulfuran	Propanil	500 ml ha^{-1}	1250 g ha^{-1}
T_{10}	Propyrisulfuran	Propanil	750 ml ha^{-1}	3750 g ha^{-1}
T_{11}	Propyrisulfuran	Propanil	750 ml ha^{-1}	3125 g ha^{-1}
T_{12}	Propyrisulfuran	Propanil	750 ml ha^{-1}	2500 g ha^{-1}
T_{13}	Propyrisulfuran	Propanil	750 ml ha^{-1}	1875 g ha^{-1}
T_{14}	Propyrisulfuran	Propanil	500 ml ha^{-1}	900g ha^{-1}
T_{15}	Propyrisulfuran	Propanil	750 ml ha^{-1}	900 g ha^{-1}
T_{16}	Acetochlor 14%	Bensulfuron methyl 4%	2000 g ha^{-1} (premix)	
T_{17}	Bispyribac sodium	Pyralosulfuran ethyl	150 g ha^{-1}	150 g ha^{-1}
T_{18}	Untreated check			

3.7 Design and layout of the experiment

The experiment was conducted in Randomized Complete Block Design (RCBD) with three replications. The experiment consisted of one factor and eighteen treatments. The area was divided into 54 unit plots for the experiment. Each plot size was 5 m× 2 m and plant spacing was 20 cm× 15 cm. The space between every two plot was 0.75 m and two replications was 1 m. The layout of the experimental plot is has been shown in appendix III.

3.8 Cultivation procedure

3.8.1 Growing of Crop

3.8.1.1 Seed collection

Healthy and vigorous seeds of aus rice variety named BRRI dhan48 were collected from the Bangladesh Agricultural Development Corporation (BADC), Gabtoli Branch, Dhaka.

3.8.1.2 Seed sprouting

Healthy seeds were selected by specific gravity method. Seeds were then immersed in water in bucket for 24 hours. Then seeds were taken out of water and kept thickly in gunny bags. The seeds started sprouting and were sown after 48 hours respectively.

3.8.1.3 Preparation of seedbed and raising of seedling

A piece of high land was selected in the Agronomy Field Laboratory, Sher-e-Bangla Agricultural University, Dhaka for raising seedlings. The land was ploughed with a tractor, puddle well and then leveling with a ladder. The sprouted seeds were sown in the seedbed on 19 March, 2015. .Necessary care was taken to raise the healthy seedlings in the nursery bed. Weeding was done and irrigation was given in the nursery bed as per requirement.

3.8.1.4 Final land preparation

The land was first ploughed with a tractor drawn disc plough on 8 April, 2015. Then it was puddled thoroughly and leveled by using ladder. The field layout

was made on 10 April, 2015 after final land preparation. Weeds and stubbles were removed from individual plots and final plots were leveled properly by wooden plank so that no water pocket could remain in the field

3.8.1.5 Fertilizer application

The land was fertilized with urea, triple super phosphate, muriate of potash. gypsum, zinc sulphate at 250 kg, 120 kg, 120 kg, 100 kg. 10 kg ha^{-1} respectively. The whole amount of triple super phosphate, murate of potash, gypsum, zinc sulphate were applied at the time of final land preparation. Urea was applied in 3 equal split at 10, 30 and 45 DAT.

3.8.1.6 Uprooting of seedlings

The soil of the seedbed was made soft by application of water in the morning and evening on the previous day before uprooting. Uprooting of seedlings was done carefully to avoid any mechanical injure to the roots and then they were kept in the soft mud in shade. The age of seedling on the day of uprooting was 24 days.

3.8.1.7 Transplanting of seedlings

Seedlings were transplanted on 14 April, 2015 in 54 experimental plots. Transplanting was done by using two seedlings $hill^{-1}$ and the spacing was 20 cm x 15 cm between the rows and hills respectively,

3.8.2 Intercultural operation

3.8.2.1 Gap filling and thinning

Some gaps were observed in some plots due to death of some plants. The gaps were filled up with the seedlings from the same source within 7 days after transplanting.

3.8.8.2 Weeding

No weeding was done in the experimental field as herbicide were used to control weeds.

3.8.2.3 Irrigation and drainage

Flood irrigation was given to maintain a level of standing water up to 2-4 cm till tillering stage and after that a water level of 7-10 cm was maintained up to grain filling stage and then drained out after milk stage to enhance maturity.

3.8.2.4 Herbicide application

Herbicides spraying were done by a Knapsack sprayer (model- AM S021, capacity- 20 Liter, Brand name- AGROS, Made in- Zhejiang, China, Working Pressure: 0.2-0.3 Mpa) at 20 days after transplanting.

3.8.2.5 Plant protection measures

The crop was attacked by yellow rice stem borer (Scirpopaga incertulas) at the panicle initiation stage which was successfully controlled with Sumithion @ 1.5 L $ha^{-1.}$

3.8.2.6 General observations

Observations were regularly made and the field looked nice with normal green plants. The flowering was uniform. All the grains matured at the same time,

3.9 Harvesting, Sampling and Processing

Five hills were randomly selected from each plot (excluding boarder rows and central 1 m^2). At maturity (when 80- 90 % of the seeds became golden yellow in color) one square meter area from each plot was selected from the central portion and was cut manually from the ground level to take grain and straw yield. The harvested crop of each plot was separately bundled, properly tagged and then brought to the threshing floor. The harvested crops were threshed manually. The grain was cleaned and dried with care. Straws were sun dried properly. Final grain and straw yield per plot were recorded and converted to ton/ha.

3.10 Data collection

3.10.1 Data collection on weed parameter

The data were collected from $1m^2$ pre –selected quadrate from the each unit plot. The data on weed infestation was taken from the plots 3 DBA (days before application), 3 DAA (days after application), 7 DAA ,14 DAA , 28 DAA and 45 DAA of following $T_{1,}$ T_2, T_3, T_4, T_5, T_6, T_7, T_8, T_9, T_{10}, T_{11}, T_{12}, T_{13}, T_{14}, T_{15}, T_{16}, T_{17} and T_{18} treatments.

3.10.1.1 Weed fresh weight (g)

After 45 days of herbicide application , the weeds grown in pre- selected quadrate were uprooted , cleaned and separated. The roots of those weeds were cut and fresh weight was taken.

3.10.1.2 Weed dry weight (g)

After taking the fresh weight, the collected weeds were dried in an electric oven for 72 hours maintaining a constant temperature of 80°C and allowed to cool down to the room temperature. Then weight of dried weeds was measured with electrical balance.

3.10.1.3 Dry matter content of weed

Dry matter content of weed is the ratio of weight of oven dried weed to fresh weight of weed multiplied by 100. The formula is here

$$\text{Dry matter content of weed (\%)} = \frac{\text{Weight of oven dried weed}}{\text{Fresh weight of weed}} \times 100$$

3.10.1.4 Weed control efficacy (%)

Weed control efficiency of different weed control treatments was calculated using the following formula developed by Sawant and Jadhav (1985):

$$\text{Weed control efficacy (\%)} = \frac{\text{DWC} - \text{DWT}}{\text{DWC}} \times 100$$

Where, DWC = Dry weight of weeds in the weedy check

DWT = Dry weight of weeds in the weed management treatment

The extent of weed control by different weed control treatments and susceptibility of different weed species were graded on the basis of weed ontrol efficiency by the following, scales as suggested by Mian and Gaffer (1968).

Degrees of weed susceptibility	Weed control efficacy	Grades of weed control
Complete susceptible (CS)	100	Completely control (CC)
Very highly susceptible (VHS)	90-99	Excellent control (EC)
Highly susceptible (HS)	70-89	Good control (GC)
Moderately susceptible (MS)	40-69	Fair control (FC)
Poorly Susceptible (PS)	20-39	Poor control (PC)
Slightly susceptible (SS)	1-19	Slightly control (SC)
Completely resistant (CR)	0	No control (NC)

3.10.1.5 Importance value of weed (%)

Importance value of weed (IVW) was calculated using the following formula developed by Rao (1985).

$$\text{IVW (\%)} = \frac{\text{Weight of a given oven dried weed species}}{\text{Weight of all oven dried weed species}} \times 100$$

3.11 Data collection on crop parameters

3.11.1 Plant height (cm)

The height of plant was recorded in centimeter (cm) at 30, 60 and 90 days after transplanting on 5 randomly selected plants from the middle rows. The height was measured from ground level up to tip of the plant.

3.11.2 Number of effective tillers hill^{-1}

The total number of effective tillers hill^{-1} was counted as the number of panicle bearing tillers per hill. Data on effective tiller per hill were recorded from 5 randomly selected hill at harvesting time and average value was recorded

3.11.3 Number of non effective tillers hill^{-1}

Non effective tillers are the tillers which have no panicle on the head. Data on non effective tiller per hill were counted from 5 pre-selected (used in effective tiller count) hill at harvesting time and average value was recorded.

3.11.4 Total number of tillers hill^{-1}

It is the sum total of effective and non-effective tillers per hill

3.11.5 Tiller length (cm)

Tiller length was measured using a meter scale from 5 selected panicles and average value was recorded.

3.11.6 Panicle length (cm)

Panicle length was measured using a meter scale from 5 selected panicles and average value was recorded.

3.11.7 Number of primary branch panicle^{-1}

Primary branches present in a single panicle was counted as number of primary branches panicle^{-1}.

3.11.8 Number of secondary branch panicle^{-1}

Secondary branches present in a single primary branch of panicle was counted as number of secondary branches panicle^{-1} .

3.11.9 Number of filled grains panicle^{-1}

The total number of filled grains was collected from 5 randomly selected panicles of a plot and then average number of filled grains per panicle was recorded.

3.11.10 Number of unfilled grains penicle^{-1}

The total number of unfilled grains was collected randomly from selected 5 Plants of a plot on the basis of not grain in spikelet and then average number of unfilled grains per panicle was recorded.

3.11.11 Number of total grains panicle^{-1}

Number of total grains panicle was obtained by summation of filled and unfilled grains panicle^{-1}.

3.11.12 Thousand (1000) grain weight (g)

One thousand clean and dried grains were randomly taken from the sample hills of each plot and the weight was taken in an electrical balance.

3.11.13 Straw yield (t ha^{-1})

The straw yield was calculated by using the following formula:

$$\text{Straw yield } (\text{tha}^{-1}) = \frac{\text{Straw yield m}^{-2} \times 10000}{1000}$$

3.11.14 Grain yield (t ha^{-1})

The following formula was used to measure grain yield t ha^{-1} :

$$\text{Grain yield } (\text{tha}^{-1}) = \frac{\text{Grain yield m}^{-2} \times 10000}{1000}$$

3.11.15 Biological yield (t ha^{-1})

Biological yield is the summation of straw yield (t ha^{-1}) and grain yield (t ha^{-1})

$$\text{Biological yield}(\text{ t ha}^{-1}) = \text{Grain yield } (\text{ t ha}^{-1}) + \text{ Straw yield } (\text{ t ha}^{-1})$$

3.11.16 Harvest index (%)

Harvest Index denotes the ratio of economic yield to biological yield and was calculated with the following formula

$$\text{Harvest index (\%)} = \frac{\text{Economic yield (Grain weight)}}{\text{Biological yield (Total weight)}} \times 100$$

3.12 Statistical analysis

The recorded data were compiled in Microsoft office Excel 2010 package program and subjected to statistical analysis. Analysis of variance and co-relation analysis were done with MSTAT C (Russell, 1986).The mean differences among the weed control treatments were adjudged by Duncan's New Multiple Range Test (Gomez and Gomez, 1984). The significant differences among the treatment means were compared by Least Significant Difference (LSD) at 5% levels of probability.

CHAPTER IV

RESULTS AND DISCUSSION

CHAPTER IV

RESULTS AND DISCUSSION

The results on weed parameters and crop characters on the production of transplant *aus* rice as influenced by herbicides have been presented in this chapter. The analyses of variance on different parameters were calculated and presented in Appendices III to VIII. The mean results of different characters have been presented in Tables 3-10 and Figures 1-12.

4.1 Weed parameters

4.1.1 Infesting weed species

The weeds which grow in transplant *aus* rice field are aquatic, semiaquatic, broad leafed, fern, grasses and sedges that can withstand water logging. In total weed species belonging to ten families infested the experimental crop. Local name, common name, scientific name, family and types of the weed species have been presented in Table 3. In this field trial, weed flora infested in the field were comprised of 83% *Cyperus deformis*, 6% *Marsilea quadrifolia* and 11% others such as Halde mutha (*Cyperus esculentus*), Durba (*Cynodon dactylon*), Boro shama (*Echinochloa crussgalli*), Soto shama (*Echinochloa colona*), Chapra (*Eleusine indica*), Kasoti (*Eclipta alba*), Malancha (*Alternanthera philoxeroides*), Chanchi (*Alternanthera sessilis*), Pani kachu (*Monochoria vaginalis*), Pani lang (*Ludwigia sp.*), Chad mala (*Sagittaria guyanensis*), Arail(*Leersia hexandra*), Zhirkata (*Spilanthes acmella*), Pata jhanji(*Vallisneria spiralis*), Jhoyana (*Fimbristylis miliacea*), Mayur laja (*Leptocloa sp*.), Baro chesse (*Cyperus irria*), Kanai bashi (*Commelina benghalensis*), Zil marich (*Sphenoclea zhilanica*), Khet papri(*Hedyotis corymbosa*). Among the twenty two species of weeds 8 were grasses, 7 were aquatic, 4 were sedges, 2 were broad-leaved and one was fern. An experiment carried out by Hossain (2015) at Agronomy Research Field, Sher-e-Bangla Agricultural University found that 66% *Marsilea quadrifolia*, 32% *Cyperus deformis* and 2% others such as *Cynodon dactylon*, *Cyperus esculentus*,

Cyperus irria, Echinochloa crussgalli, Leersia hexandra, Leptochloa chinensis, Monochoria vaginalis, Eclipta alba, Ludwigia hyssopifolia, Alternanthera philoxeroides, Alternanthera sessilis, Spilenthes acmella, Sagitaria guyanensis, Commelina benghalensis and Sphenoclea zeylanica dominated in this field. Similar results also reported by several researchers (Sharmin, 2014; Chowdhury, 2012; Mamun *et al.*, 2011; Bhuiyan *et al.*, 2011; Hasanuzzaman *et al.*,2008). The present result varied slightly from those reports and this might be due to location and seasonal variation.

Table 3. Weed species found in the experimental plots in transplanted *Aus* rice.

Local name	Common name	Scientific name	Family	Types
Sushni	European water clover	*Marsilea quadrifolia*	Marsileaceae	Fern
Behua	Small flower umbrella	*Cyperus difformis*	Cyperaceae	Sedge
Holde mutha	Yellow nutsedge	*Cyperus esculentus*	Cyperaceae	Sedge
Durba	Bermuda grass	*Cynodon dactylon*	Poaceae	Grass
Boro Shama	Barnyard Grass	*Echinochloa crussgalli*	Poaceae	Grass
Soto Shama	Shama Grass	Echinochloa colona	Poaceae	Grass
Chapra	Indian goosegrass	*Eleusine indica*	Poaceae	Grass
Kesuti	False Daisy	*Eclipta alba*	Compositae	Broadleaf
Malancha	Alligator weed	*Alternanthera philoxeroides*	Amaranthaceae	Aquatic
Chanci	Sessilejoyweed	*Alternanthera sessilis*	Amaranthaceae	Aquatic
Pani kochu	Monochoria	*Monochoria vaginalis*	Pontederiaceae	Aquatic
Pani long	Water primose	*Ludwigia hyssopifolia*	Poaceae	Aquatic
Chandmala	Duck weed	*Sagittaria guyanensis*	Genetiaceae	Aquatic
Arail	Rice grass	*Leersia hexandra*	Poaceae	Grass
Zira kata	Toothache plant	*Spilanthes acmella*	Compositae	Aquatic
Pata jhanji	tape grass	*Vallisneria spiralis*	Hydrocharitaceae	Grass
Joyna	Fringerush	*Fimbristylis miliaceae*	Cyperaceae	Sedge
Moyurleja	Red sprangletop	*Leptochloa chinensis*	Poaceae	Grass
Boro Chech	Mud sedge	*Cyperus irria*	Cyperaceae	Sedge
Kanai bashi	Spider wort	*Commelina benghalensis*	Commelinacea	Aquatic
Jhilmorich	Goose weed	*Sphenoclea zeylanica*	Sphenocleaceae	Broadleaf
Khet Papri	Khet Papri	*Lindemia procumbens*	Scrophulariaceae	Grass

In T_1 treatment, significant variation was found on number of weed species (Appendix IV). At early growth stage of the field in T_1 {Propyrisulfuran (500 ml ha^{-1})} treatment, there were found 15 species of weeds like Susni (*Marsilea quadrifolia*), Behua (*Cyperus deformis*) , Holde mutha (*Cyperus esculentus*), Durba (*Cynodon dactylon*), Boro shama (*Echinochloa crussgalli*), Maloncho *(Alternanthera philoxeroides),* Chanchi *(Alternanthera sessilis),* Pani cochu (*Monochoria vaginalis*), Pani long *(Ludwigia hyssopifolia),* Chad mala *(Sagittaria guyanensis),* Arial *(Leersia hexandra),* Zira kata *(Spilanthes acmella),* Zoyna (*Fimbristylis miliacea*), Mour leja*(Leptocola sp),* Jhil morich(*Sphenoclea zhilanica)* in which Behua (233.30) was highest and Pani kochu (0.33), Chandmala (0.33) were lowest in number (Table 4). Within 14 DAA Halde mutha, Chandmala, Zilmarich etc. were fully controlled; Zira kata was observed upto 14 DAA; but Boro Shama and Chanci was found upto 21 DAA. After 45 days of herbicide after application, only 8 weed species; Susni (1.33), Behua (2.33), Durba (0.67), Malancha (2.00), Pani long (0.33), Arail (1.33) Joyna (0.33) and Mour leja (6.67) were observed. So it can be suggested that application of Propyrisulfuran (500 ml/ha) controlled 47% weeds species (found at initial stage in this plot); 40% decreased gradually and 13% was uncontrolled. Kurmi and Das (1993) found that Pyrazosulfuron-ethyl at 0.01 kg ha^{-1} applied at 7 DAT resulted in the greatest weed control (74.4-77.5%). Saha *et al.* (2003) also experimented that Pyrazosulfuron-ethyl + Molinate at 1500 g ha^{-1} controlled the weeds effectively and increased the rice grain yield compared to hand-weeded control.

Significant variation was found in T_2 {Propyrisulfuran (750 ml/ha)} treatment on number of weed species (Appendix V). In T_2 treatment, there were 13 species of weeds like like Susni (*Marsilea quadrifolia*), Behua (*Cyperus deformis*) , Durba (*Cynodon dactylon*), Boro shama (*Echinochloa crussgalli*), Maloncho *(Alternanthera philoxeroides),* Chanchi *(Alternanthera sessilis),* Pani cochu (*Monochoria vaginalis*), Pani long *(Ludwigia hyssopifolia),* Chad mala *(Sagittaria guyanensis),* Arial *(Leersia hexandra),* Mour leja *(Leptocola sp), Baro chesse (Cyperus irria),*Jhil morich(*Sphenoclea zhilanica)* were found

in the experimental rice field at the early growth stage stage in which Behua (144.30) was highest; Malancha (1.00), Pani kochu (1.00), Arail (1.00) were lowest in number (Table 4). Within 14 DAA (days after application) Boro Shama, Pani kochu, Pani long, Chandmala, Zil marich etc. were fully controlled and boro chech was found upto 14 DAA. Durba was found upto 14 DAA. After 45 days of herbicide after application, 6 weed species; Susni (2.33), Behua (7.67), Malancha (1.00), Chanci (0.3), Arail (1.33) and Mour leja (2.00) were observed. So it can be concluded that application of T_2 {Propyrisulfuran (750 ml/ha)} controlled 54% weeds species (found at initial stage in this plot); 23% decreased gradually and 23% was uncontrolled. Halder *et al.* (2005) stated that among all the chemicals tried in in his experiment pyrazosulfuron ethyl 10% WP @ 16 g/ha was the best in reducing weed population and weed dry weight without showing any phytotoxic symptoms in rice.

Table 4. Effect of herbicide on the number of specific weed on rice field

Treatment	Weed name	3 DBA	3 DAA	7 DAA	14 DAA	21 DAA	28 DAA	45 DAA
T_1	*Marsilea quadrifolia*	11.00 b	5.67 b	5.33 b	4.67 b	3.00 b	2.33 b	1.33 d
	Cyperus diformis	233.33a	225.3 a	198.3 a	8.67 a	4.67 a	4.67 a	2.33 b
	Cyperus esculentus	2.33 de	2.33 bc	0.00 e	0.00 i	0.00 g	0.00 g	0.00 g
	Cynodon dactylon	2.33 de	1.33cd	1.33cde	1.33 f	1.67 e	1.33 e	0.67 e
	Echinochloa crussgalli	1.00 ef	2.67 bc	2.67bcd	4.33 c	2.00 d	0.00 g	0.00 g
	Alternanthera philoxeroides	1.33def	1.33 cd	1.33 de	1.00 g	2.33 c	1.33 e	2.00 c
	Alternanthera sessilis	1.00 ef	1.33cd	1.00 de	0.33 h	0.33 f	0.00 g	0.00 g
	Monochoria vaginalis	0.33 f	1.00cd	0.33de	0.00 i	0.00 g	0.33 f	0.00 g
	Ludwigia sp.	2.67 d	1.33cd	1.33cde	0.33 h	0.33 f	1.67 d	0.33 f
	Sagittaria guyanensis	0.33 f	1.33 cd	0.33 de	0.00 i	0.00 g	0.00 g	0.00 g
	Leersia hexandra	2.33de	2.33 bc	2.67bcd	2.33 d	2.33 c	2.33 b	1.33 d
	Spilanthes acmella	4.67 c	2.33 bc	0.33 de	0.33 h	0.00 g	0.00 g	0.00 g
	Fimbristylis miliacea	2.33de	2.67 bc	3.67 bc	1.67 e	1.67 e	1.33 e	0.33 f
	Leptocloa sp.	4.67 c	1.33 cd	2.67bcd	2.33 d	2.33 c	2.00 c	6.67 a
	Sphenoclea zhilanica	4.67c	2.67 bc	2.67bcd	0.00 i	0.00 g	0.00 g	0.00 g
	LSD $_{(0.05)}$	1.58	2.28	2.59	0.13	0.07	0.07	0.05
	CV (%)	8.61	11.6	15.49	6.38	4.69	5.09	5.17
T_2	*Marsilea quadrifolia*	8.67 c	8.67 b	8.67 c	7.00 b	2.00 b	1.00 c	2.33b
	Cyperus diformis	144.3 a	131.30a	87.33 a	11.00a	11.00 a	11.00a	7.67 a
	Cynodon dactylon	2.00 f	2.00 d	2.00 e	2.00 c	1.33 c	0.00 e	0.00g
	Echinochloa crussgalli	2.00 f	2.00 d	2.00 e	0.00 f	0.00 f	0.00 e	0.00 g
	Alternanthera philoxeroides	1.00fgh	1.00def	1.00 fg	1.00 d	1.00 d	1.00 c	1.00 e
	Alternanthera sessilis	3.67 e	0.67 ef	0.67fgh	0.33 e	0.33 e	0.33 d	0.33 f
	Monochoria vaginalis	1.00fgh	1.00def	1.00 fg	0.00 f	0.00 f	0.00 e	0.00 g
	Ludwigia sp.	1.33fg	1.33de	1.33ef	0.00 f	0.00 f	0.00 e	0.00 g
	Sagittaria guyanensis	5.00 d	5.00 c	4.67 d	0.00 f	0.00 f	0.00 e	0.00 g
	Leersia hexandra	1.00fgh	1.00def	1.00 fg	1.00 d	1.00 d	1.00 c	1.33 d
	Leptocloa sp.	11.00 b	7.67 b	11.00 b	2.00 c	2.00 b	2.00 b	2.00 c
	Cyperus irria	2.00 f	1.33de	0.33gh	0.33 e	0.00 f	0.00 e	0.00 g
	Sphenoclea zhilanica	2.00 f	1.33de	1.00 fg	0.00 f	0.00 f	0.00 e	0.00 g
	LSD $_{(0.05)}$	1.1	1.13	0.9	0.16	0.09	0.09	0.1
	CV (%)	8.02	9.22	9.8	8.91	6.7	7.6	8.25

In a column means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.

T_1 = Propyrisulfuran (500 ml/ha)
T_2 = Propyrisulfuran (750 ml/ha)

Significant variation was found in T_3 {Propanil (3750 g/ha)} treatment on number of weed species (Appendix VI). In T_3 treatment, there were 16 species of weeds Susni (*Marsilea quadrifolia*), Behua (*Cyperus deformis*) , Halde mutha (Cyperus esculentus), Durba (*Cynodon dactylon*), Boro shama (*Echinochloa crussgalli*), Chapra (Eleusine indica), Maloncho *(Alternanthera philoxeroides),* Chanchi *(Alternanthera sessilis),* Pani cochu (*Monochoria vaginalis*), Pani long *(Ludwigia hyssopifolia),* Chad mala *(Sagittaria guyanensis)),* Arial *(Leersia hexandra),* Pata Zhangi (*Vallisneria spiralis*), Zoyna (*Fimbristylis miliacea*), Mour leja*(Leptocola sp),* Jhil morich (*Sphenoclea zhilanica)* were found in the experimental rice field at the early growth stage in which Behua (166.00) was highest; Joyna (0.33) were lowest in number (Table 4). Within 3 DAA (days after application) Halde mutha, Chapra, Pata Jhanji, Joyna etc. were fully controlled and boro Shama was found upto 7 DAA. Chandmala was found upto 28 DAA. After 45 days of herbicide after application, 8 weed species; Susni (3.33), Behua (5.67), Chanci (1.00), Pani kochu (1.00), Pani long (0.67) Arail (0.33) and Mour leja (3.67) were observed. So it can be concluded that application of T_3 {Propanil (3750 g/ha)} controlled 56% weeds species (found at initial stage in this plot); 31% decreased gradually and 13% was uncontrolled. Meier *et al*. (2011) evaluated the addition of propanil plus thiobencarb to the first application of imazethapyr provided greater control of red rice and barnyardgrass (*Echinochloa crussgalli*) earlier in the season, thus reducing early competition.

Significant variation was found in T_4 {Propyrisulfuran + Propanil (500 ml/ha + 3750g /ha)} treatment on number of weed species (Appendix VII). In T_4 treatment, there were 13 weed species such as Susni (*Marsilea quadrifolia*), Behua (*Cyperus deformis*) , Halde mutha (Cyperus esculentus), Durba (*Cynodon dactylon*), Boro shama (*Echinochloa crussgalli*), Maloncho *(Alternanthera philoxeroides),* Chanchi *(Alternanthera sessilis),* Pani cochu (*Monochoria vaginalis*), Pani long *(Ludwigia hyssopifolia),* Chad mala *(Sagittaria guyanensis)),* Arial *(Leersia hexandra),* Mour leja (*Leptocola sp.*) *and* Jhil morich (*Sphenoclea zhilanica*) found in the experimental rice field at

the early growth stage in which Behua (171.70) was highest; Pani kochu (0.33) was lowest in number (Table 4). Within 3 DAA (days after application) Pani Kochu, Arail etc. were fully controlled; Holde Mutha, Boro Shama, Chanci, Pani long, Jhil morich were found upto 21 DAA. After 45 days of herbicide after application, 5 weed species; Susni (2.00), Behua (2.00), Durba (1.67) and Mour leja (5.33) were observed. So it can be concluded that application of T_4 {Propyrisulfuran + Propanil (500 ml/ha + 3750g /ha)} treatment controlled 62% weeds species (found at initial stage in this plot); 15% was decreased gradually and 23% was uncontrolled. Saha (2005) observed that Pretilachlor (500 or 750 g ha^{-1}) treatment significantly reduced weed dry matter and density. Parvez et al. (2013) stated that Complete weed free resulted in the lowest weed population and weed dry weight followed by application of Pretilachlor herbicide + one hand weeding at 21 DAT treatment.

Table 4. Effect of herbicide on the number of specific weed on rice field (continued)

Treatment	Weed name	3 DBA	3 DAA	7 DAA	14 DAA	21 DAA	28 DAA	45 DAA
T_3	*Marsilea quadrifolia*	5.00 c	4.33 c	3.67de	2.67 c	2.67 c	3.67 b	3.33c
	Cyperus diformis	166.0 a	152.0 a	124.0 a	5.33a	5.33 a	3.33 c	5.67 a
	Cyperus esculentus	2.33 de	0.00 f	0.00 i	0.00 i	0.00 h	0.00 h	0.00 g
	Cynodon dactylon	1.00def	0.67 ef	0.67ghi	0.67g	0.67 f	0.67 f	0.00 g
	Echinochloa crussgalli	1.00def	5.33 c	5.33 c	0.00 i	0.00 h	0.00 h	0.00 g
	Eleusine indica	2.67 d	0.00 f	0.00 i	0.00 i	0.00 h	0.00 h	0.00 g
	Alternanthera philoxeroides	1.33def	1.67 de	1.67fg	1.67e	1.67 d	0.00 h	0.00 g
	Alternanthera sessilis	2.33 de	2.67 d	2.67ef	2.67 c	2.67 c	2.67 d	1.00 d
	Monochoria vaginalis	2.67 d	1.67 de	1.67 fg	1.67 e	1.67d	1.67 e	1.00 d
	Ludwigia sp.	2.67d	1.67 de	1.67 fg	0.67g	0.67 f	0.67 f	0.67 e
	Sagittaria guyanensis	2.33de	7.17 b	7.33 b	2.33d	1.00 e	1.67 e	0.00 g
	Leersia hexandra	2.33de	1.33 e	0.33 hi	0.33h	0.33 g	0.33 g	0.33 f
	Vallisneria spiralis	0. 67 ef	0.00 f	0.00 i	0.00 i	0.00 h	0.00 h	0.00 g
	Fimbristylis miliacea	0.33 f	0.00 f	0.00 i	0.00 i	0.00 h	0.00 h	0. 00 g
	Leptocloa sp.	10.67 b	4.67 c	4.67 cd	4.67b	4.67 b	4.67 a	3.67b
	Sphenoclea zeylanica	2.67 d	1.33 e	1.33 gh	1.33 f	0.67 f	0.67 f	0.00 g
	$LSD_{(0.05)}$	1.86	1.22	1.27	0.09	0.09	0.09	0.07
	CV (%)	12.17	8.8	10.9	4.75	5.07	5.56	5.89
T_4	*Marsilea quadrifolia*	4.67 c	4.67 b	1.67 de	0.67 g	3.33c	2.00 c	2.00b
	Cyperus diformis	171.7 a	150.3 a	116.0 a	11.67a	11.67a	11.00a	2.00b
	Cyperus esculentus	2.33 de	1.33 de	1.00 ef	0.67 g	0.33h	0.00 e	0.00 d
	Cynodon dactylon	2.33 de	0. 67 e	1.00 ef	0.67 g	1.00 f	2.00 c	1.67 c
	Echinochloa crussgalli	10.67 b	6.33 b	6.00 c	5.67 b	2.33d	0.00e	0.00 d
	Alternanthera philoxeroides	1.33def	2.67cd	2.67 d	2.00 e	1.33 e	0.00 e	1.67c
	Alternanthera sessilis	1.00def	1.33 de	1.00 ef	0.67 g	0.33h	0.00 e	0.00 d
	Monochoria vaginalis	0.33 ef	0.00 e	0.00 f	0.00 h	0.00 i	0.00 e	0.00d
	Ludwigia sp.	2.67cd	1.00 e	1.00ef	1.00 f	1.00 f	0.00 e	0.00 d
	Sagittaria guyanensis	2.33 de	4.67 b	5.67 c	4.00 d	0.33 h	0.33 d	0.00 d
	Leersia hexandra	2.33de	0.00 e	0.00 f	0.00 f	0.00 i	0.00 e	0.00 d
	Leptocloa sp.	10.67 b	5.33 b	11.67b	5.33bc	5.33b	5.33 b	5.33 a
	Sphenoclea zeylanica	0. 67def	3.00 c	2.67 d	2.00 e	0.33 h	0.00 e	0.00 d
	$LSD_{(0.05)}$	2.04	1.59	1.27	0.16	0.07	0.1	0.07
	CV (%)	13.35	11.85	11.62	6.77	4.73	7.49	6.61

In a column means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.

T_3 = Propanil (3750 g/ha)

T_4 = Propyrisulfuran + Propanil (500 ml/ha + 3750g /ha)

Significant variation was found in T_5 {Propyrisulfuran + Propanil (500 ml/ha + 2916.7g/ha)} treatment on number of weed species (Appendix VIII). In T_5 treatment, there 18 weed species Susni (*Marsilea quadrifolia*), Behua (*Cyperus deformis*) , Halde mutha (Cyperus esculentus), Durba (*Cynodon dactylon*), Boro shama (*Echinochloa crussgalli*), Soto shama (Echinochloa colona), Chapra (Eleusine indica), Kasoti (Eclipta alba), Maloncho *(Alternanthera philoxeroides),* Chanchi *(Alternanthera sessilis),* Pani long *(Ludwigia hyssopifolia),* Chad mala *(Sagittaria guyanensis)),* Arial *(Leersia hexandra), Zhirkata (Spilanthes acmella),* Mour leja *(Leptocola sp), Baro chesse (Cyperus irria), Khet papri(Lindemia procumbens) and* Jhil morich (*Sphenoclea zhilanica)* were found in the experimental rice field at the early growth stage in which Behua (182.70) was highest; Kesoti (0.33) and Boro chesse (0.33) were lowest in number (Table 4). Within 3 DAA (days after application) Halde mutha, Soto shama, chapra, Zhirkata etc. were fully controlled; Pani long and Jhil marich were found upto 7 DAA. Boro Shama was found upto 21 DAA. After 45 days of herbicide after application, 8 weed species; Susni (7.33), Behua (0.33), Maloncho (1.00), Chanci (0.33), Arail (1.00), Mour leja (6.00), Boro chesse (0.33) and Khetpapri (0.33) were observed. So it can be concluded that application of T_5 {Propyrisulfuran + Propanil (500 ml/ha + 2916.7g/ha)} treatment controlled 55% weeds species (found at initial stage in this plot); 28% was decreased gradually and 17% was uncontrolled.

Significant variation was found in T_6 {Propyrisulfuran + Propanil (500 ml/ha + 2500 g/ha)} treatment on number of weed species (Appendix IX). In T_6 treatment, there 13 weed species Susni (*Marsilea quadrifolia*), Behua (*Cyperus deformis*) , Halde mutha (Cyperus esculentus), Durba (*Cynodon dactylon*), Boro shama (*Echinochloa crussgalli*), Maloncho *(Alternanthera philoxeroides),* Chanchi *(Alternanthera sessilis), Pani kachu (Monochoria vaginalis),* Pani long *(Ludwigia hyssopifolia),* Chandmala *(Sagittaria guyanensis),* Arial *(Leersia hexandra), Khet papri (Lindemia procumbens) and* Jhil morich (*Sphenoclea zhilanica)* were found in the experimental rice field at the early growth stage in which Behua (180.70) was highest; Pani kochu (0.33)

was lowest in number (Table 4). Within 3 DAA (days after application) Pani long was fully controlled; and Halde mutha and Chandmala were found upto 7 DAA. Boro Shama was found upto 21 DAA. After 45 days of herbicide after application, 8 weed species; Susni (0.33), Behua (5.67), Durba (1.67), Malancha (0.33), Chanci (0.67), Arail (1.00), Jhil marich (2.00) and Khetpapri (0.33) were observed. So it can be concluded that application of T_6 {Propyrisulfuran + Propanil (500 ml/ha + 2500 g/ha)} treatment controlled 38% weeds species (found at initial stage in this plot); 31% was decreased gradually and 31% was uncontrolled.

Table 4. Effect of herbicide on the number of specific weed on rice field (continued)

Treat-ment	Weed name	3 DBA	3 DAA	7 DAA	14 DAA	21 DAA	28 DAA	45 DAA
T_5	*Marsilea quadrifolia*	4.67 e	9.33 b	9.33 b	2.33d	1.67 e	3.33 c	7.33 a
	Cyperus diformis	182.7 a	263.7 a	198.3 a	15.00a	6.67 b	5.33 b	0.33 d
	Cyperus esculentus	2.33 fg	0.00 d	0.00 e	0.00 g	0.00 h	0.00 g	0.00 e
	Cynodon dactylon	2.33 fg	2.33 d	2.67 d	2.33d	2.33d	2.33d	0.00 e
	Echinochloa crussgalli	1.00 fg	5.33 c	5.33 c	5.33c	5.33 c	0.00 g	0.00 e
	Echinochloa colona	23.33 c	0.00 d	0.00 e	0.0 g	0.00 h	0.00 g	0.00 e
	Eleusine indica	27.67 b	0.00 d	0.00 e	0.00 g	0.00 h	0.00 g	0.00 e
	Eclipta alba	0.33 g	1.67 d	1.67 de	0.00 g	0.00 h	0.00 g	0.00 e
	Alternanthera philoxeroides	1.67fg	1.00 d	1.00 de	1.00 e	1.00 f	0.00 g	1.00 c
	Alternanthera sessilis	1.00 fg	1.33d	0.33 e	0.33 f	0.33 g	0.00 g	0.33 d
	Ludwigia sp.	2.67 ef	5.00 c	5.00 c	0.00 g	0.00 h	0.00 g	0.00 e
	Sagittaria guyanensis	2.33fg	6.33 c	6.33c	0.33 f	0.00 h	0.00 g	0.00 e
	Leersia hexandra	2.33fg	1.00d	1.00 de	1.00 e	1.00 f	1.00 e	1.00 c
	Spilanthes acmella	27.00 b	0.00 d	0.00 e	0.00 g	0.00 h	0.00 g	0.00 e
	Leptocloa sp.	10.67 d	9.00 b	9.00 b	9.00 b	9.00 a	9.00 a	6.00 b
	Cyperus irria	0.33 g	1.33 d	0.33e	0.33 f	0.33 g	0.33 f	0.33 d
	Sphenoclea . zeylanica	0.67 fg	1.67 d	1.67de	0.00g	0.00 h	0.00 g	0.00 e
	Hedyotis corymbosa	2.33fg	1.33 d	0.33 e	0.33 f	0.33 g	0.33 f	0.33 d
	$LSD_{(0.05)}$	2.32	2.35	2	0.2	0.12	0.1	0.12
	CV (%)	10.6	10.11	11.03	7.49	5.67	5.89	9.74
T_6	*Marsilea quadrifolia*	4.67 c	5.00 c	4.00 d	1.00f	1.67 c	1.33 e	0.33 g
	Cyperus diformis	180.7 a	127.3 a	93.33 a	9.67 a	5.33 a	5.33 a	5.67 a
	Cyperus esculentus	2.33 de	1.33 de	0.67efg	0.00 i	0.00 g	0.00 h	0.00 h
	Cynodon dactylon	2.33de	1.67 d	1.00efg	1.67 d	1.67 c	2.67 c	1.67 d
	Echinochloa crussgalli	1.00def	5.33bc	5.33 c	5.33 b	0.33 f	0.00 h	0.00 h
	Alternanthera philoxeroides	1.33 def	1.33 de	1.33 ef	1.33 e	1.67c	2.00 d	0.33 g
	Alternanthera sessilis	1.00 def	0.67 de	0.67efg	0.67g	1.00 d	0.67 f	0.67f
	Monochoria vaginalis	0.33 f	1.33de	0.33fg	0.33 h	0.33 f	0.33 g	0.00 h
	Ludwigia sp.	2.67 d	0.00 e	0.00 g	0.00 i	0.00 g	0.00 h	0.00 h
	Sagittaria guyanensis	2.33 de	6.67 b	6.67 b	0.00 i	0.00 g	0.00h	0.00 h
	Leersia hexandra	2.33 de	0.67 de	0.67efg	0.67 g	1.00d	0.67 f	1.00 e
	Sphenoclea . zeylanica	0.67 ef	1.67 d	1.67 e	0.67 g	0.33 f	0.00 h	2.00 c
	Hedyotis corymbosa	2.33 de	1.33 de	1.67 e	0.33 h	0.67 e	0.33 g	0.33 g
	$LSD_{(0.05)}$	1.8	1.42	1.01	0.14	0.07	0.09	0.07
	CV (%)	11.29	11.96	11.01	6.94	5.38	6.24	5.89

In a column means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.

T_5 = Propyrisulfuran + Propanil (500 ml/ha + 2916.7g/ha)

T_6 = Propyrisulfuran + Propanil (500 ml/ha + 2500 g/ha)

Significant variation was found in T_7 {Propyrisulfuran + Propanil (500 ml/ha + 2083.3 g/ha)} treatment on number of weed species (Appendix X). In T_7 treatment, there 12 weed species Susni (*Marsilea quadrifolia*), Behua (*Cyperus deformis*) , Halde mutha (Cyperus esculentus), Durba (*Cynodon dactylon*), Boro shama (*Echinochloa crussgalli*), Maloncho *(Alternanthera philoxeroides), Pani kachu (Monochoria vaginalis),* Pani long *(Ludwigia hyssopifolia),* Chad mala *(Sagittaria guyanensis), Zhirkata (Spilanthes acmella), Mayur laja (Leptocloa sp.) and* Jhil morich (*Sphenoclea zhilanica)* were found in the experimental rice field at the early growth stage in which Behua (181.70) was highest; Pani kochu (0.33) was lowest in number (Table 4). Within 3 DAA (days after application) Pani long was fully controlled; and Halde mutha and Khet papri were found upto 3 DAA. Boro Shama was found upto 21 DAA. After 45 days of herbicide after application, 7 weed species; Susni (2.33), Behua (2.00), Durba (0.67), Malancha (1.00), Pani Kachu (1.00), Chandmala (0.33) and Moyer leja (2.67) were observed. So it can be concluded that application of T_7 {Propyrisulfuran + Propanil (500 ml/ha + 2083.3 g/ha)} treatment controlled 42% weeds species (found at initial stage in this plot); 33% was decreased gradually and 25% was uncontrolled.

Significant variation was found in T_8 {Propyrisulfuran + Propanil (500 ml/ha + 1666.7 g/ha)} treatment on number of weed species (Appendix XI). In T_8 treatment, there 14 weed species Susni (*Marsilea quadrifolia*), Behua (*Cyperus deformis*) , Halde mutha (Cyperus esculentus), Durba (*Cynodon dactylon*), Boro shama (*Echinochloa crussgalli*), Soto shama (Echinochloa colona), Chanchi *(Alternanthera sessilis), Pani kachu (Monochoria vaginalis),* Pani long *(Ludwigia hyssopifolia),* Chad mala *(Sagittaria guyanensis),* Arial *(Leersia hexandra),* Zhirkata (Spilanthes acmella), *Mayur laja (Leptocloa sp.) and* Jhil morich (*Sphenoclea zhilanica)* were found in the experimental rice field at the early growth stage in which Behua (285.70) was highest; Pani kochu (0.33) and Zira kata (0.33) were lowest in number (Table 4). Within 3 DAA (days after application) Soto shama was fully controlled; and Halde mutha and Jilmarich were found upto 3 DAA. Zira kata was found upto 7 DAA

and Boro Shama was observed upto 21 DAA. After 45 days of herbicide after application, 6 weed species; Susni (3.33), Behua (3.33), Durba (2.33), Chanci (0.33), Arail (1.33), Moyurleja (3.33) were observed. So it can be concluded that application of T_8 {Propyrisulfuran + Propanil (500 ml/ha + 1666.7 g/ha)} treatment controlled 57% weeds species (found at initial stage in this plot); 28% was decreased gradually and 15 % was uncontrolled.

Table 4. Effect of herbicide on the number of specific weed on rice field (continued)

Treat-ment	Weed name	3 DBA	3 DAA	7 DAA	14 DAA	21 DAA	28 DAA	45 DAA
T_7	*Marsilea quadrifolia*	4.67 c	5.67 bc	5.67 cd	5.00 b	3.67 c	1.67 c	2.33 b
	Cyperus diformis	181.7 a	170.7 a	136.7 a	26.00 a	9.33 a	6.33 a	2.00 c
	Cyperus esculentus	2.33 de	0.00 d	0.00 e	0.00 g	0.00 i	0.00 f	0.00 g
	Cynodon dactylon	2.33 de	0.67 d	0.67 e	2.0 d	0.67 g	0.67 d	0.67 e
	Echinochloa crussgalli	1.00 ef	6.33 bc	6.33 bc	2.33 c	1.33 e	0.00 f	0.00 g
	Alternanthera philoxeroides	1.33def	1.33 d	0.33 e	1.67 e	0.33 h	0.33 e	1.00 d
	Monochoria vaginalis	0.33 f	1.33 d	0.00 e	1.00 f	2.33 d	0.33 e	1.00 d
	Ludwigia sp.	2.67 d	2.00 d	0.00 e	0.00 g	0.00 i	0.00 f	0.00 g
	Sagittaria guyanensis	2.33de	7.17 b	7.33 b	2.00 d	1.00 f	0.33 e	0.33 f
	Spilanthes acmella	2.33de	1.33 d	0.33 e	0.00 g	0.00 i	0.00 f	0.00 g
	Leptocloa sp.	10.67 b	5.00 c	5.00 d	5.00 b	5.00 b	5.00 b	2.67 a
	Sphenoclea zeylanica	1.00 ef	1.00 d	0.00 e	0.00 g	0.00 i	0.00 f	0.00 g
	$LSD_{(0.05)}$	1.65	2.06	1.03	0.31	0.13	0.09	0.05
	CV (%)	10.33	13.59	8.31	10.34	6.28	7.43	4.28
T_8	*Marsilea quadrifolia*	5.58 c	5.00 bc	5.00 bc	4.33 c	6.33 c	4.33 c	3.33 a
	Cyperus diformis	285.7 a	246.0 a	161.3 a	15.67 a	10.00 a	8.67 a	3.33 a
	Cyperus esculentus	2.33cde	0.67 e	0.00 f	0.00 g	0.00 j	0.00 g	0.00 e
	Cynodon dactylon	2.33cde	2.00 de	2.00 ef	1.67 e	2.00 f	2.00 d	2.33 b
	Echinochloa crussgalli	1.00 de	6.33 b	4.33 cd	4.33 c	2.33 e	0.00 g	0.00 e
	Echinochloa colona	1.33 de	0.00 e	0.00 f	0.00 g	0.00 j	0.00 g	0.00 e
	Alternanthera sessilis	1.00 de	1.00 e	0.67 ef	4.33 c	2.67 d	1.00 f	0.33 d
	Monochoria vaginalis	0.33de	1.33 de	0.33 f	1.00 f	0.67 h	0.00 g	0.00 e
	Ludwigia sp.	2.67cd	0.67 e	0.33 f	0.00 g	0.00 j	0.00 g	0.00 e
	Sagittaria guyanensis	2.33cde	6.00 b	6.00 bc	0.00 g	0.00 j	0.00 g	0.00 e
	Leersia hexandra	2.33cde	1.33 de	1.33 ef	3.00 d	1.33 g	1.33 e	1.33 c
	Spilanthes acmella	0.33 de	1.33 de	0.33 f	0.00 g	0.33 i	0.00 g	0.00 e
	Leptocloa sp.	10.67 b	6.67 b	6.67 b	8.00 b	6.67 b	6.67 b	3.33 a
	Sphenoclea zeylanica	0.67 de	3.30cd	2.67 de	0.00 g	0.00 j	0.00 g	0.00 e
	$LSD_{(0.05)}$	2.65	2.31	2.12	0.23	0.13	0.13	0.07
	CV (%)	11.12	10.94	14.79	8.18	5.02	6.89	6.8

In a column means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.

T_7 = Propyrisulfuran + Propanil (500 ml/ha + 2083.3 g/ha)
T_8 = Propyrisulfuran + Propanil (500 ml/ha + 1666.7 g/ha)

In T_9 {Propyrisulfuran + Propanil (500 ml/ha + 1250 g/ha)} treatment, number of weed species varied significantly in rice field (Appendix XII). In T_9 treatment, 13 weed species named Susni (*Marsilea quadrifolia*), Behua (*Cyperus deformis*) , Halde mutha (Cyperus esculentus), Durba (*Cynodon dactylon*), Boro shama (*Echinochloa crussgalli),* Maloncho *(Alternanthera philoxeroides),* Chanchi *(Alternanthera sessilis), Pani kachu (Monochoria vaginalis),* Pani long *(Ludwigia hyssopifolia),* Chad mala *(Sagittaria guyanensis)),* Arial *(Leersia hexandra),* Mour leja *(Leptocola sp) and Jhoyana (Fimbristylis miliacea)* were found in the experimental rice field at the early growth stage in which Behua (338.30) was highest and Pani kochu (0.33), Joyna (0.33) were lowest in number (Table 4). Within 14 DAA Boro Shama, Malancha, Pani kochu, Pani long etc. were fully controlled and Durba was found upto 28 DAA. After 45 days of herbicide after application, only 3 weed species; Susni (0.33), Behua (6.67) and Mour leja (4.33) were observed. So it can be suggested that application of {Propyrisulfuran + Propanil (500 ml/ha + 1250 g/ha)} controlled all weeds species (found at initial stage in this plot) except Susni, Behua and Mour leja where as first two were decreased gradually and rest one was uncontrolled. Meier *et al.* (2011) reported that the addition of propanil with thiobencarb to the first application of imazethapyr provided greater control of red rice and barnyardgrass earlier in the season, thus reducing early competition.

Significant variation was found in T_{10} {Propyrisulfuran + Propanil (750 ml/ha + 3750 g/ha)} treatment on number of weed species (Appendix XIII). In T_{10} treatment, there 14 weed species Susni (*Marsilea quadrifolia*), Behua (*Cyperus deformis*) , Halde mutha (Cyperus esculentus), Durba (*Cynodon dactylon*), Boro shama (*Echinochloa crussgalli*), Maloncho *(Alternanthera philoxeroides),* Chanchi *(Alternanthera sessilis), Pani kachu (Monochoria vaginalis),* Pani long *(Ludwigia hyssopifolia),* Chad mala *(Sagittaria guyanensis)),* Arial *(Leersia hexandra), Jhoyana (Fimbristylis miliacea),* Mour leja *(Leptocola sp) and* Jhil morich (*Sphenoclea zhilanica)* were found in the experimental rice field at the early growth stage stage in which Behua (198.30) was highest and Pani kochu (0.33), Joyna (0.33) were lowest in number (Table 4). Within 14 DAA (days after application) Boro Shama, Arail, Joyna etc. were fully controlled and Halde mutha was found upto 28 DAA. After 45 days of

herbicide after application, only 4 weed species; Susni (8.33), Behua (6.00), Malancha (1.00) and Mour leja (4.00) were observed. So it can be suggested that application of Propyrisulfuran + Propanil (750 ml/ha + 3750 g/ha) controlled all weeds species (found at initial stage in this plot) except Susni, Behua, Malancha and Mour leja where as first one was uncontrolled and rest three were decreased gradually.

Table 4. Effect of herbicide on the number of specific weed on rice field (continued)

Treat-ment	Weed name	3 DBA	3 DAA	7 DAA	14 DAA	21 DAA	28 DAA	45 DAA
T_9	*Marsilea quadrifolia*	4.67 c	7.33 b	7.33 bc	10.00a	2.33 c	0.33 c	0.33d
	Cyperus diformis	338.3 a	309.7 a	298.3a	8.33 b	8.33 a	8.33 a	6.67a
	Cyperus esculentus	2.33 cd	2.00cd	0.67 e	2.33 e	0.00 e	0.00 d	0.00 e
	Cynodon dactylon	2.33 cd	1.33 d	0.33 e	1.33 f	0.33 d	0.33 c	0.00 e
	Echinochloa crussgalli	16.00 b	10.00 b	8.33 b	0.00 i	0.00 e	0.00 d	0.00 e
	Alternanthera philoxeroides	1.33 cd	0.00 d	0.00 e	0.00 i	0.00 e	0.00 d	0.00 e
	Alternanthera sessilis	1.00 d	1.33 d	1.33 de	2.67 d	0.00 e	0.00 d	0.00 e
	Monochoria vaginalis	0.33 d	1.33 d	0.33 e	0.00 i	0.00 e	0.00 d	0.00 e
	Ludwigia sp.	2.67 cd	0.00 d	0.00 e	0.00 i	0.00 e	0.00 d	0.00 e
	Sagittaria guyanensis	2.33 cd	4.67 bc	4.67cd	1.00 g	0.33 d	0.00 d	0.00 e
	Leersia hexandra	2.33 cd	1.33 d	0.33 e	0.33 h	0.00 e	0.00 d	0.00 e
	Fimbristylis miliacea	0.33 d	0.00 d	0.00 e	0.00 i	0.00 e	0.00 d	0.00 e
	Leptocloa sp.	10.67 b	6.33 b	6.33bc	6.33 c	5.00 b	5.00 b	4.33b
	$LSD_{(0.05)}$	3.66	3.2	3.39	0.15	0.12	0.12	0.07
	CV (%)	13.21	11.4	13.75	6.04	9.96	11.41	7.94
T_{10}	*Marsilea quadrifolia*	10.67 b	7.67 b	7.67 b	7.67 b	5.67 c	3.00 c	8.33 a
	Cyperus diformis	198.3 a	174.0 a	147.0 a	15.00a	8.00 a	7.67 a	6.00b
	Cyperus esculentus	2.33de	0.00 d	0.00 c	1.67 d	1.00 d	1.33 d	0.00 e
	Cynodon dactylon	10.00def	7.33 b	6.33 b	0.67 f	0.67 e	0.00 f	0.00 e
	Echinochloa crussgalli	2.33de	0.00 d	0.00 c	0.00 h	0.00 g	0.00 f	0.00 e
	Alternanthera philoxeroides	1.33def	1.33cd	1.33 c	1.33e	1.00 d	0.33 e	1.00d
	Alternanthera sessilis	1.00def	0.67cd	0.67 c	0.67 f	0.67 e	0.00 f	0.00 e
	Monochoria vaginalis	0.33 ef	1.33cd	0.33 c	0.33 g	0.33 f	0.00 f	0.00 e
	Ludwigia sp.	2.67 cd	2.67 c	1.00 c	0.67 f	0.67 e	0.00 f	0.00 e
	Sagittaria guyanensis	2.33de	7.00 b	6.00 b	0.33 g	0.33 f	0.00 f	0.00e
	Leersia hexandra	2.33 de	0.00 d	0.00 c	0.00 h	0.00 g	0.00 f	0.00 e
	Fimbristylis miliacea	0.33 ef	0.00 d	0.00 c	0.00 h	0.00 g	0.00 f	0.00e
	Leptocloa sp.	10.67 b	6.33 b	6.33 b	5.67 c	6.67 b	6.33 b	4.00 c
	Sphenoclea zeylanica	0.67def	1.33cd	0.33 c	0.33 g	0.33 f	0.00 f	0.00 e
	$LSD_{(0.05)}$	2.01	2.31	1.54	0.2	0.1	0.12	0.13
	CV (%)	13.41	14.72	11.6	7.95	5.66	7.95	8.73

In a column means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.

T_9 = Propyrisulfuran + Propanil (500 ml/ha + 1250 g/ha)
T_{10} = Propyrisulfuran + Propanil (750 ml/ha + 3750 g/ha)

Significant variation was found in T_{11} {Propyrisulfuran + Propanil (750 ml/ha + 3125 g/ha)} treatment on number of weed species (Appendix XIV). In T_{11} treatment, there 14 weed species Susni (*Marsilea quadrifolia*), Behua (*Cyperus deformis*) , Halde mutha (Cyperus esculentus), Durba (*Cynodon dactylon*), Boro shama (*Echinochloa crussgalli*), Kasoti (Eclipta alba), Maloncho *(Alternanthera philoxeroides),* Chanchi *(Alternanthera sessilis), Pani kachu (Monochoria vaginalis),* Pani long *(Ludwigia hyssopifolia),* Chad mala *(Sagittaria guyanensis)),* Arial *(Leersia hexandra, Mayur laja (Leptocloa sp.) and* Jhil morich (*Sphenoclea zhilanica)* were found in the experimental rice field at the early growth stage stage in which Behua (213.70) was highest and Pani kochu (0.33) was lowest in number (Table 4). Within 14 DAA Halde mutha, Pani kachu, Chand mala and Jhil morich etc. were fully controlled and Kasoti was found upto 14 DAA. After 45 days of herbicide after application, only 7 weed species; Susni (2.00), Behua (1.67), Durba (1.67), Malancha (1.00), Pani long (2.67), Arail (2.33) and Mour leja (5.67) were observed.

Significant variation was found in T_{12} {Propyrisulfuran + Propanil (750 ml/ha + 2500 g/ha)} treatment on number of weed species (Appendix XV). In T_{12} treatment, there 17 weed species Susni (*Marsilea quadrifolia*), Behua (*Cyperus deformis*) , Halde mutha (Cyperus esculentus), Durba (*Cynodon dactylon*), Boro shama (*Echinochloa crussgalli*), Maloncho *(Alternanthera philoxeroides),* Chanchi *(Alternanthera sessilis), Pani kachu (Monochoria vaginalis),* Pani long *(Ludwigia hyssopifolia),* Chad mala *(Sagittaria guyanensis)),* Arial *(Leersia hexandra), Zhirkata (Spilanthes acmella),* Mour leja *(Leptocola sp) and* Jhil morich (*Sphenoclea zhilanica)* were found in the experimental rice field at the early growth stage in which Behua (107.0) was highest and Pani kochu (0.33) was lowest in number (Table 4). Within 14 DAA Halde mutha, Pani kochu, Pani long, Chandmala, Zhirkata, Jhilmarich etc. were fully controlled and Boro Shama was found upto 21 DAA. After 45 days of herbicide after application, only 7 weed species; Susni (6.00), Behua (2.33), Durba (0.67), Malancha (0.33), Chanchi (1.00), Arail (1.00) and Mour leja (5.00) were observed. So it can be suggested that application of {Propyrisulfuran + Propanil (750 ml/ha + 2500 g/ha)} controlled all weeds species (found at initial stage in this plot) except 7 weed species where Behua, Durba, Malancha, Chanchi, Arail were decreased gradually and Susni, Mour

leja were uncontrolled. Meier *et al.* (2011) reported that the addition of propanil with thiobencarb to the first application of imazethapyr provided greater control of red rice and barnyardgrass earlier in the season, thus reducing early competition.

Table 4. Effect of herbicide on the number of specific weed on rice field (continued)

Treat -ment	Weed name	3 DBA	3 DAA	7 DAA	14 DAA	21 DAA	28 DAA	45 DAA
T_{11}	*Marsilea quadrifolia*	4.67 c	19.33 b	3.67cd	2.00 d	10.33 a	5.33 a	3.33 b
	Cyperus diformis	213.7 a	217.0 a	170.0a	10.00 a	2.67 c	2.67 c	1.67 e
	Cyperus esculentus	2.33de	0.00 g	0.00 f	0.00 h	0.00 i	0.00 f	0.00 g
	Cynodon dactylon	2.33 de	2.00 ef	0.00 f	4.00 c	1.33 e	0.33 e	1.67 e
	Echinochloa crussgalli	1.00def	1.00 fg	1.00 ef	1.00 e	0.33 h	0.00 f	0.00 g
	Eclipta alba	0.333 f	4.67 d	4.33cd	0.67 f	0.00 i	0.00 f	0.00 g
	Alternanthera philoxeroides	1.33def	3.33 de	2.67 de	4.00 c	2.33 d	1.67d	1.00 f
	Alternanthera sessilis	1.00def	0.67 fg	0.67 f	0.67 f	0.67 g	0.33e	0.00 g
	Monochoria vaginalis	0.33 f	1.33 fg	0.00 f	0.00 h	0.00 i	0.00 f	0.00 g
	Ludwigia sp.	2.67 d	4.67 d	4.67 c	1.00 e	0.33 h	0.33 e	2.67 c
	Sagittaria guyanensis	2.33 de	7.00 c	7.00 b	0.00 h	0.00 i	0.00 f	0.00 g
	Leersia hexandra	2.33 de	2.33 ef	2.67 de	0.33 g	2.33 d	1.67d	2.33 d
	Leptocloa sp.	10.67 b	8.00 c	4.67 c	6.67 b	8.00 b	3.67b	5.67 a
	Sphenoclea zeylanica	0.67 ef	1.33 fg	1.33 ef	0.00 h	0.00 i	0.00 f	0.00 g
	$LSD_{(0.05)}$	1.93	1.84	1.76	0.12	0.14	0.07	0.09
	CV (%)	10.47	9.03	11.58	5.14	6.1	6.31	4.99
T_{12}	*Marsilea quadrifolia*	4.67 c	7.33 b	7.33 b	1.67e	8.00 a	6.67 a	6.00 a
	Cyperus diformis	107.0 a	112.0 a	102.3 a	15.67 a	2.67 c	4.67b	2.33 c
	Cyperus esculentus	2.33 d	0.00 h	0.00 g	0.00 i	0.00 f	0.00h	0.00 g
	Cynodon dactylon	2.33 d	1.33 fg	0.33 g	2.67 c	1.33 e	0.67 f	0.67 e
	Echinochloa crussgalli	1.00 ef	2.67 e	2.67 e	2.67 c	1.33 e	0.00h	0.00 g
	Alternanthera philoxeroides	1.33 e	0.67 gh	0.33 g	2.00 d	1.33 e	1.33d	0.33 f
	Alternanthera sessilis	1.00ef	1.00 fg	1.00 fg	1.00 f	2.00 d	1.00 e	1.00 d
	Monochoria vaginalis	0.33 fg	0.00 h	0.00 g	0.00 i	0.00 f	0.00h	0.00 g
	Ludwigia sp.	2.67 d	0.67 gh	0.67 fg	0.33h	0.00 f	0.00h	0.00 g
	Sagittaria guyanensis	2.33 d	4.67 d	4.33 d	0.67 g	0.00f	0.00h	0.00 g
	Leersia hexandra	2.33 d	1.67 f	1.67 ef	1.67 e	2.00 d	2.67 c	1.00 d
	Spilanthes acmella	0.00 g	1.33fg	1.00 fg	0.33 h	0.00 f	0.00h	0.00 g
	Leptocloa sp.	10.67 b	5.67 c	5.67 c	5.67 b	5.00 b	6.67 a	5.00 b
	Sphenoclea v zeylanica	0.67fg	1.00 fg	0.33 g	0.33 h	0.00 f	0.33g	0.00 g
	$LSD_{(0.05)}$	0.93	0.94	1.14	0.21	0.12	0.09	0.09
	CV (%)	8.94	8.97	11.9	8.18	6.5	5.07	7.11

In a column means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.

T_{11} = Propyrisulfuran + Propanil (750 ml/ha + 3125 g/ha)
T_{12} = Propyrisulfuran + Propanil (750 ml/ha + 2500 g/ha)

Significant variation was found in T_{13} {Propyrisulfuran + Propanil (750 ml/ha + 1875 g/ha)} treatment on number of weed species (Appendix XVI). In T_{13} treatment, there 17 weed species Susni (*Marsilea quadrifolia*), Behua (*Cyperus deformis*) , Halde mutha (Cyperus esculentus), Durba (*Cynodon dactylon*), Boro shama (*Echinochloa crussgalli*), Maloncho *(Alternanthera philoxeroides),* Chanchi *(Alternanthera sessilis), Pani kachu (Monochoria vaginalis),* Pani long *(Ludwigia hyssopifolia),* Chad mala *(Sagittaria guyanensis)),* Arial *(Leersia hexandra), Zhirkata (Spilanthes acmella),* Mour leja *(Leptocola sp), Baro chesse (Cyperus irria), Khet papri(Lindemia procumbens) and* Jhil morich (*Sphenoclea zhilanica)* were found in the experimental rice field at the early growth stage at the early growth stage at the early growth stage in which Behua (107.0) was highest and Pani kochu (0.33) was lowest in number (Table 4). Within 21 DAA Boro Shama, Arail, Zhirkata etc. were fully controlled. After 45 days of herbicide after application, weed species were observed in reduced number.

Significant variation was found in T_{14} {Propyrisulfuran + Propanil (500 ml/ha + 900g/ha)} treatment on number of weed species (Appendix XVII). In T_{14} treatment, there 17 weed species Susni (*Marsilea quadrifolia*), Bahuya (*Cyperus diformis*), Halde mutha (*Cyperus esculentus*), Durba (Cynodon dactylon), Boro shama (Echinochloa crussgalli), Soto shama (Echinochloa colona), Kasoti (Eclipta alba), Malancha (Alternanthera philoxeroides), Chanchi (Alternanthera sessilis), Pani kachu (Monochoria vaginalis), Pani lang (Ludwigia sp.), Chad mala (Sagittaria guyanensis), Arail(Leersia hexandra), Pata jhanji(Vallisneria spiralis), Jhoyana (Fimbristylis miliacea), Mayur laja (Leptocloa sp.), Zil marich (Sphenoclea zhilanica) were found in the experimental rice field at the early growth stage in which Behua (213.70) was highest and Pani kochu (0.33), Joyna (0.33) were lowest in number (Table 4). Within 21 DAA Halde mutha, Malancha, Pani kochu, Chanchi, Pata Jhanji, Joyna etc. were fully controlled and Kasoti, Chandmala were found upto 28 DAA. After 45 days of herbicide after application, only 7 weed species; Susni (6.67), Behua (7.33), Durba (1.00), Soto Shama (0.33), Arail (3.67), Zil morich (2.67) and Mour leja (2.67) were observed. So it can be suggested that application of {Propyrisulfuran + Propanil (500 ml/ha + 900 g/ha)} controlled

all weeds species (found at initial stage in this plot) except 7 weed species which decreased gradually.

Table 4. Effect of herbicide on the number of specific weed on rice field (continued)

Treat -ment	Weed name	3 DBA	3 DAA	7 DAA	14 DAA	21 DAA	28 DAA	45 DAA
T_{13}	*Marsilea quadrifolia*	4.67 c	5.67 b	4.00 cd	6.00 b	6.00 a	6.00 a	14.33a
	Cyperus diformis	209.3 a	218.3a	171.7 a	8.33 a	6.00a	5.67 b	2.33 c
	Cyperus esculentus	2.33de	1.00 c	1.00efg	1.00 g	1.00 f	1.00 g	1.00 f
	Cynodon dactylon	2.33 de	0.67 c	0.67efg	0.67 h	0.67 g	0.67 h	0.33 g
	Echinochloa crussgalli	1.00def	6.00 b	6.00 b	6.00 b	0.00 i	0.00 j	0.00 h
	Alternanthera philoxeroides	1.33def	1.33 c	1.33 ef	1.33 f	1.33 e	1.33 f	2.33 c
	Alternanthera sessilis	1.00def	1.00 c	0.33 fg	0.67 h	0.67 g	0.67 h	1.66 d
	Monochoria vaginalis	0.33 f	2.00 c	3.33 d	3.33 d	3.33 c	3.33 d	1.33 e
	Ludwigia sp.	2.67 d	1.33 c	1.33 ef	1.00 g	1.00 f	1.00 g	1.00 f
	Sagittaria guyanensis	2.33de	4.33 b	4.33cd	1.33 f	1.33 e	1.33f	1.66 d
	Leersia hexandra	2.33de	0.00 c	0.00 g	0.00 j	0.00 i	0.00 j	0.00 h
	Spilanthes acmella	0.33f	1.33c	0.33fg	0.00 j	0.00 i	0.00 j	0.00 h
	Leptocloa sp.	10.67 b	5.00 b	5.00 bc	5.00 c	5.00b	5.00c	3.00 b
	Cyperus irria	0.00 f	1.33 c	0.33 fg	0.33 i	0.33 h	0.33 i	0.33 g
	Sphenoclea . zeylanica	0.67 ef	1.67 c	1.67 e	1.67e	1.67 d	1.67 e	0.33 g
	Hedyotis corymbosa	0.00 f	1.33c	0.67efg	0.67 h	0.33 h	0.33 i	0.33 g
	$LSD_{(0.05)}$	1.81	2.15	1.24	0.16	0.12	0.12	0.15
	CV (%)	10.02	11.35	8.18	5.6	5.59	5.32	6.25
T_{14}	*Marsilea quadrifolia*	4.67 c	8.00 b	7.67 b	13.00b	16.33a	14.67a	6.67 b
	Cyperus diformis	213.7 a	183.7a	116.3 a	30.00a	11.00b	4.33 c	7.33 a
	Cyperus esculentus	2.33de	0.00 e	0.00 f	0.00 i	0.00 n	0.00 i	0.00 g
	Cynodon dactylon	2.33de	0.33 e	0.33 f	0.33hi	9.00c	1.00 h	1.00 e
	Echinochloa crussgalli	1.00ef	2.00 d	2.00de	2.00 f	8.00d	2.00 e	0.00 g
	Echinochloa colona	0.00 f	0.00 e	0.00 f	6.00 d	2.67h	1.33 g	0.33 f
	Eclipta alba	0.00 f	0.00e	0.00 f	0.00i	2.33 i	2.00 e	0.00 g
	Alternanthera philoxeroides	1.33def	2.00 d	2.00de	2.00 f	4.33 e	0.00 i	0.00 g
	Alternanthera sessilis	1.00 ef	1.00de	1.00 ef	0.00 i	3.33 g	0.00 i	0.00 g
	Monochoria vaginalis	0.33 f	0.67de	0.67 f	0.67 h	0.00 n	0.00 i	0.00 g
	Ludwigia sp.	2.67 d	0.67de	0.67 f	0.67 h	0.33m	0.00 i	0.00 g
	Sagittaria guyanensis	2.33 de	4.00 c	4.00 c	4.33 e	4.00 f	3.00 d	0.00 g
	Leersia hexandra	2.33 de	0.67de	0.67 f	0.67 h	1.33 j	1.67 f	3.67 c
	Vallisneria spiralis	0.00 f	0.00 e	0.00 f	1.33g	0.67i	0.00 i	0.00 g
	Fimbristylis miliacea	0.33 f	0.00e	0.00 f	0.33hi	1.00 k	0.00 i	0.00 g
	Leptocloa sp.	10.67b	8.00 b	8.00 b	8.00c	8.00 d	11.33b	2.67 d
	Sphenoclea . zeylanica	0.67 f	1.33de	2.67d	0.67 h	0.67 i	2.00 e	2.67 d
	$LSD_{(0.05)}$	1.59	1.42	1.14	0.4	0.27	0.24	0.13
	CV (%)	8.61	8.92	10.39	7.57	4.78	7.35	6.14

In a column means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.

T_{13} = Propyrisulfuran + Propanil (750 ml/ha + 1875 g/ha)

T_{14} = Propyrisulfuran + Propanil (500 ml/ha + 900g/ha)

Significant variation was found in T_{15} {Propyrisulfuran + Propanil (750 ml/ha + 900 g/ha)} treatment on number of weed species (Appendix XVIII). In T_{15} treatment, there 15 weed species Susni (*Marsilea quadrifolia*), Bahuya (*Cyperus diformis*), Halde mutha (*Cyperus esculentus*), Durba (Cynodon dactylon), Boro shama (Echinochloa crussgalli), Malancha (Alternanthera philoxeroides), Chanchi (Alternanthera sessilis), Pani kachu (Monochoria vaginalis), Pani lang (Ludwigia sp.), Chad mala (Sagittaria guyanensis), Arail (Leersia hexandra), Zhirkata (Spilanthes acmella), Pata jhanji (Vallisneria spiralis), Jhoyana (Fimbristylis miliacea), Mayur laja (Leptocloa sp.) were found in the experimental rice field at the early growth stage in which Behua (217.70) was highest and Pani kochu (0.33), Joyna (0.33) were lowest in number (Table 4). Within 21 DAA Boro Shama, Chanchi, Pani long, Chand mala, Pata Jhanji, etc. were fully controlled and Pani kochu was found upto 28 DAA. After 45 days of after herbicide application, only 10 weed species; Susni (0.67), Behua (6.67), Durba (1.33), Boro Shama (2.00), Malancha (4.00), Arail (2.33), Zhirkata (0.67), Pata jhanji (0.33), Joyna (4.33) and Mour leja (3.00) were observed. So it can be suggested that application of {Propyrisulfuran + Propanil (750 ml/ha + 900 g/ha)} controlled all weeds species (found at initial stage in this plot) except 10 weed species which decreased gradually.

Significant variation was found in T_{16} {Acetochlor 14% + Bensulfuron methyl 4% (2000 g/ha (premix))} treatment on number of weed species (Appendix XIX). In T_{16} treatment, there 17 weed species Susni (*Marsilea quadrifolia*), Bahuya (*Cyperus diformis*), Halde mutha (*Cyperus esculentus*), Durba (Cynodon dactylon), Boro shama (Echinochloa crussgalli), Soto shama (Echinochloa colona), Kasoti (Eclipta alba), Malancha (Alternanthera philoxeroides), Chanchi (Alternanthera sessilis), Pani kachu (Monochoria vaginalis), Pani lang (Ludwigia sp.), Chad mala (Sagittaria guyanensis), Arail (Leersia hexandra), Pata jhanji (Vallisneria spiralis), Jhoyana (Fimbristylis miliacea), Mayur laja (Leptocloa sp.), Zil marich (Sphenoclea zhilanica) were found in the experimental rice field at the early growth stage (Table 4). At 3 DBA (days before application) the highest number of weed was Behua

(215.00) and the lowest number of weed was Pani kachu (0.33) and Jhoyana (0.33). At 3 DAA (days after application) the highest number of weed was Susni (128.30) and the lowest number of weed was Pani kachu (0.33). At 7 DAA (days after application) the highest number of weed was Behua (161.30) and the lowest number of weed was Pani kachu (0.33). At 14 DAA (days after application) the highest number of weed was Behua (18.33) and the lowest number of weed were Zil marich (0.33). At 21 DAA, the highest number of weed was Susni (10.00) and the lowest number of weed Soto shama (0.33). At 28 DAA, the highest number of weed was Susni (6.67) and the lowest number of weed were Chad mala (0.33) and Zil marich (0.33). At 45 DAA, the highest number of weed was Susni (7.33) and the lowest number of weed was Zil marich (0.33). So it can be suggested that T16 {Acetochlor 14% + Bensulfuron methyl 4% (2000 g/ha (premix))} treatment reduces total weed population in rice field and treatment has the good effect Behua, Halde mutha, Durba, Boro shama, Chapra, Kasoti, Maloncho, Chanchi, Pani kachu, Pani long, Chad mala, Arial, and Jhil morich weed species. Because these weed species have reduced in number from the rice field (Table 4). Similar results found from Madhukumar *et al.* (2013) who revealed that pre emergent application of bensulfuron methyl @ 60 g + pretilachlor @ 600 g a.i ha^{-1} recorded significantly higher plant height, dry matter production per hill, productive tillers per hill, No. of filled spikelets per panicle, grain and straw yield and lower total weed density and their dry weight followed by two hand weedings at 20 and 40 DAS and oxyfluorfen @ 90 g a.i. ha^{-1}.

Table-4. Effect of herbicide on the number of specific weed on rice field (continued)

Treat-ment	Weed name	3 DBA	3 DAA	7 DAA	14 DAA	21 DAA	28 DAA	45 DAA
T_{15}	*Marsilea quadrifolia*	4.67c	27.00b	10.67b	6.33d	21.67a	15.00a	0.67h
	Cyperus diformis	217.7a	152.0a	113.0a	36.00 a	12.67b	3.00 d	6.67 a
	Cyperus esculentus	2.33cde	0.00 g	0.00 f	9.33 b	6.33 d	0.00 g	0.00 j
	Cynodon dactylon	2.33cde	0.67fg	0.67ef	0.67 i	10.00c	3.00 d	1.33g
	Echinochloa crussgalli	1.00de	4.00cd	4.00 c	4.00 f	5.33 e	9.00 b	2.00 f
	Alternanthera philoxeroides	1.33de	0.33fg	0.33f	0.33 ij	1.33 h	0.33 f	4.00 c
	Alternanthera sessilis	1.00de	0.00 g	0.00 f	4.67 e	1.00 i	0.00 g	0.00 j
	Monochoria vaginalis	0.33 de	0.33 fg	0.33 f	0.33 ij	0.33 k	0.33 f	0.00 j
	Ludwigia sp.	2.67cd	1.67 ef	1.67 de	2.33 h	0.67 j	0.00g	0.00 j
	Sagittaria guyanensis	2.33cde	4.67 c	4.67 c	0.00j	0.00i	0.00 g	0.00j
	Leersia hexandra	2.33cde	0.33 fg	0.33 f	0.33 ij	1.33 h	2.00 e	2.33 e
	Spilanthes acmella	0.00 e	0.33 fg	0.33 f	0.33 ij	1.00 i	2.00 e	0.67h
	Vallisneria spiralis	0.67 de	0.33 fg	0.33 f	7.33 c	3.33 f	0.00 g	0.33 i
	Fimbristylis miliacea	0.33de	0.00 g	0.00 f	2.67gh	1.00 i	0.00 g	4.33b
	Leptocloa sp.	10.67b	3.00de	2.67d	3.00g	3.00g	5.00 c	3.00d
	$LSD_{(0.05)}$	2.39	1.57	1.22	0.4	0.26	0.2	0.09
	CV (%)	12.8	10.8	11.72	6.49	4.79	6.8	4.64
T_{16}	*Marsilea quadrifolia*	4.67 c	128.3a	8.00b	12.00 b	10.00a	6.67 a	5.67b
	Cyperus diformis	215.0 a	61.67b	161.3 a	18.33 a	6.67 c	4.00c	0.00g
	Cyperus esculentus	2.33 de	0.00 h	0.00 g	0.00 i	0.00 j	0.67 g	0.00g
	Cynodon dactylon	2.33 de	1.33fg	1.33efg	1.33 f	1.33 f	1.33 e	0.67 e
	Echinochloa crussgalli	1.00def	8.00c	8.33b	8.33 c	8.33 b	6.00 b	8.33a
	Echinochloa colona	0.00 f	0.00 h	0.00 g	0.00 i	0.33 i	0.00 i	0.33 f
	Eclipta alba	0.00 f	0.00 h	0.00g	0.00 i	0.67 h	0.00 i	0.00g
	Alternanthera philoxeroides	1.33def	3.67 e	1.00fg	1.00 g	1.00 g	1.00 f	1.67d
	Alternanthera sessilis	1.00def	0.00 h	0.00 g	0.00 i	0.00 j	0.00 i	0.00g
	Monochoria vaginalis	0.33 f	0.33gh	0.33fg	0.00 i	0.67 h	0.00 i	0.00g
	Ludwigia sp.	2.67 d	1.33 fg	1.33efg	0.00 i	0.00 j	0.00 i	0.00g
	Sagittaria guyanensis	2.33 de	6.00 d	4.33 c	0.00 i	0.67 h	0.33 h	0.00g
	Leersia hexandra	2.33de	1.67 f	1.67ef	1.67 e	2.00 e	1.67 d	4.33 c
	Vallisneria spiralis	0.00 f	0.00 h	0.00g	0.00 i	0.00 j	0.00 i	0.00g
	Fimbristylis miliacea	0.33 f	0.00 h	0.00 g	0.00 i	0.00 j	0.00 i	0.00g
	Leptocloa sp.	10.67 b	3.67e	4.00cd	4.00 d	4.00 d	4.00 c	4.33c
	Sphenoclea . zeylanica	0.67ef	2.33 f	2.67de	0.33 h	0.00 j	0.33 h	0.33 f
	$LSD_{(0.05)}$	1.75	1.14	1.47	0.25	0.15	0.1	0.14
	CV (%)	9.46	6.98	10.12	7.16	5.49	5.05	7.24

In a column means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.

T_{15} = Propyrisulfuran + Propanil (750 ml/ha + 900 g/ha)
T_{16} = Acetochlor 14% + Bensulfuron methyl 4% (2000 g/ha (premix))

Significant variation was found in T_{17} {Bispyriback sodium + Pyralosulfuran ethyl (150 g/ha + 150 g/ha)} treatment on number of weed species (Appendix XX). In T_{17} treatment, there 18 weed species Susni (*Marsilea quadrifolia*), Bahuya (*Cyperus diformis*), Halde mutha (*Cyperus esculentus*), Durba (Cynodon dactylon), Boro shama (Echinochloa crussgalli), Soto shama (Echinochloa colona), Kasoti (Eclipta alba), Malancha (Alternanthera philoxeroides), Chanchi (Alternanthera sessilis), Pani kachu (Monochoria vaginalis), Pani lang (Ludwigia sp.), Chad mala (Sagittaria guyanensis), Arail(Leersia hexandra), Zhirkata (Spilanthes acmella), Pata jhanji (Vallisneria spiralis), Jhoyana (Fimbristylis miliacea), Mayur laja (Leptocloa sp.), Zil marich (Sphenoclea zhilanica) were found in the experimental rice field at the early growth stage (Table 4). At 3 DBA (days before application) the highest number of weed was Behua (273.30) and the lowest number of weed was Pani kachu (0.33) and Joyna (0.33). At 3 DAA (days after application) the highest number of weed was Behua (264.00) and the lowest number of weed were Zhirkata (0.33) and Joyna (1.33). At 7 DAA (days after application) the highest number of weed was Behua (235.00) and the lowest number of weed were Zhirkata (0.33) and Joyna (1.33). At 14 DAA (days after application) the highest number of weed was Behua (45.33) and the lowest number of weed was Soto shama (0.33). At 21 DAA, the highest number of weed was Susni (24.33) and the lowest number of weed Soto shama (0.33), Chanchi (0.33), Chad mala (0.33) and Pata jhanji (0.33). At 28 DAA, the highest number of weed was Susni (16.33) and the lowest number of weed was Chanchi (0.33). At 45 DAA, the highest number of weed was Behua (11.33) and lowest number of weed were Durba (0.67) and Chad mala (0.67). So it can be suggested that T_{17} { Bispyriback sodium + Pyralosulfuran ethyl (150 g/ha + 150 g/ha)} treatment reduces total weed population in rice field and treatment has the good effect Susni, Halde mutha, Durba, Boro shama, Kasoti, Maloncho, Chanchi, Pani kachu, Pani long, Chad mala, Arial, and Jhil morich weed species. Because these weed species have reduced in number from the rice field (Table 4). Yadav *et al.* (2009) reported that application of Bispyribac at 15 or 25 DAT

was found equally effective against grassy weeds, but control of broad-leaved weeds and sedges was comparatively more when applied at 15 DAT. Bispyribac 25 g/ha applied at 15 or 25 DAT was adjudged the most suitable herbicidal treatment resulting in 174-199% and 37-41% increase in the rice grain yield over weedy check during 2006 and 2007, respectively.

Significant variation was found in T18 (Untreated check) treatment on number of weed species (Appendix XXI). In T_{18} treatment, there 21 weed species Susni (*Marsilea quadrifolia*), Bahuya (*Cyperus diformis*), Halde mutha (*Cyperus esculentus*), Durba (Cynodon dactylon), Boro shama (Echinochloa crussgalli), Soto shama (Echinochloa colona), Chapra (Eleusine indica),Kasoti (Eclipta alba), Malancha (Alternanthera philoxeroides), Chanchi (Alternanthera sessilis), Pani kachu (Monochoria vaginalis), Pani lang (Ludwigia sp.), Chad mala (Sagittaria guyanensis), Arail(Leersia hexandra), Zhirkata (Spilanthes acmella), Pata jhanji(Vallisneria spiralis), Jhoyana (Fimbristylis miliacea), Mayur laja (Leptocloa sp.), Baro chesse (Cyperus irria), Kanai bashi (Commelina benghalensis), Zil marich (Sphenoclea zhilanica) were found in the experimental rice field at the early growth stage (Table 4). At 3 DBA (days before application) the highest number of weed was Behua (268.30) and the lowest number of weed wasPani kachu (0.33) and Jhoyana (0.33). At 3 DAA (days after application) the highest number of weed was Susni (253.30) and the lowest number of weed was Jhoyana (2.00). At 7 DAA (days after application) the highest number of weed was Behua (311.70) and the lowest number of weed was Chanchi (0.33). At 14 DAA (days after application) the highest number of weed was Behua (233.30) and the lowest number of weed was Chapra (2.67). At 21 DAA, the highest number of weed was Susni (296.70) and the lowest number of weed was Jhoyana (0.33). At 28 DAA, the highest number of weed was Susni (228.30) and the lowest number of weed were Chanchi (0.33) and Jhoyana (0.33). At 45 DAA, the highest number of weed was Bahuya (257.70) and the lowest number of weed was Zhirkata (1.33). So it can be suggested that T18 (Untreated check) treatment reduces total weed population in rice field and treatment has the good effect Susni, Halde mutha,

Durba, Boro shama, Chapra, Kasoti, Maloncho, Chanchi, Pani kachu, Pani long, Chad mala, Arial, and Jhil morich weed species. Because these weed species have reduced in number from the rice field (Table 4). Mondal and Nandal (1995) found that the lower doses of Rilof H @ 1 litre ha^{-1} and Rifit @ 1 litre ha^{-1} failed to kill the weeds properly.

Table 4. Effect of herbicide on the number of specific weed on rice field (continued)

Treat-ment	Weed name	3 DBA	3 DAA	7 DAA	14 DAA	21 DAA	28 DAA	45 DAA
T_{17}	*Marsilea quadrifolia*	4.67c	4.33c	5.00bc	26.67b	24.33a	16.33a	0.00 j
	Cyperus diformis	273.3 a	264.0 a	235.0 a	45.33a	15.33 c	8.67b	11.33a
	Cyperus esculentus	2.33 de	0.00d	0.00d	0.00 j	7.67d	5.00e	3.00e
	Cynodon dactylon	2.33de	0.67d	0.67d	5.33d	6.33e	8.00c	0.67i
	Echinochloa crussgalli	1.00def	7.33b	7.33b	7.33 c	17.33 b	7.33d	4.67c
	Echinochloa colona	0.00 f	0.33d	0.33d	0.33ij	0.33jk	1.33h	1.33g
	Eclipta alba	0.00f	0.00d	0.00d	5.33d	3.00f	1.00i	0.00j
	Alternanthera philoxeroides	1.33def	0.67d	1.33d	1.33h	2.33g	0.67j	2.33f
	Alternanthera sessilis	1.00def	0.67d	0.67d	0.67i	0.33jk	0.33k	1.0h
	Monochoria vaginalis	0.33 ef	1.00 d	1.00d	0.00 j	1.00 hi	0.00 l	0.00 j
	Ludwigia sp.	2.67 cd	0.67d	0.67 d	0.00 j	0.67 ij	0.00 l	0.00j
	Sagittaria guyanensis	2.33de	5.33bc	5.33b	1.67gh	0.33jk	0.00 l	0.67i
	Leersia hexandra	2.33de	0.67d	0.67d	0.67i	1.33h	2.00g	5.00 b
	Spilanthes acmella	0.00f	0.33d	0.33d	2.33ef	0.67ij	0.00l	0.00 j
	Vallisneria spiralis	0.00 f	0.00 d	0.00d	2.67e	0.33jk	0.00 l	0.00 j
	Fimbristylis miliacea	0.33 ef	0.33 d	0.33 d	5.67d	0.67ij	0.33k	4.33d
	Leptocloa sp.	10.67b	2.00d	2.00cd	2.00fg	2.00g	4.33f	4.67c
	Sphenoclea . zeylanica	0.67def	0.67d	0.67d	0.00 j	0.67ij	0.00l	0.00 j
	LSD $_{(0.05)}$	2.04	2.15	3.04	0.59	0.37	0.28	0.17
	CV (%)	8.9	9.92	15.54	7.39	5.88	6.78	6.02
T_{18}	*Marsilea quadrifolia*	4.67 c	253.3 a	51.67b	76.67b	296.7a	228.3a	30.00b
	Cyperus diformis	268.3a	56.67b	311.7 a	233.3a	49.67 b	208.3b	261.3a
	Cyperus esculentus	2.33de	6.33f	5.00efg	18.33e	7.67efg	35.67c	30.00b
	Cynodon dactylon	2.33de	8.00f	4.00fgh	26.00d	10.33de	15.33e	22.33d
	Echinochloa crussgalli	1.00def	24.33 c	28.67c	40.67c	18.00c	22.00d	26.00c
	Echinochloa colona	0.00 f	2.33g	8.33e	6.67 i	4.67ghi	0.67ij	14.67f
	Eleusine indica	0.00 f	0.00 h	0.00 i	2.67 k	2.33 ij	0.00j	27.33bc
	Eclipta alba	0.00 f	0.00 h	0.00 i	6.67i	3.00 hij	0.00j	25.67c
	Alternanthera philoxeroides	1.33def	2.33 g	5.67efg	12.00g	3.33 hij	1.00hij	18.33 e
	Alternanthera sessilis	1.00def	0.00 h	0.33 hi	6.00 i	4.67ghi	0.33 ij	19.67de
	Monochoria vaginalis	0.33 ef	6.33 f	6.67 ef	6.67 i	3.67 hij	3.67ghi	14.00 f
	Ludwigia sp.	2.67 cd	7.67f	8.67e	7.00hi	6.33fgh	4.33 gh	10.00gh
	Sagittaria guyanensis	2.33de	8.00f	8.67e	9.33 h	10.00def	10.00f	12.33fg
	Leersia hexandra	2.33de	0.00 h	6.00efg	19.33e	0.00 j	1.00hij	6.67 i
	Spilanthes acmella	0.00 f	0.00 h	0.00 i	5.33ij	5.00 ghi	1.33hij	1.33 j
	Vallisneria spiralis	0.00 f	0.00 h	2.67ghi	15.67f	0.00 j	0.67 ij	2.33 j
	Fimbristylis miliacea	0.33ef	2.00 gh	7.00 ef	3.33jk	0.33 j	0.33 ij	7.33 hi
	Leptocloa sp.	10.67 b	16.00d	14.67d	14.67f	12.00d	14.67 e	7.00 i
	Cyperus irria	0.00 f	0.00 h	8.33 e	0.00 l	0.00 j	0.67 ij	7.67 hi
	Commelina benghalensis	0.00 f	0.00 h	0.00 i	0.00 l	0.00 j	0.00 j	1.67 j
	Sphenoclea . zeylanica	0.67def	13.00e	6.33efg	6.33 i	6.33fgh	6.33 g	25.33 c
	LSD $_{(0.05)}$	2.04	2.11	3.67	2.37	3.68	3.36	2.79
	CV (%)	9.07	6.94	10.12	6.13	11.05	8.08	6.53

In a column means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.

T_{17} = Bispyriback sodium + Pyralosulfuran ethyl(150 g/ha + 150 g/ha,

T_{18} = Untreated check

4.1.2 Effect of herbicidal treatments on weed population (No. m-2) after 28 days of spray

After 28 days of spray the weed population was significantly influenced by different weed control treatments (Appendix XXII). From the table it was observed that the highest weed population was found from T18 (Untreated check) for 12 weed species named Susni (228.33), Bahuya (208.33), Halde mutha (35.67), Durba (15.33), Boro shama (22.00), Pani kachu (3.67), Pani lang (4.33), Chad mala (10.00), Pata jhanji (0.67), Mayur laja (14.67), Baro chesse (0.67) and Jil marich (6.33). Soto shama (1.33) highest in T_{14} & $T_{17,}$ Kasoti (2.00) highest in $T_{14,}$ Malanca (2.67) highest in $T_{11,}$ Chanci (1.00) highest in T_{12} and Arail highest in T_{12}. Zirkata was found only from T_{15} and T_{18} treated plot where highest (2.00) in T15 treatment. Pata jhanji was found only in T_{18} treatment. Joyna was obtained only from T_1, T_{17} and T_{18} treated plot where highest (1.33) in T_{15} treatment. Boro Chech was found only from T_5, $T_{12,}$ T_{13} and T_{18} treated plot where highest (0.67) in T_{18} treatment. Kanai bashi was found only in T_{12} treatment. Khet Papri was obtained only from T_5, T_6 and T_{13} treated plot. This results are in agreement with the findings of Jordan (1997) who reported that Propanil + molinate applied with quinclorac at 0.28 or 0.40 kg ha-I controlled barnyardgrass (*Echinochloa crussgalli*) more effectively. This finding was inconsistence with the result of Chowdhury (2012) who revealed that pre-emergence herbicide Sunrice 150WG controlled weeds very significantly.

Table 5. Effect of herbicide on the number of specific weed at 28 days after transplanting

Treat-ment	Susni	Bahuya	Halde mutha	Durba	Boro shama	Soto shama	Kasoti	Malancha	Chanci	Pani kochu
T_1	2.33 f-i	0.00 e	0.00 d	1.33 g	0.00 i	0.00 c	0.00 b	1.33 c	0.00 d	0.33 d
T_2	1.00 i	11.00 e	0.00 d	1.00 h	2.00 k	0.00 c	0.00 b	1.00 d	0.33 c	0.00 e
T_3	3.67 d-g	3.33 e	0.00 d	0.67 d	3.33 j	0.00 c	0.00 b	0.00 g	2.67 a	1.67 c
T_4	2.33 hi	11.00 e	0.00 d	2.00 f	0.00 i	0.00 c	0.00 b	0.00 g	0.00 d	0.00 e
T_5	3.33 e-h	5.33 e	0.00 d	2.33 e	5.33 d	0.00 c	0.00 b	1.00 d	0.00 d	0.00 e
T_6	1.33 g-i	5.33 e	0.00 d	2.67d	5.33 d	0.00 c	0.00 b	2.00 b	0.67 c	0.33 d
T_7	1.67 g-i	0.67 e	0.00 d	0.67 i	6.33c	0.00 c	0.00 b	0.33 f	0.00 d	0.33 d
T_8	8.67 c	0.00 e	0.00 d	2.00 f	4.33 i	0.00 c	0.00 b	0.00 g	1.00 b	0.00 e
T_9	0.33 i	8.33 e	0.00 d	0.33 j	0.00 i	0.00 c	0.00 b	0.00 g	0.00 d	0.00 e
T_{10}	3.00e-i	7.67 de	1.33 d	0.00 k	0.00 e	0.00 c	0.00 b	0.33 f	0.00 d	0.00 e
T_{11}	5.33d-f	0.33 e	0.00 d	0.33 j	0.33 l	0.00 c	0.00 b	**2.67 a**	0.33 c	0.00 e
T_{12}	6.67 cd	0.00 e	0.00 d	0.00 k	4.67 i	0.00 c	0.00 b	1.33 c	**1.00 b**	0.00 e
T_{13}	6.00 c-e	0.00 e	1.00 c	0.67 i	5.67 d	0.00 c	0.00 b	1.33 c	0.67 b	3.33 b
T_{14}	14.67 b	4.33 c	1.00 c	0.00 k	2.00 k	**1.33 a**	**2.00 a**	0.00 g	0.00 d	0.00 e
T_{15}	15.00 b	3.00 cd	0.00 d	3.00 c	9.00 b	0.00 c	0.00 b	0.33 f	0.00 d	0.33 d
T_{16}	6.67 cd	4.00 c	0.67 c	1.33 g	6.00 c	0.00 c	0.00 b	1.00 d	0.00 d	0.00 e
T_{17}	16.33 b	8.67 b	5.000 b	8.00 b	7.33 e	**1.33a**	0.00 b	0.67e	0.33 c	0.00 e
T_{18}	**228.3 a**	**208.3 a**	**35.67 a**	**15.33 a**	**22.00 a**	0.67 b	0.00 b	1.00 d	0.33 c	**3.67 a**
LSD $_{(0.05)}$	3.03	2.25	0.45	0.25	0.34	0.02	0.02	0.05	0.02	0.05
CV (%)	10.17	10.59	11.34	6.24	3.22	5.25	10.61	3.38	4.06	6.93

Table 5. Effect of herbicide on the number of specific weed at 28 days after spraying(continued)

Treat-ment	Pani long	Chandmala	Arail	Zira kata	Pata jhanji	Joyna	Moyurleja	Boro Chech	Kanai bashi	Jhilmorich	Khet Papri
T_1	1.67 b	0.00 f	2.33 b	0.00 c	0.00 b	**1.33 a**	2.00 m	0.00 c	0.00 b	0.00 f	0.00 b
T_2	0.00 f	0.00 f	1.00 f	0.00 c	0.00 b	0.00 c	2.00 m	0.00 c	0.00 b	0.00 f	0.00 b
T_3	0.67 d	1.67 c	0.33 h	0.00 c	0.00 b	0.00 c	4.67 i	0.00 c	0.00 b	0.67 d	0.00 b
T_4	0.00 f	0.33 e	0.00 i	0.00 c	0.00 b	0.00 c	5.33 f	0.00 c	0.00 b	0.00 f	0.00 b
T_5	0.00 f	0.00 f	1.00 f	0.00 c	0.00 b	0.00 c	9.00 c	0.33 b	0.00 b	0.00 f	**0.33 a**
T_6	0.00 f	0.00 f	0.67 g	0.00 c	0.00 b	0.00 c	5.00 g	0.00 c	0.00 b	0.00 f	**0.33 a**
T_7	0.00 f	0.33 e	0.00 i	0.00 c	0.00 b	0.00 c	5.00 g	0.00 c	0.00 b	0.00 f	0.00 b
T_8	0.00 f	0.00 f	1.33 e	0.00 c	0.00 b	0.00 c	6.67 d	0.00 c	0.00 b	0.00 f	0.00 b
T_9	0.00 f	0.00 f	0.00 i	0.00 c	0.00 b	0.00 c	5.00 g	0.00 c	0.00 b	0.00 f	0.00 b
T_{10}	0.00 f	0.00 f	0.00 i	0.00 c	0.00 b	0.00 c	6.33 e	0.00 c	0.00 b	0.00 f	0.00 b
T_{11}	0.33e	0.00 f	1.67 d	0.00 c	0.00 b	0.00 c	3.67 l	0.00 c	0.00 b	0.00 f	0.00 b
T_{12}	0.00 f	0.00 f	**2.67 a**	0.00 c	0.00 b	0.00 c	6.67 d	0.33 b	**0.67 a**	0.00 f	0.00 b
T_{13}	1.00 c	1.33 d	0.00 i	0.00 c	0.00 b	0.00 c	5.00 g	0.33 b	0.00 b	1.67 c	**0.33 a**
T_{14}	0.00 f	3.00 b	1.67 d	0.00 c	0.00 b	0.00 c	11.33 b	0.00 c	0.00 b	2.00 b	0.00 b
T_{15}	0.00 f	0.00 f	2.00 c	**2.00 a**	0.00 b	0.00 c	5.00g	0.00 c	0.00 b	0.00 f	0.00 b
T_{16}	0.00 f	0.33 e	1.67 d	0.00 c	0.00 b	0.00 c	4.00 h	0.00 c	0.00 b	0.33 e	0.00 b
T_{17}	0.00 f	0.00 f	2.00 c	0.00 c	0.00 b	0.33 b	4.33 h	0.00 c	0.00 b	0.00 f	0.00 b
T_{18}	**4.33 a**	**10.00 a**	1.00 f	1.33 b	**0.67 a**	0.33 b	**14.67a**	**0.67 a**	0.00 b	**6.33 a**	0.00 b
LSD $_{(0.05)}$	0.05	0.1	0.05	0.02	0.02	0.02	0.3	0.02	0.02	0.07	0.02
CV (%)	8.56	6.57	3.44	7.51	9.72	6.73	2.86	5.85	9.72	6.74	7.97

In a column means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability. [T_1 = Propyrisulfuran (500 ml/ha), T_2 = Propyrisulfuran (750 ml/ha), T_3 = Propanil (3750 g/ha), T_4 = Propyrisulfuran + Propanil (500 ml/ha + 3750g /ha), T_5 = Propyrisulfuran + Propanil (500 ml/ha + 2916.7g/ha), T_6 = Propyrisulfuran + Propanil (500 ml/ha + 2500 g/ha), T_7 = Propyrisulfuran + Propanil (500 ml/ha + 2083.3 g/ha), T_8 = Propyrisulfuran + Propanil (500 ml/ha + 1666.7 g/ha), T_9 = Propyrisulfuran + Propanil (500 ml/ha + 1250 g/ha), T_{10} = Propyrisulfuran + Propanil (750 ml/ha + 3750 g/ha), T_{11} = Propyrisulfuran + Propanil (750 ml/ha + 3125 g/ha), T_{12} = Propyrisulfuran + Propanil (750 ml/ha + 2500 g/ha), T_{13} = Propyrisulfuran + Propanil (750 ml/ha + 1875 g/ha), T_{14} = Propyrisulfuran + Propanil (500 ml/ha + 900g/ha), T_{15} = Propyrisulfuran + Propanil (750 ml/ha + 900 g/ha), T_{16} = Acetochlor 14% + Bensulfuron methyl 4% (2000 g/ha (premix)), T_{17} = Bispyriback sodium + Pyralosulfuran ethyl(150 g/ha + 150 g/ha), T_{18} = Untreated check]

4.1.3 Total Number of Weed Species and their Decrease Percentage

In experimental field, significant variation (Appendix XXIII) was found on different data collection date such as 3 DBA, 3 DAA, 7 DAA, 14 DAA, 21 DAA, 28 DAA, 45 DAA etc. (Table-6). At the initial stage (3 days before herbicide application), maximum number of weeds (374.33) was found in T_9 treatment where as minimum number (140.00) was observed in T_{12} treatment. After 3 days of herbicides application (3 DAA), weed population was observed lower in all treatments except T_{18} (Untreated check). From 3DBA to this stage, weed population decreases highest (25.39%) in T_7 treatment and lowest (0.71%) in T_{12} treatment. In T_{18} treatment, weed population was found more (35.31%) (Figure 1).

After 7 days of herbicides application (7 DAA), weed population was found lower than 3 DAA in all treatment except T_{18} (Untreated check). From 3 DAA to this stage, weed population decreases highest (31.46%) in T_{14} treatment and lowest (9.20%) in T_1 treatment. In T_{18} treatment, weed population was observed more (9.25%).

After 14 days of herbicides application (14 DAA), weed population was observed lower than 7 DAA in all treatment except T_{18} (Untreated check). From 3DAA to this stage, weed population decreases highest (90.17%) in T_9 treatment and lowest (41.33%) in T_{15} treatment. On the other hand, weed population was increasd (9.09%) in T_{18} treatment. Weed population decreased drastically at this stage.

After 21 days of herbicides application (21 DAA), weed population was found lower than 14 DAA in all treatments except T_{18} (Untreated check). From 14 DAA to this stage, weed population decreases highest (49.48%) in T_9 treatment and lowest (4.39%) in T_{11} treatment. In T_{18} treatment, weed population was observed more (6.54%).

After 28 days of herbicides application (28 DAA), weed population was observed lower than 21 DAA in all treatments except T_{18} (Untreated check).

During 3DAA to this stage, weed population decreases highest (48.82%) in T_{11} treatment and lowest (1.16%) in T_{13} treatment, but weed population was increasd (7.50%) in T_{18} treatment.

After 45 days of herbicides application (45 DAA), weed population was found lower than 28 DAA in all treatments except T_{18} (Untreated check). From 28 DAA to this stage, weed population decreases highest (40.28%) in T_8 treatment and lowest (1.15%) in T_{16} treatment. In T_{18} treatment, weed population was observed more (3.06%).

It was observed that highest number (96.90%) of weed population decreased from beginning to 45 DAA in T9 treatment.

So, it is suggested that T9 was the best treatment to control weed in rice field.

Table 6: Total number of weed species at different days after spraying

Treatment	3 DBA	3 DAA	7 DAA	14 DAA	21 DAA	28 DAA	45 DAA
T1	245.6 c	245.61de	223.0 de	25.67 ef	21.00 d-f	17.33 e	15.00 d
T2	182.3 f	164.3 ij	122.0 j	24.67 ef	18.67 ef	17.42 e	16.33 cd
T3	203.8ef	184.5 g-i	155.0 hi	24.00 f	22.00 d-f	20.01 e	18.01 cd
T4	203.9 ef	179.0 hi	145.7 ij	31.67 d-f	21.67 d-f	19.01 e	14.67 d
T5	310.34 b	292.7 c	242.3 cd	35.67 d-f	28.00 c-f	22.67 e	16.67 cd
T6	212.7 de	158.7 ij	122.3 j	26.00 ef	20.00 ef	18.33 e	15.00 d
T7	213.5 de	202.5 f-h	164.7 hi	40.00 de	27.34 c-f	15.33 e	14.00 d
T8	317.6 b	281.7 c-e	191.0 fg	38.00 d-f	32.67cd	24.00 e	14.33 d
T9	374.33 a	369.67 b	329.0 b	32.33 d-f	16.33 f	14.01 e	11.60 d
T10	209.67ef	200.33 fg	177.0 gh	34.33 d-f	25.33c-f	19.33 e	18.67 cd
T11	272.83 c	245.67 de	203.7 ef	30.67 ef	29.32 c-e	23.33 e	15.01 b-d
T12	140.0 g	139 j	127.7 j	34.67 d-f	23.67 c-f	23.00 e	17.33 cd
T13	252.33cd	241.44 e	202.0 e-g	37.33 d-f	28.67c-f	31.67 de	28.33 bc
T14	245.7 c	213.0 fg	146.0 ij	75.67 c	70.67 b	43.33 bc	27.34 b-d
T15	249.7 c	194.7 f-h	139.0 ij	81.56 c	75.33 b	39.67 cd	26.00 b-d
T16	247.0 c	218.3 f	194.4 fg	47.00 d	35.33 c	26.00 de	25.70 b-d
T17	305.3 b	289.0 cd	261.3 c	104.3 b	84.45 b	55.33 b	39.00 b
T18	300.3 b	406.4 a	443.3 a	484.33 a	516.00 a	554.7 a	571.7 a
LSD (0.05)	29.81	29.67	25.78	15.8	12.53	14.93	16.44
CV (%)	7.32	7.46	7.7	13.88	13.2	16.67	19.43

In a column means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.

T_1 = Propyrisulfuran (500 ml/ha)
T_2 = Propyrisulfuran (750 ml/ha)
T_3 = Propanil (3750 g/ha)
T_4 = Propyrisulfuran + Propanil (500 ml/ha + 3750g /ha)
T_5 = Propyrisulfuran + Propanil (500 ml/ha + 2916.7g/ha)
T_6 = Propyrisulfuran + Propanil (500 ml/ha + 2500 g/ha)
T_7 = Propyrisulfuran + Propanil (500 ml/ha + 2083.3 g/ha)
T_8 = Propyrisulfuran + Propanil (500 ml/ha + 1666.7 g/ha)
T_9 = Propyrisulfuran + Propanil (500 ml/ha + 1250 g/ha)
T_{10} = Propyrisulfuran + Propanil (750 ml/ha + 3750 g/ha)
T_{11} = Propyrisulfuran + Propanil (750 ml/ha + 3125 g/ha)
T_{12} = Propyrisulfuran + Propanil (750 ml/ha + 2500 g/ha)
T_{13} = Propyrisulfuran + Propanil (750 ml/ha + 1875 g/ha)
T_{14} = Propyrisulfuran + Propanil (500 ml/ha + 900g/ha)
T_{15} = Propyrisulfuran + Propanil (750 ml/ha + 900 g/ha)
T_{16} = Acetochlor 14% + Bensulfuron methyl 4% (2000 g/ha (premix))
T_{17} = Bispyriback sodium + Pyralosulfuran ethyl(150 g/ha + 150 g/ha)
T_{18} = Untreated check

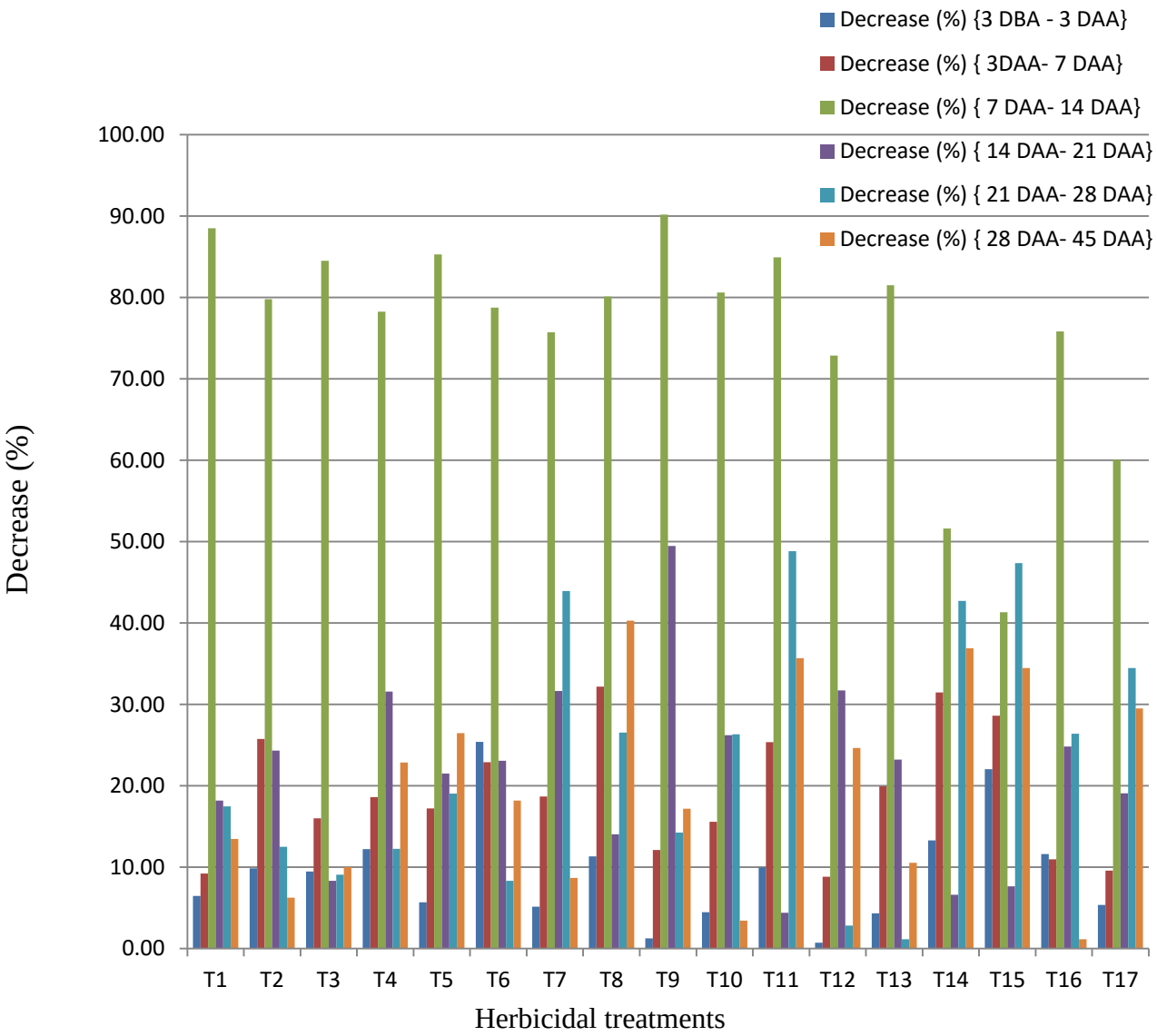


Figure 1: Decrease Percentage of weed species with effect of different treatments at various times.

{T_1 = Propyrisulfuran (500 ml/ha), T_2 = Propyrisulfuran (750 ml/ha), T_3 = Propanil (3750 g/ha), T_4 = Propyrisulfuran + Propanil (500 ml/ha + 3750g /ha), T_5 = Propyrisulfuran + Propanil (500 ml/ha + 2916.7g/ha), T_6 = Propyrisulfuran + Propanil (500 ml/ha + 2500 g/ha), T_7 = Propyrisulfuran + Propanil (500 ml/ha + 2083.3 g/ha), T_8 = Propyrisulfuran + Propanil (500 ml/ha + 1666.7 g/ha), T_9 = Propyrisulfuran + Propanil (500 ml/ha + 1250 g/ha), T_{10} = Propyrisulfuran + Propanil (750 ml/ha + 3750 g/ha), T_{11} = Propyrisulfuran + Propanil (750 ml/ha + 3125 g/ha), T_{12} = Propyrisulfuran + Propanil (750 ml/ha + 2500 g/ha), T_{13} = Propyrisulfuran + Propanil (750 ml/ha + 1875 g/ha), T_{14} = Propyrisulfuran + Propanil (500 ml/ha + 900g/ha), T_{15} = Propyrisulfuran + Propanil (750 ml/ha + 900 g/ha), T_{16} = Acetochlor 14% + Bensulfuron methyl 4% (2000 g/ha (premix)), T_{17} = Bispyriback sodium + Pyralosulfuran ethyl(150 g/ha + 150 g/ha), T_{18} = Untreated check)

4.1.4 Weed Fresh weight per square meter (g)

The fresh weight of weed varied significantly due to the application of different herbicidal treatments in the rice field (Appendix XXIV). The maximum weed fresh weight (163.30 g) was found from T_{18} (Untreated check) treatment, while the minimum weed fresh weight (24.81 g) was obtained from T9 {Propyrisulfuran + Propanil (500 ml/ha + 1250 g/ha)} treatment, which is statistically similar to T_{11} treatment (Table 7).

4.1.5 Weed Dry weight per square meter (g)

The dry weight of weed varied significantly due to the application of different herbicidal treatments in the rice field (AppendixXXIV). The maximum weed dry weight (93.86 g) was found from T_{18} (Untreated check) treatment, while the minimum weed dry weight (6.07 g) was obtained from from T9 {Propyrisulfuran + Propanil (500 ml/ha + 1250 g/ha)} treatment, which is statistically similar to T_{11} treatment (Table 7). From this result it was clear that control treatments produced highest weed density and Propyrisulfuran + Propanil (500 ml/ha + 1250 g/ha) treatment produced lowest weed density. The results are in agreement with that of Singh *et al.* (1999) and Singh and Singh (1998) who also found similar result.

4.1.6 Dry matter content of weed (%)

Significant variation was found due to the application of different herbicidal treatments in the rice field (Appendix XXIV). The maximum weed dry matter content (57.45%) was found from T_{18} (Untreated check) treatment and the minimum weed dry matter content (24.55%) was obtained from T9 {Propyrisulfuran + Propanil (500 ml/ha + 1250 g/ha)} treatment, which is statistically identical to T_6, T_7, T_{10} and T_{14} treatments and statistically similar to T_3 and T_{13} treatments (Table 7). Gogoi *et al*. (2000) reported that different weed control practices significantly reduced the dry matter accumulation of weed and increased the rice yield over the unweeded control in Boro rice.

4.1.7 Weed control efficacy (%)

Significant variation was observed due to the application of different doses of herbicides in the rice field (Appendix XXIV). The maximum weed control efficacy (91.00 % EC) was obtained from T9 {Propyrisulfuran + Propanil (500 ml/ha + 1250 g/ha)} treatment which is statistically identical to T_6, T_{11}, T_{14} and T_{15} treatments and statistically similar to T_1, T_2, T_4 and T_7 treatments (Table 7). According to Mian and Gaffer (1968) the extent of weed control by different weed control treatments and susceptibility of different weed species were graded on the basis of weed control efficiency by the following scales.

Degrees of weed susceptibility	**Weed control**	
	Efficiency (%)	**Grades**
Completely susceptible (CS)	100	Completely control (CC)
Very highly susceptible (VHS)	90-99	Excellent control (EC)
Highly Susceptible (HS)	70-89	Good control (GC)
Moderately susceptible (MS)	40-69	Fair control (FC)
Poorly susceptible (PS)	20-39	Poor control (PC)
Slightly susceptible (SS)	1-19	Slightly control (SC)
Completely resistant (CR)	0	No control (NC)

According to Mian and Gaffer (1968) the weeds which were grown in T_6, T_9 and T_{11} treated plot are very highly susceptible (VHS) to T_6, T_9 and T_{11} treatment respectively. Various weed control efficacy was recorded from different weed control treatment. On the other hand, the lowest weed control efficacy (0.00 %) was obtained from T_{18} (Untreated check) treatment that means no weed was checked in this treatment. Mamun *et al*. (2011) evaluated that application of Bensulfuron methyl + Pretilachlor 6.6% GR @ 652 g a.i ha^{-1} gave more than 80% weed control efficiency in boro rice.

4.1.8 Importance value of weed (%)

The Importance value of weed varied significantly due to the application of different herbicidal treatments in the rice field (Appendix XXIV). The maximum importance value of weed (22.69%) was found from T_{18} (Untreated check) treatment and the minimum importance value of weed (1.19%) was obtained from T9 {Propyrisulfuran + Propanil (500 ml/ha + 1250 g/ha)} treatment (Table 7).

Table 7. Effect of herbicide on the fresh weight of weed at harvest, dry weight of weed, dry matter content of weed, weed control efficacy and importance value of weed

Treatment	Fresh weight of weed/m^2 at harvesting (g)	Dry weight of weed/m^2 (g)	Dry matter content of weed (%)	Weed control efficacy (%)	Importance value of weed (%)
T_1	79.21 hi	24.25 ef	30.64 fg	81.10 a-c	6.50 c
T_2	100.3 d-f	33.42 c	34.06 d-f	83.91 ab	5.92 cd
T_3	96.71 e-g	28.16 de	29.21 gh	78.02 bc	4.99 e
T_4	69.82 i	23.27 ef	33.29 e-g	81.84 a-c	4.12 fg
T_5	71.20 i	30.11 cd	42.64 bc	76.50 b-d	5.33 de
T_6	87.14 gh	22.33 f	25.81 h	**90.52 a**	2.15 h
T_7	86.40 gh	21.76 f	25.16 h	84.32 ab	3.55 g
T_8	111.4 d	42.56 b	38.24 cd	66.79 d	7.53 b
T_9	**24.81** l	**6.07 h**	**24.55 h**	**91.00 a**	**1.19 i**
T_{10}	125.7 c	31.51 cd	25.23 h	76.06 b-d	5.43 de
T_{11}	31.97 kl	10.33 gh	32.69 e-g	90.52 a	4.82 ef
T_{12}	47.68 j	22.12 f	46.40 b	82.84 a-c	3.92 g
T_{13}	144.3 b	41.84 b	29.03 gh	67.35 d	7.40 b
T_{14}	53.25 j	13.61 g	25.70 h	89.38 a	2.40 h
T_{15}	44.55 jk	14.27 g	32.17 e-g	88.86 a	2.52 h
T_{16}	107.3 de	34.27 c	32.15 e-g	73.25 cd	6.06 cd
T_{17}	89.07 f-h	31.80 cd	35.86 de	75.19 b-d	5.63 de
T_{18}	**163.3** a	**93.86 a**	**57.45 a**	0.00 e	**22.69 a**
LSD $_{(0.05)}$	13.05	5.25	4.84	10.26	0.84
CV (%)	9.23	10.83	8.74	8.08	8.93

In a column means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.

{T_1 = Propyrisulfuran (500 ml/ha), T_2 = Propyrisulfuran (750 ml/ha), T_3 = Propanil (3750 g/ha), T_4 = Propyrisulfuran + Propanil (500 ml/ha + 3750g /ha), T_5 = Propyrisulfuran + Propanil (500 ml/ha + 2916.7g/ha), T_6 = Propyrisulfuran + Propanil (500 ml/ha + 2500 g/ha), T_7 = Propyrisulfuran + Propanil (500 ml/ha + 2083.3 g/ha), T_8 = Propyrisulfuran + Propanil (500 ml/ha + 1666.7 g/ha), T_9 = Propyrisulfuran + Propanil (500 ml/ha + 1250 g/ha), T_{10} = Propyrisulfuran + Propanil (750 ml/ha + 3750 g/ha), T_{11} = Propyrisulfuran + Propanil (750 ml/ha + 3125 g/ha), T_{12} = Propyrisulfuran + Propanil (750 ml/ha + 2500 g/ha), T_{13} = Propyrisulfuran + Propanil (750 ml/ha + 1875 g/ha), T_{14} = Propyrisulfuran + Propanil (500 ml/ha + 900g/ha), T_{15} = Propyrisulfuran + Propanil (750 ml/ha + 900 g/ha), T16 = Acetochlor 14% + Bensulfuron methyl 4% (2000 g/ha (premix)), T_{17} = Bispyriback sodium + Pyralosulfuran ethyl(150 g/ha + 150 g/ha), T_{18} = Untreated check}

4.2 Crop parameters

4.2.1 Plant height (cm)

The plant height varied significantly due to the application of different herbicidal treatments in the rice field (Appendix XXV). The highest plant height (67.48 cm) at 30 DAT was found from T9 {Propyrisulfuran + Propanil (500 ml/ha + 1250 g/ha)} treatment which is statistically dissimilar to others (Table-8). The lowest plant height was obtained from T_{18} (control) treatment (44.51 cm). At 60 DAT and 90 DAT plant height was highest in T_9 tratment (107.50 cm and 108.80 cm respectively) and was lowest in T_{18} traetment (99.98 cm and 101.2 cm respectively). But both at 60 DAT and 90 DAT, plant height was nearly similar for all treatments and was statistically non significant. The plant height was highest at T_9 treatment due to the lowest weed infestation. These results are in aggrement with Attalla and Kholosy (2002) who observed that herbicide application significantly enhanced plant height of rice and Poornima *et al.* (2015) & Islam (2014) who reported that weeding reduced crop-weed competition thus enhanced plant height significantly. These results are also in aggrement with Patil *et al*. (1986) who conducted experiment on rice.

Table 8. Effect of herbicide on the plant height of rice at different days after transplanting

Treatment	Plant height at different days after transplanting (cm)		
	30	60	90
T_1	47.16 bc	102.4	105.6
T_2	49.15 bc	103.1	107.4
T_3	51.44 b	103.4	105.3
T_4	47.19 bc	100.6	106.3
T_5	48.35 bc	103.1	106.6
T_6	49.57 bc	102.1	106.4
T_7	49.52 bc	101.9	107.4
T_8	50.72 b	104.6	105.9
T_9	**67.48 a**	**107.5**	**108.8**
T_{10}	49.35 bc	103.3	105.5
T_{11}	46.04 bc	100.9	106.7
T_{12}	46.12 bc	101.8	103.2
T_{13}	46.06 bc	101.4	103.1
T_{14}	50.54 b	102.0	104.5
T_{15}	46.93 bc	102.2	103.4
T_{16}	47.85 bc	102.7	105.3
T_{17}	51.18 b	103.0	104.5
T_{18}	**44.51 c**	99.98	101.2
LSD $_{(0.05)}$	5.94	NS	NS
CV (%)	7.24	7.89	8.27

In a column means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.

{T_1 = Propyrisulfuran (500 ml/ha), T_2 = Propyrisulfuran (750 ml/ha), T_3 = Propanil (3750 g/ha), T_4 = Propyrisulfuran + Propanil (500 ml/ha + 3750g /ha), T_5 = Propyrisulfuran + Propanil (500 ml/ha + 2916.7g/ha), T_6 = Propyrisulfuran + Propanil (500 ml/ha + 2500 g/ha), T_7 = Propyrisulfuran + Propanil (500 ml/ha + 2083.3 g/ha), T_8 = Propyrisulfuran + Propanil (500 ml/ha + 1666.7 g/ha), T_9 = Propyrisulfuran + Propanil (500 ml/ha + 1250 g/ha), T_{10} = Propyrisulfuran + Propanil (750 ml/ha + 3750 g/ha), T_{11} = Propyrisulfuran + Propanil (750 ml/ha + 3125 g/ha), T_{12} = Propyrisulfuran + Propanil (750 ml/ha + 2500 g/ha), T_{13} = Propyrisulfuran + Propanil (750 ml/ha + 1875 g/ha), T_{14} = Propyrisulfuran + Propanil (500 ml/ha + 900g/ha), T_{15} = Propyrisulfuran + Propanil (750 ml/ha + 900 g/ha), T_{16} = Acetochlor 14% + Bensulfuron methyl 4% (2000 g/ha (premix)), T_{17} = Bispyriback sodium + Pyralosulfuran ethyl(150 g/ha + 150 g/ha), T_{18} = Untreated check)}

4.2.2 Total number of tillers hill^{-1}

Significant variation was found in total number of tillers hill^{-1} due to the application of different doses of herbicides in the rice field (Appendix XXV). The maximum number of total tillers hill^{-1} (12.87) was obtained from T_9 {Propyrisulfuran + Propanil (500 ml/ha + 1250 g/ha)} treatment which is statistically similar to T_2, T_3, T_4, T_5, T_7, T_8, T_{12} and T_{17} treatment (Table-9). The minimum number of tillers hill^{-1} (9.47 cm) was found from T_{18} (Untreated check) treatment which is statistically similar to T_1, T_6, T_{10}, T_{11}, T_{13}, T_{14}, T_{15} and T_{16} treatment. These results are in aggrement with Amarajit *et al.* (2005). Ahmed *et al.* (1998) reported the highest number of tillers m^{-2} (33.1) obtained by using herbicide.

4.2.3 Number of effective tillers hill^{-1}

The number of effective tillers hill^{-1} varied significantly due to the application of different doses of herbicides in the rice field (Appendix XXV). The maximum number of effective tillers hill^{-1} (11.52) was obtained from T_9 {Propyrisulfuran + Propanil (500 ml/ha + 1250 g/ha)} treatment which is statistically similar to T_2, T_4, T_5, T_7, T_8, T_{10} and T_{14} treatments (Table-9). The minimum number of effective tillers hill^{-1} was obtained from T_{18} (Untreated check) treatment which is statistically similar to T_6, T_{11}, T_{12}, T_{13} T_{15} and T_{16} treatments. The minimum number of effective tillers hill^{-1} in the control plot was the result of higher competition for nutrient, air space, light and water between crop plants and weeds. Result of this study revealed that control treatment failed to produce more effective tillers hill^{-1} due to severe infestation of weeds in rice field (Hasanuzzaman *et al.*, 2009). Similar result was also reported by Ahmed et al. (1986).

4.2.4 Number of non-effective tillers hill^{-1}

The number of non-effective tillers hill^{-1} varied significantly due to the application of different doses of herbicides (Appendix XXV). The maximum number of non-effective tillers hill^{-1} (3.17) was obtained from T_{12} (Propyrisulfuran 750 ml/ha + Propanil 2500 g/ha) treatment which is statistically dissimilar to other treatments (Table-9). The minimum number of non-effective tillers hill^{-1} was obtained from T7 {Propyrisulfuran + Propanil (500 ml/ha + 2083.3 g/ha)} treatment which is statistically similar to T_{14} treatment and statistically identical to T_5 & T_8 treatments. Different weed management treatment kept the land clear and soil was airated which facilitated the crop for absorption of greater amount plant nutrient, moisture and greater reception of solar radiation for growth resulted in lower number of non-effective tillers hill^{-1}. Similar result was reported by Chowdhury (2012) who revealed that highest non effective tillers hill^{-1} was found from no weeding treatment.

4.2.5 Tiller length (cm)

Tiller length (cm) varied but statistically non significant in the rice field (Appendix XXV). The highest tiller length (102.40 cm) was recorded from T_9 {Propyrisulfuran + Propanil (500 ml/ha + 1250 g/ha)} treatment and the lowest tiller length (91.15 cm) was obtained from T_{18} (Untreated check) treatment which is statistically identical to other treatments (Table-9). This result is in agreement with Hasanuzaman *et al.* (2008) who described that tiller length varied significantly due to different herbicidal treatments.

Table 9. Effect of herbicide on the yield contributing character of rice

Treatment	Total no of tiller hill^{-1}	No. of Effective tiller hill^{-1}	No. of ineffective tiller hill^{-1}	Tiller length (cm)
T_1	11.07 b-g	9.87 b-d	1.87 def	99.97
T_2	12.27 a-c	10.47 ab	1.80 ef	100.8
T_3	12.00 a-e	9.60 b-d	2.40 c	96.26
T_4	12.73 ab	10.93 ab	1.80 ef	101.5
T_5	11.27 a-f	10.47 ab	1.13 hi	101.2
T_6	10.27 fg	8.67 c-e	1.60 fg	90.41
T_7	11.80 a-f	10.87 ab	**0.93 i**	100.2
T_8	11.60 a-f	10.44 ab	1.16 hi	101.6
T_9	**12.87 a**	**11.52 a**	1.35 gh	**102.4**
T_{10}	11.00 c-g	9.67 b-d	1.33 gh	98.78
T_{11}	10.93 c-g	9.07 c-e	1.87 d-f	95.88
T_{12}	12.10a-d	8.90 c-e	**3.17 a**	101.7
T_{13}	10.33 e-g	8.20 e	2.13 cd	93.85
T_{14}	10.73 c-g	9.67 b-d	1.06 i	95.73
T_{15}	10.57 d-g	8.53 de	2.03 de	95.31
T_{16}	10.47 d-g	8.73 c-e	1.73 f	90.88
T_{17}	12.13 a-d	10.00 bc	2.73 b	95.63
T_{18}	**9.47 g**	**7.80 e**	1.67 f	**91.15**
LSD $_{(0.05)}$	1.67	1.34	0.27	NS
CV (%)	8.90	8.41	9.25	8.70

In a column means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.

{T_1 = Propyrisulfuran (500 ml/ha), T_2 = Propyrisulfuran (750 ml/ha), T_3 = Propanil (3750 g/ha), T_4 = Propyrisulfuran + Propanil (500 ml/ha + 3750g /ha), T_5 = Propyrisulfuran + Propanil (500 ml/ha + 2916.7g/ha), T_6 = Propyrisulfuran + Propanil (500 ml/ha + 2500 g/ha), T_7 = Propyrisulfuran + Propanil (500 ml/ha + 2083.3 g/ha), T_8 = Propyrisulfuran + Propanil (500 ml/ha + 1666.7 g/ha), T_9 = Propyrisulfuran + Propanil (500 ml/ha + 1250 g/ha), T_{10} = Propyrisulfuran + Propanil (750 ml/ha + 3750 g/ha), T_{11} = Propyrisulfuran + Propanil (750 ml/ha + 3125 g/ha), T_{12} = Propyrisulfuran + Propanil (750 ml/ha + 2500 g/ha), T_{13} = Propyrisulfuran + Propanil (750 ml/ha + 1875 g/ha), T_{14} = Propyrisulfuran + Propanil (500 ml/ha + 900g/ha), T_{15} = Propyrisulfuran + Propanil (750 ml/ha + 900 g/ha), T_{16} = Acetochlor 14% + Bensulfuron methyl 4% (2000 g/ha (premix)), T_{17} = Bispyriback sodium + Pyralosulfuran ethyl(150 g/ha + 150 g/ha), T_{18} = Untreated check)}

4.2.6 Panicle length (cm)

Significant variation was found in panicle length (cm) due to the application of different doses of herbicides in the rice field (Appendix XXVI). The highest panicle length (24.03 cm) was recorded from T_9 {Propyrisulfuran + Propanil (500 ml/ha + 1250 g/ha)} treatment which is statistically similar to T_1, T_2, T_5, T_6, T_7, T_8, T_{12}, T_{13}, T_{14}, T_{15}, T_{16} and T_{17} treatments. The lowest panicle length (19.60 cm) was obtained from T_{18} (Untreated check) treatment which is statistically similar to T_1, T_3, T_4, T_5, T_6, T_7, T_{10}, T_{11}, T_{12}, T_{13}, T_{15} and T_{16} treatments (Figure 2). Rafiquddua (1999) observed the maximum number of panicle length from the weed free condition.

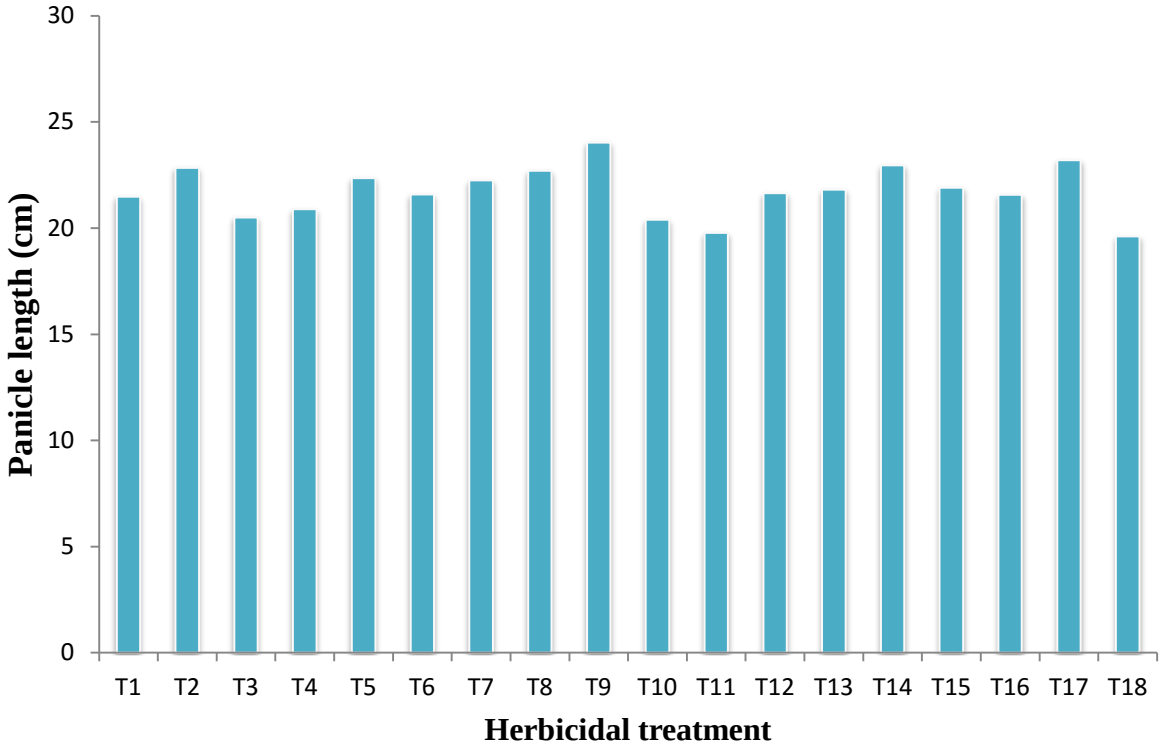


Figure 2. Effect of herbicide on the panicle length of rice (LSD $_{(0.05)}$ = 3.30)

{T_1 = Propyrisulfuran (500 ml/ha), T_2 = Propyrisulfuran (750 ml/ha), T_3 = Propanil (3750 g/ha), T_4 = Propyrisulfuran + Propanil (500 ml/ha + 3750g /ha), T_5 = Propyrisulfuran + Propanil (500 ml/ha + 2916.7g/ha), T_6 = Propyrisulfuran + Propanil (500 ml/ha + 2500 g/ha), T_7 = Propyrisulfuran + Propanil (500 ml/ha + 2083.3 g/ha), T_8 = Propyrisulfuran + Propanil (500 ml/ha + 1666.7 g/ha), T_9 = Propyrisulfuran + Propanil (500 ml/ha + 1250 g/ha), T_{10} = Propyrisulfuran + Propanil (750 ml/ha + 3750 g/ha), T_{11} = Propyrisulfuran + Propanil (750 ml/ha + 3125 g/ha), T_{12} = Propyrisulfuran + Propanil (750 ml/ha + 2500 g/ha), T_{13} = Propyrisulfuran + Propanil (750 ml/ha + 1875 g/ha), T_{14} = Propyrisulfuran + Propanil (500 ml/ha + 900g/ha), T_{15} = Propyrisulfuran + Propanil (750 ml/ha + 900 g/ha), T_{16} = Acetochlor 14% + Bensulfuron methyl 4% (2000 g/ha (premix)), T_{17} = Bispyriback sodium + Pyralosulfuran ethyl(150 g/ha + 150 g/ha), T_{18} = Untreated check)}

4.2.7 Number of primary branchespanicle^{-1}

Number of Spike panicle^{-1} varied significantly due to the application of different doses of herbicides (Appendix XXVI). The highest number of Spike panicle^{-1} (8.47) was recorded from T_1 {Propyrisulfuran + Propanil (500 ml/ha)} treatment which is statistically similar to T_2,T_3, T_5,T_7, T_8,T_9, T_{10}, T_{11}, T_{12}, T_{13}, T_{14} and T_{17} treatments. The lowest number of Spike panicle^{-1} (6.80) was obtained from T_4 treatment that is statistically similar with T_3, T_5, T_8, T_{10}, T_{11}, T_{12}, T_{15}, T_{16} and T_{18} treatments (Table 10). Spike panicle^{-1} increased due to lack of crop-weed competition for the nutrients, water, light etc. Similar results also reported by Singh *et al*. (2006).

4.2.8 Number of secondary branches panicle^{-1}

Significant variation was found in number of spikelet panicle^{-1} due to the application of different doses of herbicides in the rice field (Appendix XXVI). The highest number of spikelet panicle^{-1} (25.07) was recorded from T_9 {Propyrisulfuran + Propanil (500 ml/ha + 1250 g/ha)} treatment which is statistically similar to T_1, T_5 and T_8 treatments. Weeding reduce crop-weed competition and provides scope to the plants for efficient utilization of solar radiation and nutrients (Table 10). The lowest number of spikelet panicle^{-1} (15.67) was obtained from T_{18} (control) treatment that was statistically similar with T_3, T_6, T_7, T_{10}, T_{12}, T_{13}, T_{15} and T_{16}. This result is in agreement with Ganeshwor and Gadadhar (2000).

Table 10. Effect of herbicide on the yield contributing character of rice

Treatment	No. of primary branches panicle^{-1}	No. ofsecondary branches panicle^{1}
T_1	**8.47 a**	24.20 ab
T_2	8.13 a-c	22.20 bc
T_3	7.47 a-e	18.67 ef
T_4	6.80 e	17.73 fg
T_5	7.80 a-e	24.10 ab
T_6	7.07 c -e	19.20 ef
T_7	7.90 a-d	19.07 ef
T_8	7.47 a-e	23.60 ab
T_9	8.28 ab	**25.07 a**
T_{10}	7.70 a-e	19.80 c-f
T_{11}	7.80 a-e	21.80 b-d
T_{12}	7.47 a-e	18.07 fg
T_{13}	8.08 a-c	19.13 ef
T_{14}	7.93 a-d	21.00 c-e
T_{15}	7.33 b-e	18.20 fg
T_{16}	7.40 b-e	19.40 d-f
T_{17}	8.20 ab	21.00 c-e
T_{18}	**7.13 c-e**	**15.67 g**
LSD $_{(0.05)}$	1.01	2.54
CV (%)	7.94	7.50

In a column means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.

{T_1 = Propyrisulfuran (500 ml/ha), T_2 = Propyrisulfuran (750 ml/ha), T_3 = Propanil (3750 g/ha), T_4 = Propyrisulfuran + Propanil (500 ml/ha + 3750g /ha), T_5 = Propyrisulfuran + Propanil (500 ml/ha + 2916.7g/ha), T_6 = Propyrisulfuran + Propanil (500 ml/ha + 2500 g/ha), T_7 = Propyrisulfuran + Propanil (500 ml/ha + 2083.3 g/ha), T_8 = Propyrisulfuran + Propanil (500 ml/ha + 1666.7 g/ha), T_9 = Propyrisulfuran + Propanil (500 ml/ha + 1250 g/ha), T_{10} = Propyrisulfuran + Propanil (750 ml/ha + 3750 g/ha), T_{11} = Propyrisulfuran + Propanil (750 ml/ha + 3125 g/ha), T_{12} = Propyrisulfuran + Propanil (750 ml/ha + 2500 g/ha), T_{13} = Propyrisulfuran + Propanil (750 ml/ha + 1875 g/ha), T_{14} = Propyrisulfuran + Propanil (500 ml/ha + 900g/ha), T_{15} = Propyrisulfuran + Propanil (750 ml/ha + 900 g/ha), T_{16} = Acetochlor 14% + Bensulfuron methyl 4% (2000 g/ha (premix)), T_{17} = Bispyriback sodium + Pyralosulfuran ethyl(150 g/ha + 150 g/ha), T_{18} = Untreated check)}

4.2.9 Number of filled grains panicle^{-1}

Significant variation was found in filled grains per panicle due to the application of different doses of herbicides in the rice field (Appendix XXVI). The maximum number of filled grain per panicle (118.90) was recorded from T_9 {Propyrisulfuran + Propanil (500 ml/ha + 1250 g/ha)} treatment which is statistically similar to T_1, T_2, T_8 and T_{12} treatments (Figure 3). The minimum number of filled grain per panicle was obtained from T_{18} (control) treatment which is statistically similar to T_3, T_4, T_5, T_6, T_7, T_{16} and T_{18} treatments. Weeding reduce crop-weed competition. This might be responsible to higher number of grains panicle^{-1}. Similar results were reported by Islam (2014) and Zannat, (2014). On other hand, the highest number of grains was produced in the weed free condition in rice field (Khan, 2013; Sanjoy *et al*., 1999 and Chowdhury *et al.*, 1995).

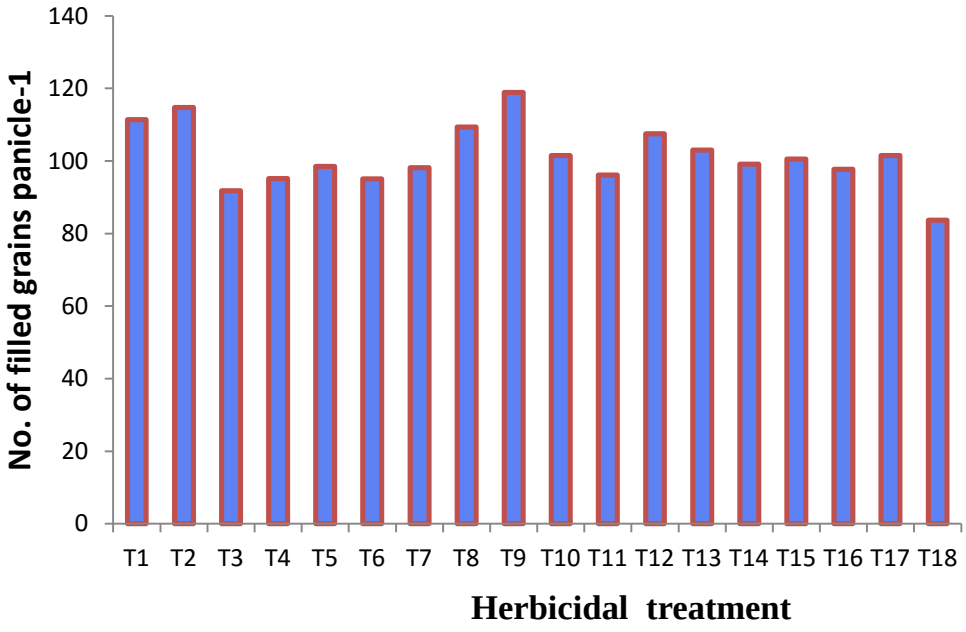


Figure 3. Effect of herbicide on the number of filled grain panicle^{-1} of rice (LSD $_{(0.05)}$ = 14.87)

{T_1 = Propyrisulfuran (500 ml/ha), T_2 = Propyrisulfuran (750 ml/ha), T_3 = Propanil (3750 g/ha), T_4 = Propyrisulfuran + Propanil (500 ml/ha + 3750g /ha), T_5 = Propyrisulfuran + Propanil (500 ml/ha + 2916.7g/ha), T_6 = Propyrisulfuran + Propanil (500 ml/ha + 2500 g/ha), T_7 = Propyrisulfuran + Propanil (500 ml/ha + 2083.3 g/ha), T_8 = Propyrisulfuran + Propanil (500 ml/ha + 1666.7 g/ha), T_9 = Propyrisulfuran + Propanil (500 ml/ha + 1250 g/ha), T_{10} = Propyrisulfuran + Propanil (750 ml/ha + 3750 g/ha), T_{11} = Propyrisulfuran + Propanil (750 ml/ha + 3125 g/ha), T_{12} = Propyrisulfuran + Propanil (750 ml/ha + 2500 g/ha), T_{13} = Propyrisulfuran + Propanil (750 ml/ha + 1875 g/ha), T_{14} = Propyrisulfuran + Propanil (500 ml/ha + 900g/ha), T_{15} = Propyrisulfuran + Propanil (750 ml/ha + 900 g/ha), T_{16} = Acetochlor 14% + Bensulfuron methyl 4% (2000 g/ha (premix)), T_{17} = Bispyriback sodium + Pyralosulfuran ethyl(150 g/ha + 150 g/ha), T_{18} = Untreated check)}

4.2.10 Number of Unfilled grains panicle^{-1}

Unfilled grains per panicle varied significantly due to the application of different doses of herbicides (Appendix XXVI). The maximum number of unfilled grains per panicle (9.33) was recorded from T_{18} (control) treatment which is statistically similar to T_1, T_{12} and T_{17} treatments. The minimum number of unfilled grain per panicle (6.52) was obtained from T9 {Propyrisulfuran + Propanil (500 ml/ha + 1250 g/ha)} treatment which is statistically similar to T_3, T_4, T_5, T_7, T_8, T_{10}, T_{11}, T_{13} and T_{16} treatments (Figure 4). Rafiquddualla (1999) observed that maximum non effective tillers hill^{-1} and sterile grains were found from the no weeding regimes.

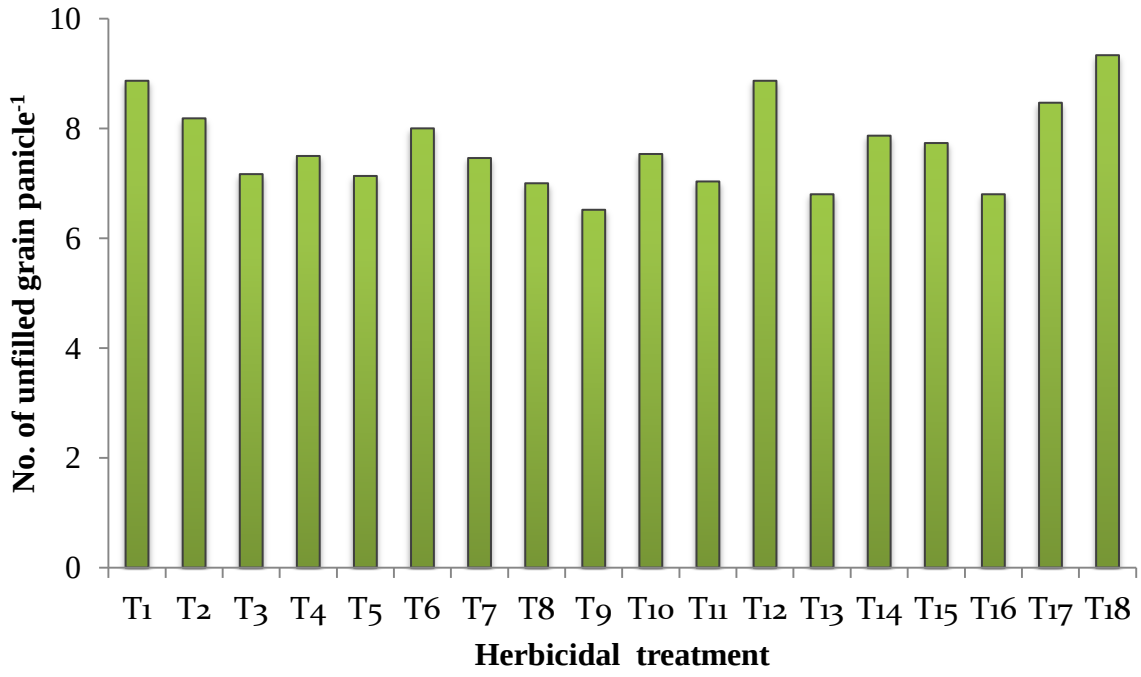


Figure 4. Effect of herbicide on the number of unfilled grain panicle^{-1} of rice (LSD $_{(0.05)}$ = 1.11)

{T_1 = Propyrisulfuran (500 ml/ha), T_2 = Propyrisulfuran (750 ml/ha), T_3 = Propanil (3750 g/ha), T_4 = Propyrisulfuran + Propanil (500 ml/ha + 3750g /ha), T_5 = Propyrisulfuran + Propanil (500 ml/ha + 2916.7g/ha), T_6 = Propyrisulfuran + Propanil (500 ml/ha + 2500 g/ha), T_7 = Propyrisulfuran + Propanil (500 ml/ha + 2083.3 g/ha), T_8 = Propyrisulfuran + Propanil (500 ml/ha + 1666.7 g/ha), T_9 = Propyrisulfuran + Propanil (500 ml/ha + 1250 g/ha), T_{10} = Propyrisulfuran + Propanil (750 ml/ha + 3750 g/ha), T_{11} = Propyrisulfuran + Propanil (750 ml/ha + 3125 g/ha), T_{12} = Propyrisulfuran + Propanil (750 ml/ha + 2500 g/ha), T_{13} = Propyrisulfuran + Propanil (750 ml/ha + 1875 g/ha), T_{14} = Propyrisulfuran + Propanil (500 ml/ha + 900g/ha), T_{15} = Propyrisulfuran + Propanil (750 ml/ha + 900 g/ha), T_{16} = Acetochlor 14% + Bensulfuron methyl 4% (2000 g/ha (premix)), T_{17} = Bispyriback sodium + Pyralosulfuran ethyl(150 g/ha + 150 g/ha), T_{18} = Untreated check)}

4.2.11 Number of total grains panicle^{-1}

Number of total grains per panicle varied significantly due to the application of different doses of herbicides (Appendix XXVI). The maximum number of total grains per panicle (125.40) was recorded T_9 {Propyrisulfuran + Propanil (500 ml/ha + 1250 g/ha)} treatment which is statistically similar to T_1, T_2, T_8 and T_{12} treatments. The minimum number (92.67) of total grains per panicle was obtained from T_{18} (control) treatment which is statistically similar to T_3, T_5, T_6, T_7 T_4, T_{11} and T_{16} treatments(Figure 5). Geethu *et al.* (2014) reported that plants were affected by weed competition resulting reduce the total number of grains panicle^{-1}. Singh *et al*. (1999) also reported that weeding increase the number of grains panicle^{-1}.

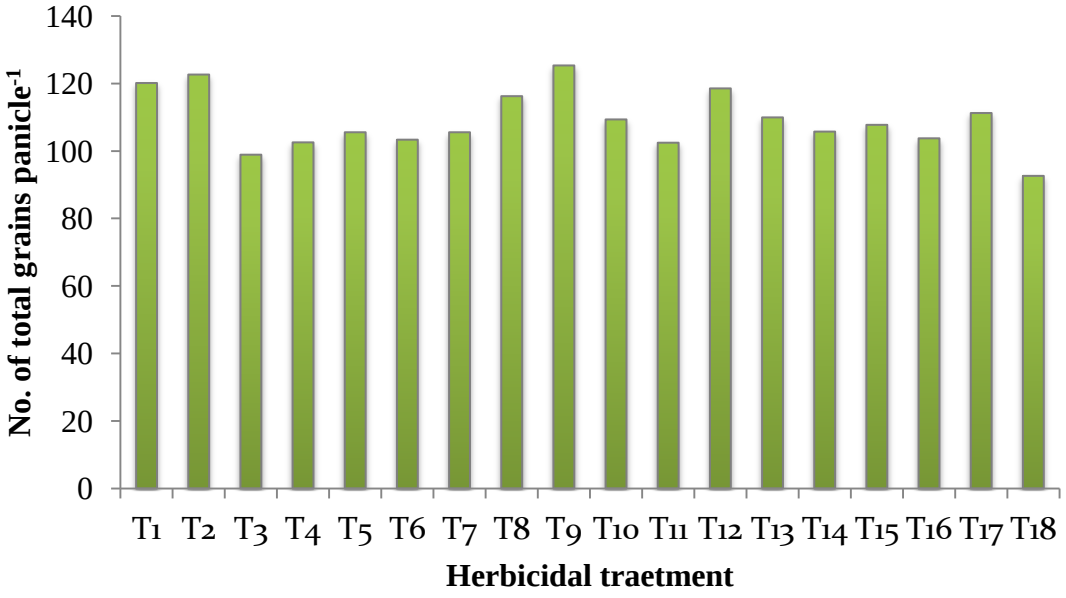


Figure 5. Effect of herbicide on the number of total grain panicle^{-1} of rice (LSD $_{(0.05)}$ = 13.14)

{T_1 = Propyrisulfuran (500 ml/ha), T_2 = Propyrisulfuran (750 ml/ha), T_3 = Propanil (3750 g/ha), T_4 = Propyrisulfuran + Propanil (500 ml/ha + 3750g /ha), T_5 = Propyrisulfuran + Propanil (500 ml/ha + 2916.7g/ha), T_6 = Propyrisulfuran + Propanil (500 ml/ha + 2500 g/ha), T_7 = Propyrisulfuran + Propanil (500 ml/ha + 2083.3 g/ha), T_8 = Propyrisulfuran + Propanil (500 ml/ha + 1666.7 g/ha), T_9 = Propyrisulfuran + Propanil (500 ml/ha + 1250 g/ha), T_{10} = Propyrisulfuran + Propanil (750 ml/ha + 3750 g/ha), T_{11} = Propyrisulfuran + Propanil (750 ml/ha + 3125 g/ha), T_{12} = Propyrisulfuran + Propanil (750 ml/ha + 2500 g/ha), T_{13} = Propyrisulfuran + Propanil (750 ml/ha + 1875 g/ha), T_{14} = Propyrisulfuran + Propanil (500 ml/ha + 900g/ha), T_{15} = Propyrisulfuran + Propanil (750 ml/ha + 900 g/ha), T_{16} = Acetochlor 14% + Bensulfuron methyl 4% (2000 g/ha (premix)), T_{17} = Bispyriback sodium + Pyralosulfuran ethyl(150 g/ha + 150 g/ha), T_{18} = Untreated check)

4.2.12 Thousand (1000) grain weight (g)

Thousand (1000) grain weight(g) varied significantly due to the application of different doses of herbicides (Appendix XXVI). The maximum 1000 grain weight (34.02 g) was recorded from T_{16} {Acetochlor 14% + Bensulfuron methyl 4% (2000 g/ha (premix)} treatment while the minimum 1000 grain weight (22.79 g) was obtained from T_{17} {Bispyriback sodium + Pyralosulfuran ethyl (150 g/ha + 150 g/ha)} treatment that was statistically similar with T_1, T_2,T_3, T_4, T_5, T_7, T_8, T_{10}, T_{11}, T_{12} and T_{15} treatments.. Khan (2013) found that the weeding regime had significant effect on all the parameters except 1000-grain weight (Figure 6).

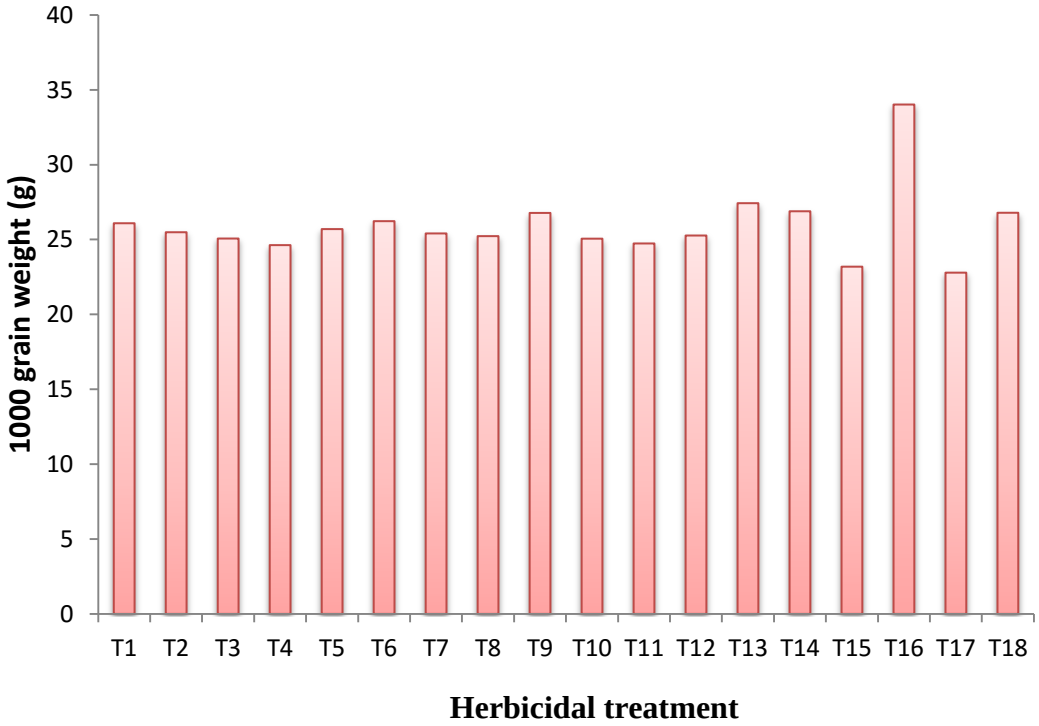


Figure-6. Effect of herbicide on the 1000 grain weight of rice (LSD $_{(0.05)}$ = 3.61)

{T_1 = Propyrisulfuran (500 ml/ha), T_2 = Propyrisulfuran (750 ml/ha), T_3 = Propanil (3750 g/ha), T_4 = Propyrisulfuran + Propanil (500 ml/ha + 3750g /ha), T_5 = Propyrisulfuran + Propanil (500 ml/ha + 2916.7g/ha), T_6 = Propyrisulfuran + Propanil (500 ml/ha + 2500 g/ha), T_7 = Propyrisulfuran + Propanil (500 ml/ha + 2083.3 g/ha), T_8 = Propyrisulfuran + Propanil (500 ml/ha + 1666.7 g/ha), T_9 = Propyrisulfuran + Propanil (500 ml/ha + 1250 g/ha), T_{10} = Propyrisulfuran + Propanil (750 ml/ha + 3750 g/ha), T_{11} = Propyrisulfuran + Propanil (750 ml/ha + 3125 g/ha), T_{12} = Propyrisulfuran + Propanil (750 ml/ha + 2500 g/ha), T_{13} = Propyrisulfuran + Propanil (750 ml/ha + 1875 g/ha), T_{14} = Propyrisulfuran + Propanil (500 ml/ha + 900g/ha), T_{15} = Propyrisulfuran + Propanil (750 ml/ha + 900 g/ha), T_{16} = Acetochlor 14% + Bensulfuron methyl 4% (2000 g/ha (premix)), T_{17} = Bispyriback sodium + Pyralosulfuran ethyl(150 g/ha + 150 g/ha), T_{18} = Untreated check)}

4.2.13 Grain yield (t/ha)

Rice grain yield per hector varied significantly due to the application different doses of herbicides in the rice field (Appendix XXVI). The maximum grain yield per hectare (3.8 t/ha) was recorded from T9 {Propyrisulfuran + Propanil (500 ml/ha + 1250 g/ha)} treatment which is statistically similar to T1, T_5, T_6, T7, T_8, T10, T15 and T17 treatments. On the other hand the minimum grain yield per hectare (0.95 t/ha) was obtained from T_{18} (control) treatment (Figure 7). These might be due to the fact that the weeding kept the rice field less infested and soil was well aerated which facilitated the crop for absorption of greater amount of plant nutrients, moisture and greater reception of solar radiation for better growth. Chowdhury *et al.* (1995) reported that the highest grain yield was produced from weed free plot as a result of less competition with weeds. The similar results also reported by several authors (Tamilselvan and Budhar, 2001; Saha, 2005; Singh *et al.*, 2014; Acharya and Bhattacharya, 2013; Halder *et al.*, 2005).

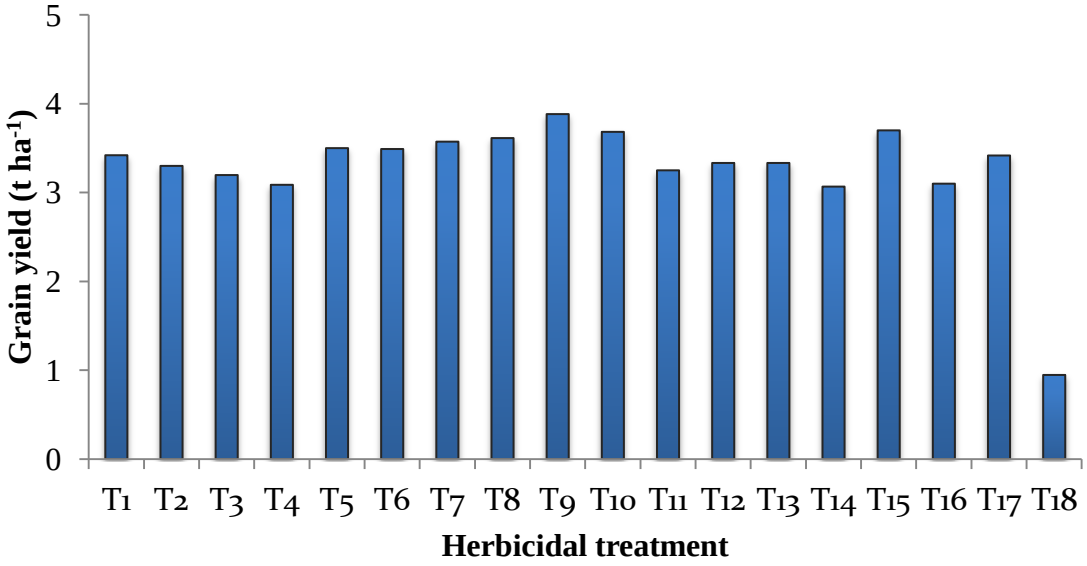


Figure-7. Effect of herbicide on the grain yield of rice (LSD $_{(0.05)}$ = 0.46)

{T_1 = Propyrisulfuran (500 ml/ha), T_2 = Propyrisulfuran (750 ml/ha), T_3 = Propanil (3750 g/ha), T_4 = Propyrisulfuran + Propanil (500 ml/ha + 3750g /ha), T_5 = Propyrisulfuran + Propanil (500 ml/ha + 2916.7g/ha), T_6 = Propyrisulfuran + Propanil (500 ml/ha + 2500 g/ha), T_7 = Propyrisulfuran + Propanil (500 ml/ha + 2083.3 g/ha), T_8 = Propyrisulfuran + Propanil (500 ml/ha + 1666.7 g/ha), T_9 = Propyrisulfuran + Propanil (500 ml/ha + 1250 g/ha), T_{10} = Propyrisulfuran + Propanil (750 ml/ha + 3750 g/ha), T_{11} = Propyrisulfuran + Propanil (750 ml/ha + 3125 g/ha), T_{12} = Propyrisulfuran + Propanil (750 ml/ha + 2500 g/ha), T_{13} = Propyrisulfuran + Propanil (750 ml/ha + 1875 g/ha), T_{14} = Propyrisulfuran + Propanil (500 ml/ha + 900g/ha), T_{15} = Propyrisulfuran + Propanil (750 ml/ha + 900 g/ha), T_{16} = Acetochlor 14% + Bensulfuron methyl 4% (2000 g/ha (premix)), T_{17} = Bispyriback sodium + Pyralosulfuran ethyl(150 g/ha + 150 g/ha), T_{18} = Untreated check)}

4.2.14 Straw yield (t/ha)

Rice straw yield per hectare varied significantly due to the application of different doses of herbicides (Appendix XXVI). The maximum straw yield (4.64 t/ha) was recorded from T9 {Propyrisulfuran + Propanil (500 ml/ha + 1250 g/ha)} treatment which is statistically similar to T_{1}- T8, T10- T15, and T17 treatments. The minimum straw yield per hectare (1.343 t/ha) was obtained from T_{18} (control) treatment (Figure 8). Rafiquddaulla (1999) observed that the weed dry weight was significantly affected by the weeding regimes. The maximum straw yield was obtained from weed free condition which was similar to three hand-weeding at 20, 40 and 60 DAT**.**

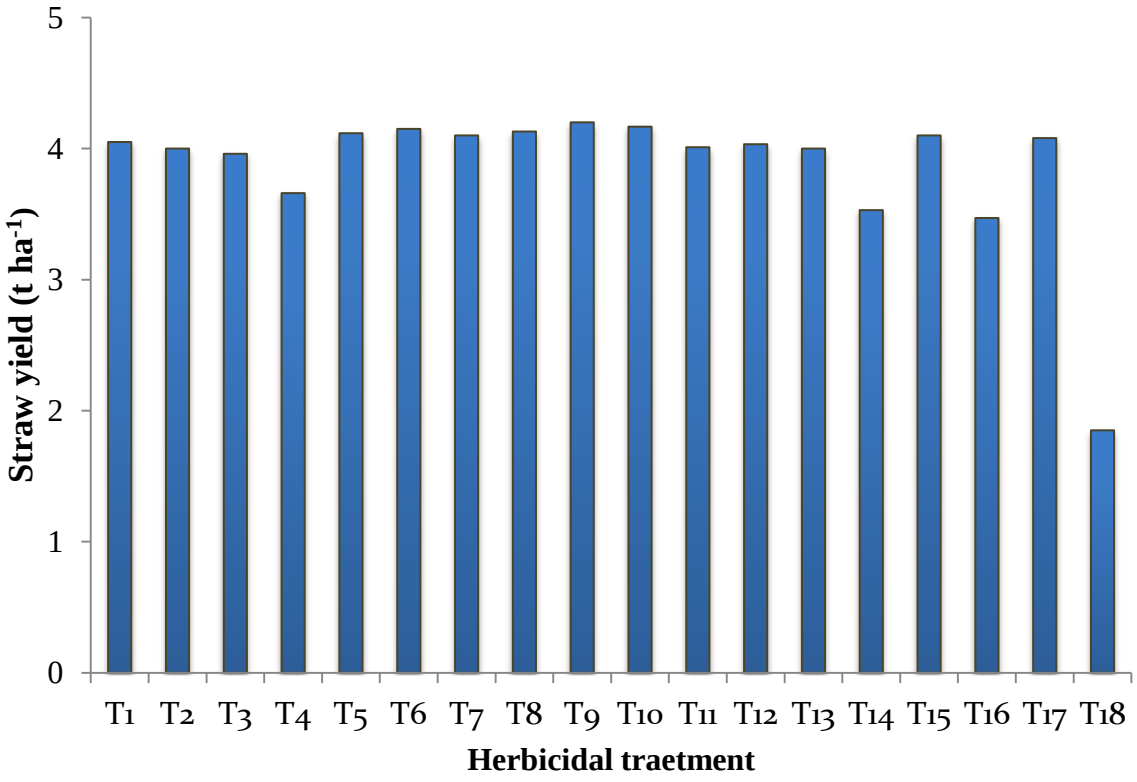


Figure- 8. Effect of herbicide on the straw yield of rice (LSD $_{(0.05)}$ = 0.55)

{T_1 = Propyrisulfuran (500 ml/ha), T_2 = Propyrisulfuran (750 ml/ha), T_3 = Propanil (3750 g/ha), T_4 = Propyrisulfuran + Propanil (500 ml/ha + 3750g /ha), T_5 = Propyrisulfuran + Propanil (500 ml/ha + 2916.7g/ha), T_6 = Propyrisulfuran + Propanil (500 ml/ha + 2500 g/ha), T_7 = Propyrisulfuran + Propanil (500 ml/ha + 2083.3 g/ha), T_8 = Propyrisulfuran + Propanil (500 ml/ha + 1666.7 g/ha), T_9 = Propyrisulfuran + Propanil (500 ml/ha + 1250 g/ha), T_{10} = Propyrisulfuran + Propanil (750 ml/ha + 3750 g/ha), T_{11} = Propyrisulfuran + Propanil (750 ml/ha + 3125 g/ha), T_{12} = Propyrisulfuran + Propanil (750 ml/ha + 2500 g/ha), T_{13} = Propyrisulfuran + Propanil (750 ml/ha + 1875 g/ha), T_{14} = Propyrisulfuran + Propanil (500 ml/ha + 900g/ha), T_{15} = Propyrisulfuran + Propanil (750 ml/ha + 900 g/ha), T_{16} = Acetochlor 14% + Bensulfuron methyl 4% (2000 g/ha (premix)), T_{17} = Bispyriback sodium + Pyralosulfuran ethyl(150 g/ha + 150 g/ha), T_{18} = Untreated check)}

4.2.15 Biological yield (t/ha)

Significant variation was found in biological yield due to the application of different doses of herbicides in the rice field (Appendix XXVI). The biological yield is the combined of grain yield and straw yield. The maximum biological yield per hectare (8.45 t/ha) was recorded T_9 {Propyrisulfuran + Propanil (500 ml/ha + 1250 g/ha)} treatment. On the other hand the minimum biological yield per hectare (2.29 t/ha) was obtained from T_{18} (control) treatment (Figure 9). Variations of biological yield among the treatment were dependent upon the severity of weed infestation thus affected grain yield and straw yield. Ahmed *et al.* (1998) reported that grain and straw yield (biological yield) decreased with increasing weed population and weed competition duration that also partially supported the present experimental result.

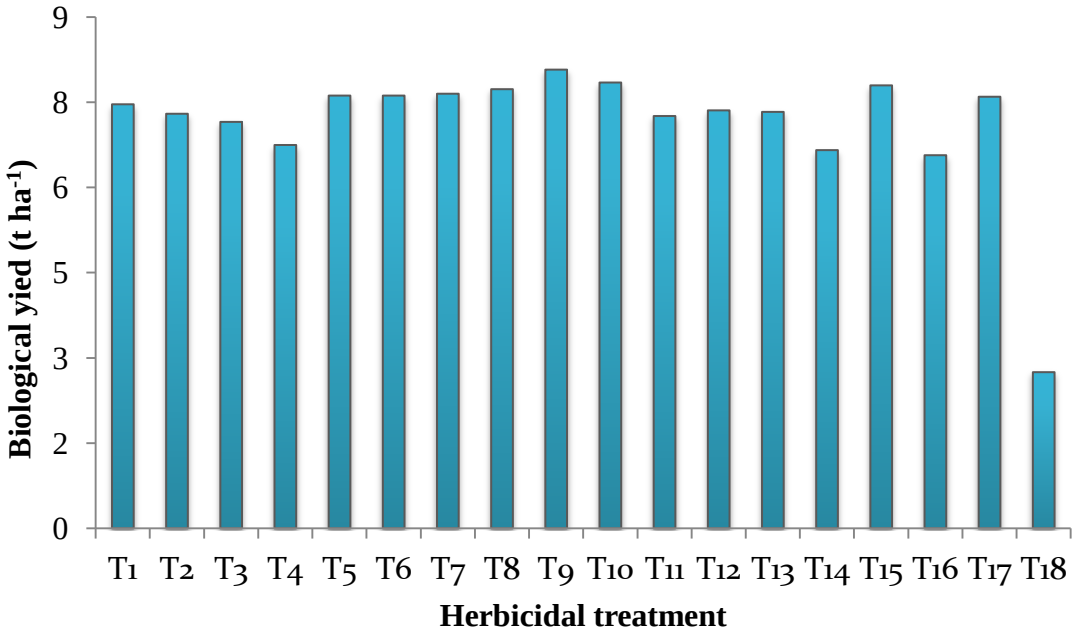


Figure-9. Effect of herbicide on the biological yield of rice (LSD $_{(0.05)}$ = 0.97)

{T_1 = Propyrisulfuran (500 ml/ha), T_2 = Propyrisulfuran (750 ml/ha), T_3 = Propanil (3750 g/ha), T_4 = Propyrisulfuran + Propanil (500 ml/ha + 3750g /ha), T_5 = Propyrisulfuran + Propanil (500 ml/ha + 2916.7g/ha), T_6 = Propyrisulfuran + Propanil (500 ml/ha + 2500 g/ha), T_7 = Propyrisulfuran + Propanil (500 ml/ha + 2083.3 g/ha), T_8 = Propyrisulfuran + Propanil (500 ml/ha + 1666.7 g/ha), T_9 = Propyrisulfuran + Propanil (500 ml/ha + 1250 g/ha), T_{10} = Propyrisulfuran + Propanil (750 ml/ha + 3750 g/ha), T_{11} = Propyrisulfuran + Propanil (750 ml/ha + 3125 g/ha), T_{12} = Propyrisulfuran + Propanil (750 ml/ha + 2500 g/ha), T_{13} = Propyrisulfuran + Propanil (750 ml/ha + 1875 g/ha), T_{14} = Propyrisulfuran + Propanil (500 ml/ha + 900g/ha), T_{15} = Propyrisulfuran + Propanil (750 ml/ha + 900 g/ha), T_{16} = Acetochlor 14% + Bensulfuron methyl 4% (2000 g/ha (premix)), T_{17} = Bispyriback sodium + Pyralosulfuran ethyl(150 g/ha + 150 g/ha), T_{18} = Untreated check)}

4.2.16 Harvest index (%)

Harvest index of rice varied significantly due to the application of different doses of herbicides in the rice field (Appendix XXVI). The maximum harvest index (50.08 %) was recorded from T_9 {Propyrisulfuran + Propanil (500 ml/ha + 1250 g/ha)} treatment. On the other hand, the minimum harvest index (34.53%) was obtained from T_{18} (Untreated check) treatment (Figure 10). These findings are further supported with the work of Al-Mamun *et al.* (2011) and Bhuiyan *et al.* (2011), who obtained better yields in rice with herbicide use.

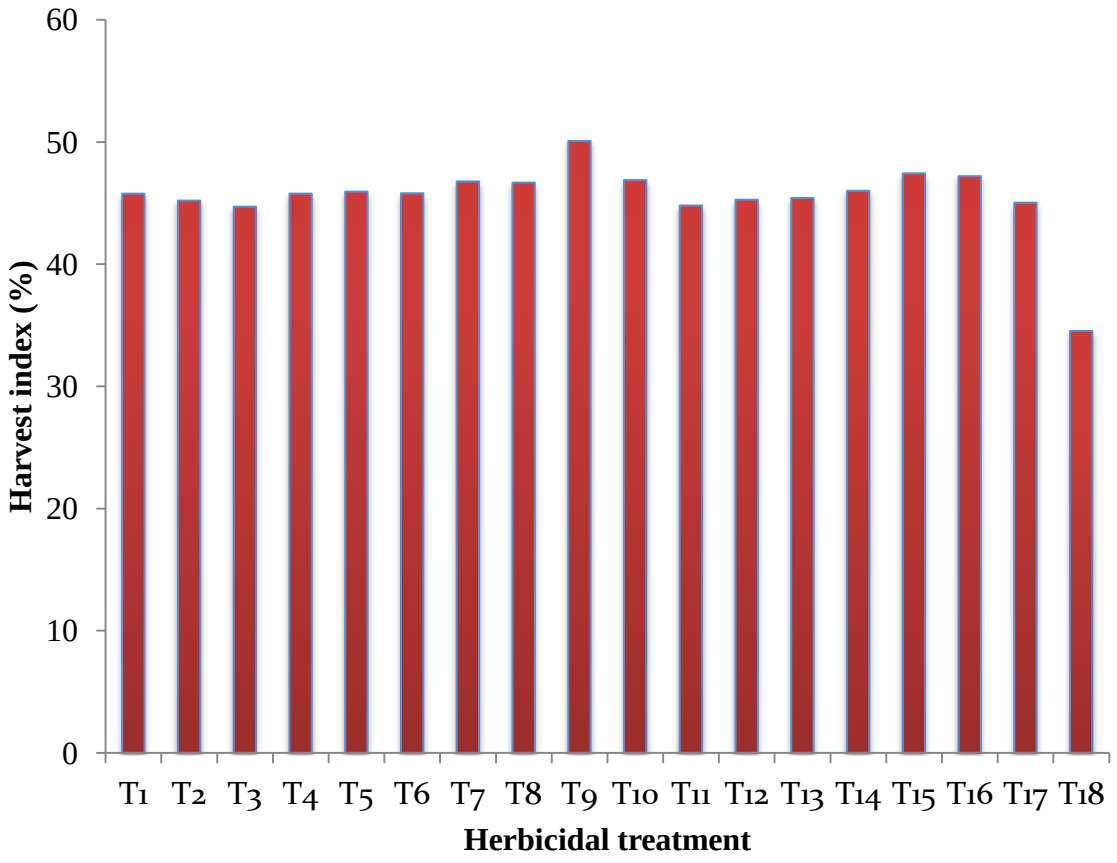


Figure-10. Effect of herbicide on the harvest index of rice (LSD $_{(0.05)}$ = 4.85)

{T_1 = Propyrisulfuran (500 ml/ha), T_2 = Propyrisulfuran (750 ml/ha), T_3 = Propanil (3750 g/ha), T_4 = Propyrisulfuran + Propanil (500 ml/ha + 3750g /ha), T_5 = Propyrisulfuran + Propanil (500 ml/ha + 2916.7g/ha), T_6 = Propyrisulfuran + Propanil (500 ml/ha + 2500 g/ha), T_7 = Propyrisulfuran + Propanil (500 ml/ha + 2083.3 g/ha), T_8 = Propyrisulfuran + Propanil (500 ml/ha + 1666.7 g/ha), T_9 = Propyrisulfuran + Propanil (500 ml/ha + 1250 g/ha), T_{10} = Propyrisulfuran + Propanil (750 ml/ha + 3750 g/ha), T_{11} = Propyrisulfuran + Propanil (750 ml/ha + 3125 g/ha), T_{12} = Propyrisulfuran + Propanil (750 ml/ha + 2500 g/ha), T_{13} = Propyrisulfuran + Propanil (750 ml/ha + 1875 g/ha), T_{14} = Propyrisulfuran + Propanil (500 ml/ha + 900g/ha), T_{15} = Propyrisulfuran + Propanil (750 ml/ha + 900 g/ha), T_{16} = Acetochlor 14% + Bensulfuron methyl 4% (2000 g/ha (premix)), T_{17} = Bispyriback sodium + Pyralosulfuran ethyl(150 g/ha + 150 g/ha), T_{18} = Untreated check)}

4.3 Functional relationship between Weed control efficacy (%), grain yield (t/ha) and filled grains per panicle of Aus rice (cv. BRRI dhan48)

4.3.1 Relationship between weed control efficacy (%) and grain yield (t/ha)

Relationship between weed control efficacy (%) and grain yield was shown in the graph (Figure 11). Weed control efficacy (%) was recorded in later growth stage of the plant. A significant relationship was observed in grain yield and weed control efficacy (%). Grain yield increases progressively with the increase in weed control efficacy (%). Grain yield was lowest (0.95 t ha^{-1}) when the weed control efficacy was (0.00 %) under unweeded treatment. On the other hand, grain yield was found highest (3.88 t ha^{-1}) in higher weed control efficacy (91.00 %) under the T9 {Propyrisulfuran + Propanil (500 ml/ha + 1250 g/ha)} treatment throughout the later growth stage period.

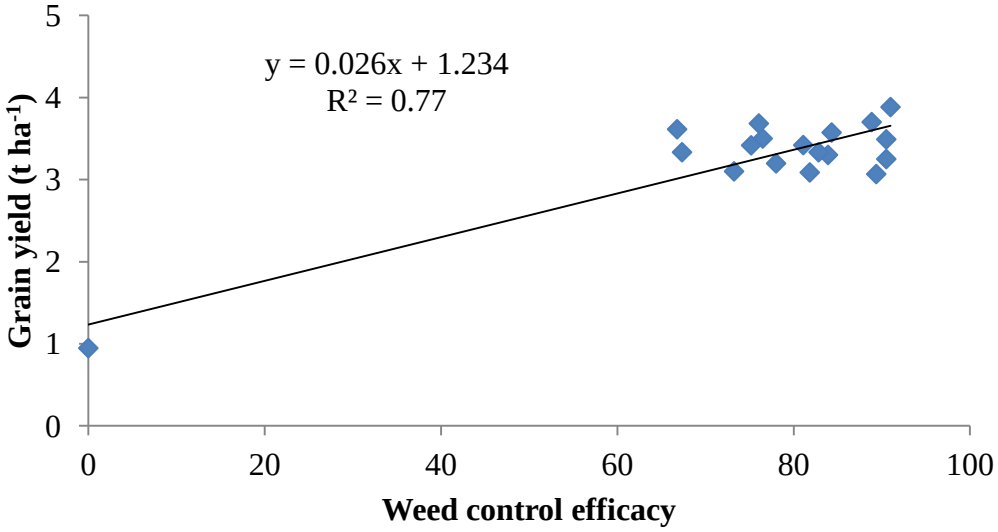


Figure-11. Regression between weed control efficiency and grain yield of rice

4.3.2 Relationship between weed control efficacy (%) and number of filled grains per panicle

Relationship between weed control efficacy (%) and filled grains per panicle was shown in the graph (Figure 12). A reciprocal relationship was observed between weed control efficacy (%) and filled grains per panicle at later growth stage of boro rice. Filled grains per panicle increased due to increase in weed control efficacy. The response of weed control efficacy (%) to the filled grains per panicle followed a linear positive relationship which could be adequately described by regression equation. Filled grains per panicle was the lowest (83.70) when the weed control efficacy (0.00 %) was lowest. On the other hand filled grains per panicle was found to be highest (118.90) when the weed control efficacy (91.00 %) is the highest.

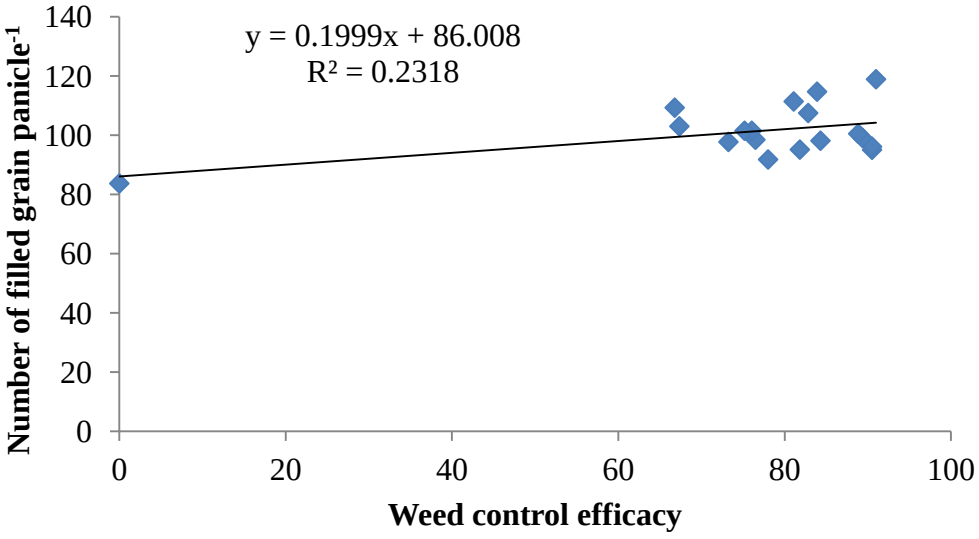


Figure-12. Regression between weed control efficacy and number of filled grain panicle^{-1} of rice

CHAPTER V

SUMMARY AND CONCLUSION

CHAPTER V

SUMMARY

A field experiment was carried out at the Agronomy Field Laboratory, Sher- e-Bangla Agricultural University, Dhaka, during the period from March-August, 2015 to evaluate the efficacy of herbicides and their effect on yield of transplanted aus rice (BRRI dhan48). The experiment included eighteen treatments, namely T_1 Propyrisulfuran (500 ml/ha) , T_2 {Propyrisulfuran (750 ml/ha)} , T_3 {Propanil (3750 g/ha)}, T_4 {Propyrisulfuran + Propanil (500 ml/ha + 3750g /ha)} , T_5 {Propyrisulfuran + Propanil (500 ml/ha + 2916.7g/ha)} , T_6 {Propyrisulfuran + Propanil (500 ml/ha + 2500 g/ha)}, T_7 {Propyrisulfuran + Propanil (500 ml/ha + 2083.3 g/ha)} , T_8 {Propyrisulfuran + Propanil (500 ml/ha + 1666.7 g/ha)} , T_9 {Propyrisulfuran + Propanil (500 ml/ha + 1250 g/ha)} , T_{10} {Propyrisulfuran + Propanil (750 ml/ha + 3750 g/ha)} , T_{11} { Propyrisulfuran + Propanil (750 ml/ha + 3125 g/ha)} , T_{12} { Propyrisulfuran + Propanil (750 ml/ha + 2500 g/ha)}, T_{13} {Propyrisulfuran + Propanil (750 ml/ha + 1875 g/ha)} , T_{14} {Propyrisulfuran + Propanil (500 ml/ha + 900g/ha)}, T15 { Propyrisulfuran + Propanil (750 ml/ha + 900 g/ha)}, T_{16} {Acetochlor 14% + Bensulfuron methy l 4% (2000 g/ha (premix))}, T_{17} { Bispyriback sodium + Pyralosulfuran ethyl(150 g/ha + 150 g/ha)} and T_{18} (Untreated check).

Soil of the experimental site belongs to Tejgaon series and its texture is silty clay loam. The area is situated in the Agro-Ecological Zone of Madhupur tract (AEZ No. 28), soil pH range is 5.8-6.5 and CEC is 25.28. The experiment was laid out in randomized complete block design with three replications. The size of a unit plot was 5 m × 2 m. Observations were made on crop characters viz. as plant height, total number of tillers hill^{-1}, number of effective tillers hill^{-1}, number of ineffective tillers hill^{-1}, tiller length, panicle length, No .of spike panicle^{-1}, No .of spikelet panicle$^{-1,}$ number of filled grains panicle-^{1}, number of unfilled grains panicle^{-1}, number of total grains panicle^{-1},1000-grain weight (g), grain yield t ha^{-1}, straw yield t ha^{-1}, and harvest index (%) and weed data were collected as no. of weeds at 3 DBA (days before application), 3 DAA

(days after application), 7DAA ,14DAA , 28 DAA and 45 DAA infestation, fresh wt. of weed at harvesting, dry wt. of weed at harvesting, weed control efficacy and importance value of weed. In T_1 treatment total number of infested weed species were 16, and dominating weed species at later growth stage was Moyurleja (*Leptochloa chinensis*) and total number of weed species were 8 at 45 DAA. In T_2 treatment total 13 weed species were found at 3 DBA, Moyurleja (*Leptochloa chinensis*) was the dominating weed species at later growth stage and total number of weed species were 7 at the final stage. In T_3 treatment total number of infested weed species were 16, dominating weed species at later growth stage was shusni (*Marsilea quadrifolia*) and total number of weed species were 7 at the final stage. In T_4 treatment total number of infested weed species 18, and dominating weed species at later growth stage was Moyurleja (*Leptochloa chinensis*), no. of weed species were 5 at the final stage. In T_5 treatment total number of infested weed species 18, shusni (*Marsilea quadrifolia*) was the dominating weed species at later growth stage and no. of weed species were 7 at the final stage. All the weed species have reduced in number from early stage to later stage.

In T_6 treatment total number of infested weed species were14 at 3 DBA, dominating weed species at later growth stage was Boro shama (*Echinochloa crussgalli*) and total 8 weed species were found at 45 DAT. In T_7 treatment total number of 12 weed species were found at early growth stage, dominating weed species at later stage was jhilmorich (*Sphenoclea zhilanica*) and total number of weed species were 9 at the final stage and some weed species have increased in number from early stage to later stage. In T_8 treatment total number of infested weed species 14 and dominating weed species at later growth stage was shusni (*Marsilea quadrifolia),* total 7 weed species were present at the later growth stage and the other 1 weed species have greatly reduced in number from early stage to later stage. In T_9 treatment total number of infested weed species 13, dominating weed species at later stage was Behua (*Cyperus difformis*) and total number of weed species was 3 at 45 DAT. In T_{10} treatment total number of infested weed species were 14, dominating weed

species at later stage was shusni (*Marsilea quadrifolia)* and total number of weed species were 4 at final growth stage. The number of most of the weed species reduced from early stage to later stage. In T_{11} treatment total number of 15 infested weed species were present at early stage, dominating weed species at later stage was Moyurleja (*Leptochloa chinensis*), and total number of weed species were 9 at 45 DAT. In T_{12} treatment total number of infested weed species were 15, dominating weed species at later stage was shusni (*Marsilea quadrifolia)* and total 8 weed species were present at 45 DAT. In T_{13} treatment total number of infested weed species were 17, shusni (*Marsilea quadrifolia)* was the dominating weed species at later stage and total 16 weed species were found at final stage. Some of the weeds have increased in number at later stage. In T_{14} treatment total number of infested weed species were 18, Behua (*Cyperus diformis)* was the dominating weed species at later stage and total number of weed species were 9 at the final stage. In T_{15} treatment total number of infested weed species were 20, dominating weed species at later stage was Behua (*Cyperus diformis*) and total number of weed species were 12 at later stage. In T_{16} treatment total number of 16 weed species emerged at 3 DBA, dominating weed species at later stage was shusni (*Marsilea quadrifolia)* and total number of weed species was 8 at 45DAT. In T_{17} treatment total number of infested weed species were 18, Behua (*Cyperus diformis* was the dominating weed species at later stage and total 11 weed species were present at final growth stage. In T_{18} treatment total number of infested weed species 21, dominating weed species at later stage was Behua (*Cyperus diformis*). All the weeds have increased in number from early stage to later stage.

Plant height was highest at 30 DAT, 60 DAT and 90 DAT (67.48 cm, 107.5 cm and 108.8 cm) in T_9 treatment while the minimum plant height was observed in T_{18} treatment. Maximum number of total tillers hill^{-1} (12.87), maximum number of effective tillers hill^{-1} (11.52), highest tiller length (102.40 cm), highest panicle length (24.03 cm), maximum spikelet panicle^{-1} (25.07), maximum filled grains per panicle (118.90), minimum unfilled grains per panicle (6.52), maximum total grains per panicle (125.4), highest grain yield

per hectare (3.8 t ha^{-1}), maximum straw yield per hectare (4.64 t ha^{-1}), maximum biological yield (8.4 t ha^{-1}) and maximum harvest index (50.08 %) were obtained from T9 treatment. On the other hand, the highest No. of spike were obtained from T1 treatment , thousand grain wt. was maximum (22.79 g) at T16 treatment and lowest non effective tiller $panicle^{-1}$ was (.93) obtained from T_7 treatment. The lowest plant height at 30 DAT, 60 DAT and 90 DAT (44.41 cm, 99.98 cm and 101.2 cm respectively) , minimum number total of tillers $hill^{-1}$ (9.47), minimum number of effective tillers $hill^{-1}$ (7.80), lowest panicle length (19.60 cm), lowest tiller length (91.15 cm), minimum No. of spike $panicle^{-1}$ (7.13), No. of spikelet $panicle^{-1}$ (15.67), minimum filled grains per panicle (83.70), maximum unfilled grains per panicle (9.33), minimum total grains per panicle (92.67), lowest grain yield per hectare (0.95 t ha^{-1}), minimum straw yield per hectare (1.343 t ha^{-1}), minimum biological yield (2.29 t ha^{-1}) and minimum harvest index (34.53 %) was recorded from T18 treatment. The highest No. of non effective tiller per hill (3.17) was obtained from T_{12} treatment while the lowest (22.79 g) 1000 grain wt. was recorded from the plots treated with T_{17} treatment.

CONCLUSION

Based on the result of the present study, it can be said that application of Propyrisulfuran + Propanil (500 ml ha^{-1}+1250 g ha^{-1}) showed the highest weed control and gave the highest yield. Highest number of weed species (21) was observed in T_{18} (control) plot. In T_9 treatment, among 13 weed species 10 were fully controlled, 1 was greatly reduced in number from early to later stage but 2 species were not controlled. Controlling Shusni, Behua and Moyorleja was difficult and in some plot, those weeds dominated early to later stage.

So in conclusion it can be said that Propyrisulfuran + Propanil (500 ml ha^{-1} + 1250 g ha^{-1}) is most effective for contolling weed successfully in transplanted *aus* rice.

RECOMMENDATION

All the herbicides used in this study were proved to be effective and economic means of weed control as an excellent alternative to traditional weed control practices in transplanted aus rice. From this study the following recommendations can be made:

- Combination of propyrisulfuran and Propanil herbicides can be used at field level in similar edaphic and weather condition at (500 ml ha^{-1}+1250 g ha^{-1}) dose due to their higher weed control efficacy, economic frugality, environmental safety and satisfactory grain yield.
- Further experiment should be done at different AEZ to observe the effect of these commercially available herbicides on crop and also on surrounding environment.

CHAPTER VI

REFERENCES

REFERENCES

Abeysekera, S. K., Wickrma, U. B. and Marambe . B. (2008). Effect of tank mixtures of quinclorac and propanil of weed control, growth and yield of rice (*Oryza sativa*). *Acta. Agron. Hungarica*. **52**(2): 328-334.

Acharya, S.S. and Bhattacharya, S.P. (2013). Comparative Efficacy of Pyrazosulfuron Ethyl and Bentazon with Acetamides for Weed Control in Transplanted Boro Rice (*Oryza sativa* L.) in the Lower Gangetic Plain Zone of West Bengal, India. *Intl. J. Bio-res. and Str. Mangt. 2013*. **4**(4): 506-509.

Achlderon, J. I., Palis, F. M., Burhan, H., Bhandhufalak, A. and Chong, W. C. (1987). Set-off new rice herbicide for the South East Asia. *In: 11* th Asia Pacific *Weed Sci. Soc. Conf*. **2**: 73-79.

Adigun, J. A., Lagoke, S. T. O. and Adekpe. I. D. (2000). Efficiency of selected herbicids for weed control in rainfed upland rice in the Nigeria Northern Guinea Savannah. *Agril. Tropic. ET subtropical.* **38**(3): 99-104.

Ahmed, G. J. U., Bhuiyan, M. K. A., Rices, C. R., Mortimer, M. and Jhonson, D. (2005). Farmer's participatory studies of irrigated weed management system for intensified lowland. Proceeding of the 8 th Biennial Agronomy Convention, *Bangladesh Agron. Soc*. Dhaka.

Ahmed, G. J. U., Mamun, A. A., Hossain, S. M. A., Siddique, S. B. and Mirdha, A. J. (1997). Effect of Basagran and raking combined with hand weeding to control weeds in aus rice. *Bangladesh Agron. J.* **7**(1&2): 31-32.

Ahmed, S. and Chauhan, B. S. (2014). Performance of Different Herbicides in Dry Seeded Rice in Bangladesh. *The Scientific World J*. **15**: 1-14.

Ahmed, S., Mamun, A. A., Islam, M. M. and Hossain, S. M. A. (1986). Critical period of weed competition of transplanted Aman rice. *Bangladesh J. Agril.* **11**: 1-7.

Ahmed, Z., Khan, D.R., Alim, S.D., Tahir, M. and Marwat, K.B. (1998). Effect of economics of time and weeds removal on the yield and yield components of rice. *Sarhad J. Agric.* **14**(4): 335-338.

AIS (Agricultural Information Service). 2008. Krishi Diary (in Bangla). *Agril. Inform. Ser*. Khamarbari, Farmgate, Dhaka, Bangladesh, 23 pp.

Alam, M. S., Islam, M. N., Zaman, A. K. M., Biswas, B. K. and Saha, M. K. (1996). Relative efficiency and economics of different cultural methods and herbicides for weed control in transplanted *aus* rice. *Bangladesh J. Agril. Sci.* **23**(1): 67-73.

Ali, M., Sardar, M. S. A., and Biswas, P. K. (2010). Weed control and yield of transplanted aman rice as affected by integrated weed management and spacing. *Bangladesh J. Weed Sci*. **1**(1): 33-40.

Amarajit, S.B., Bali, A.S., Singh, M., Kachord, D., Sharma, B.C. and Shirvan, D.R. (2005). Efficiency of herbicide in transplanted medium duration of rice under sub-tropical condition of jammu . *Indian J, Agron.* **51**(2): 128-130.

Attalla, S.I. and Kholosy, A.S. (2002). Effect of weed control treatments transplanted rice. *Bull. Fac. Agric. Cairo Uni.* **53**(4): 531-538.

Bahar, F.A. and Govendra, S. (2004). Effect of herbicides on dry seeded rice and associated weeds. *Indian J. Weed Sci*. **36**(3/4): 269-270.

Bakare, S. O., Ndarubu, A. A., Ukwungwu, M. N. and Ochigbo, A. A. (2008). Evaluation of Formulated Mixtures of Propanil plus Triclopyr for Post-Emergence Weed Control in Lowland Rice Production. *African J. Gen. Agric.* **4**(3): 123-127.

Bangladesh Economic Review (2016). The Peoples Republic of Bangladesh.

Bari, M. N. (2010). Effects of herbicides on weed suppression and rice yield in transplanted wetland rice. *Pakistan J. Weed Sci. Res.* **16**(4):349-361.

BBS (Bangladesh Bureau of Statistics). (2014). Agricultural crop cutting. Estimation of Aus, Amon and Boro rice. 2013-14. Government of Peoples Republic of Bangladesh.

Bhuiyan, A. K. and Ahmed, G. J. U. (2010). Performance of Mefenacet + Bensulfuron-Methyl 53% WP Against Weed Suppression In Transplanted Paddy. *Pakistan J. Weed Sci. Res*. **16**(2): 181-187.

Bhuiyan, M. K. A., Ahmed, G. J. U., Mridha, A. J., Ali, M. G., Begum, J. A. and Hossain, S. T. (2010). Performance of Oxadiargyl 400SC for weed control in transplanted rice. *Bangladesh J. Weed Sci.* **1**(1): 57-63.

Bhuiyan, M.K.A., Mridha, A.J., Ahmed, G.J.U., Begum, J.A., Sultana, R. (2011). Performance of chemical weed control in direct wet seeded rice culture under two agro-ecological conditions of Bangladesh. *Bangladesh J. Weed Sci*. **1**(1): 1-7.

BRRI, (2006). Bangladesh Rice Knowledge Bank. Bangladesh Rice Research Institute. http://riceknowledgebank.brri.org. Accessed on October 2009.

Chandra, S., Tiwari, A. N. and Singh, R. (1998). Efficiency of herbicides in direct seeded puddled rice. *Agril. Sci. Digest Karnal.* **18**(2): 71-72.

Chowdhury, I. F. (2012). Influence of weed control methods on the growth and yield of Aromatic *Aman* Rice varieties. Abstract of MS. Thesis, Department of Agronomy. Sher-e-Bangla Agricultural University, Dhaka, Bangladesh.

Chowdhury, M. A. H., Talukder, N. M., Chowdhury, A. K. and Hossain, M. Z. (1995). Effect of Ronstar on weed management, yield and nutrient uptake by rice. *Bangladesh J. agril. Sci.* **22**(1): 93-98.

Dhiman, M. (2006). Effect of different chemical control methods on weed growth pattern and yield of transplanted rice. *Environ*. *Ecol.* **245** : 253-256.

FAOSTAT (2015). Statistical Database. Food and Agricultural organization of United Nations, Rome, Italy.

Faruq, M. S. A. (2013). Effect of herbicide (Prechlor 500 EC) on the growth and yield of transplanted Aman rice. MS Thesis, Department of Agronomy, Bangladesh Agricultural University, Mymensingh, Bangladesh.

Ganeshwor, T. and Godadhar, M. (2000). Effectiveness of herbicides on controlling weeds in transplanted rice. *Nio-Botanica*. **8**(1/2): 1-6.

Gealy, D. R., Wailes, E. J.,Estroninos , L. E., and Chavez, R. S. C. (2003). Rice cultivar differences in suppression of barnyardgrass (*Echinochloa crus-galli*) and economics of reduced propanil rates. *Weed Sci.* **51**: 601–609.

Geethu, J., Meera, V.M. and Abraham, C.T. (2014). Comparative efficacy of new herbicides in direct seeded rice. *J. Tropic. Agric.* **52** (2): 174-177.

Gogoi, A. K., Rajkhowa, D. J. and Kandali, R. (2000). Effect of varieties and weed control practices on rice productivity and weed growth. *Indian J. Agron*. **45**(3): 580-585.

Gomez, M.A. and Gomez, A.A. (1984). Statistical procedures for Agricultural Research.Johnwiley and sons. New York, Chichesten, Brisbane, Torobto. pp. 97-129, 207-215.

Gowda, P. T., Shankaraiah, C., Jnanesha, A. C., Govindappa, M. and Murthy, K. N. K. (2009b). Studies on chemical weed control in aerobic rice (*Oryza sativa L.*). *J. of Crop and Weed*. **5**(1): 321-324.

Halder, P., Maiti, S. R., Bhattacharya, T and Banerjee. H.U. (2005) Comparative efficacy of Pyrazosulfuron Ethyl (PSE) alone and its combination with Molinate against weed complex of boro paddy. Department of Agronomy. Bidhan Chandra Krishi Viswavidyalaya, Mohanpur- 741252, Nadia, West Bengal.

Hasanuzzaman, M., Ali, M. H., Alam, M. M., Akther, M. and Alam, K. F. (2008). Evaluation of Preemergence Herbicide and Hand Weeding on the Weed Control Efficiency and Performance of Transplanted Aus Rice. Am-Euras. *J. Agron.* **2**(3): 138-143.

Hasanuzzaman, M., Islam, M.O., Bapari, M.S. (2009). Efficacy of different herbicides over manual weeding in weed control in transplanted rice. *Australian J. Crop Sci.* **2**(1): 18-24.

Hasanuzzaman, M., Nahar, K. and Karim, M. R. (2007). Effectiveness of different weed control methods on the performance of transplanted rice. *Pakistan. J. Weed Sci. Res*. **13**(1-2): 17-25.

Hoque, M. M., Hossain, M. M., Khan, M. R. H., Khalequzzaman, K.M. and Karim, S. M. R. (2003). Effect of varieties of rice and weeding on weed growth and yield of transplant Aman rice. *Asian J. of Plant Sci*. **2**(13): 993-998.

Hossain, A .B. Z. and Rahman, M. A. (2013). Effect of herbicides on the growth, yield components and yield of BR 11 paddy. *J. Asiat. Soc. Banladesh. Sci*. **39**(1): 21-26.

Hossain, M. D. (2000). Autecology of *Echinochloa crus galli* and its control in direct seeded Aus rice. M.S. Thesis, Department of Agronomy. Bangladesh Agricultural University, Mymensingh, Bangladesh.

Hossain, M. H. (2015). Efficacy and residual activity of herbicide on growth and yield of transplanted aus rice. MS. thesis, Department of Agronomy. Sher-e-Bangla Agricultural University, Dhaka, Bangladesh.

Ikeda, H., Ito, S., Okada, Y., Mikata, K., Endo, M. and Komoto, I. (2011). Development of a Novel Paddy Rice Herbicide Propyrisulfuron (ZETAONE ®).*Tropic. J. Agril.* **2**: 9-13.

IRRI (International Rice Research Institute). (2006). Bringing hope, improving lives: Strategic Plan 2007-2015. Manila, Philippines. p. 61.

IRRI (International Rich Research Institute). (2001). Rice Research for Food Security and Poverty Alleviation, Yunan, China, p. 5.

Ishaya, D. B., Dadari, S. A., and Shebayan, J. A. Y. (2007). Evaluation of herbicides for weed control in three varieties of upland rice (*Oryza sativa* L.) in the Nigerian Savannah. *Crop Protection.* **26**(10): 1490–1495.

Islam, S. S., Amin, M. H. A., Parvin, S., Amanullah, A. S. M. and Ahsanullah, A. S. M. (2010). Effect of pre and post-emergence herbicides on the yield of transplant aman rice. *Bangladesh Res. Public. J*. **3**(4): 1242-1252.

Islam, S.M.M. (2014). Effect of weeding regime and integrated nutrient management on growth and yield of transplant Aman rice (cv. BRRI dhan49). M.S. Thesis, Department of Agronomy, Bangladesh Agricultural University, Mymensingh, Bangladesh.

James, T. K. and Rahman, A. (2009). Efficacy of pre-emergence herbicides on three annual grass weeds in different soils. *New Zealand Plant Protection.***53**: 356-362.

Jena, S. N., Tripathy, S., Sarangi, S. K. and Biswal, S. (2002). Integrated weed management in direct seedbed rainfed lowland rice. *Indian J. Weed Sci.* **34**(1-4): 32-35.

Jesmin, F. A. (2006). Study on the effectiveness of different herbicides in controlling weeds in boro rice. MS Thesis, Department of Agronomy. Bangladesh Agricultural University, Mymensingh. Bangladesh.

Jucai, H., Liu, H. P., Guo, P. and Hao, C. (2002). Weed control in summer-sown soybeans with flumioxazin plus acetochlor and flumiclorac-pentyl plus clethodim. *Weed Biol and Mng* **2**(2): 120-122.

Julfiqur, A. W., Haquae, M. M., Enamul Haque, A. K. Z. G. M. and Rashid, M. A. (1998). Current status of Hybrid Rice Research and Future Programme in Bangladesh. A country report presented in the workshop on use and development of hybrid rice in Bangladesh. May 18-19. BARC, Dhaka, Bangladesh.

Juraimi, A. S., Uddin, M. K., Anwar, M. P., Mohamed, M. T. M., Ismail M. R. and Man, A. (2011). Sustainable weed management in direct seeded rice culture: A review. *Australian J. Crop Sci.* **7**(7): 989-1002.

Jurasik, M., Kocarek, M., Hamouzova, K., Soukup, J. and Venclova, V. (2013). Effect of precipitation on the dissipation, efficacy and selectivity of three chloroacetamide herbicides in sunflower. *Plant Soil Environ.* **59**(4): 175-182.

Kabir, M. H., Bari, M. N., Haque, M. M., Ahmed, G. J. U. and Islam, A. J. M. S. (2008). Effect of water management and weed control treatments on the performance of transplanted aman rice. *Bangladesh J. Agril. Res.* **33**(3): 399-408.

Kaes, I. (2015). Evaluation of herbicidal efficacy and residual activity on .derect seeded boro rice. MS thesis, Department. of Agronomy. Sher-e-Bangla Agricultural University, Dhaka, Bangladesh.

Khaliq, A., Matloob, A., Ahmad, N., Rasul, F. and Awan, I. U. (2012).Post emergence chemical weed control in direct seeded fine rice. *J. Animal & Plant Sci.* **22**(4): 1101-1106.

Khaliq, H., Abdul, H. S., Matloob. M. A., and Amar. H. (2011). Germination and Growth Response of Rice an Weeds to Herbicides under Aerobic Conditions. *Intl. J. Agril. & Bio.* **14**(5): 95-100.

Khan, K. Z. (2013). Influence of plant spacing and weeding regime on the performance of transplant Aman rice cv. BINA Dhan 7. M.S. Thesis, Department of Agronomy, Bangladesh Agricultural University, Mymensingh. Bangladesh.

Kumaran, S. T., Kathiresan, G., MuraliArthanari, P., Chinnusamy, C. and Sanjivkumar, V. (2015). Efficacy of new herbicide (bispyribac sodium 10% SC) against different weed flora, nutrient uptake in rice and their residual effects on succeeding crop of green gram under zero tillage. *J. of App. and Nat. Sci*. **7** (1): 279-285.

Kurmi, S. and Das, N. (1993). Effect of herbicides on weed control in transplanted rice. Integrated weed management for sustainable agriculture. Proceedings of an Ind. Soc. of India. Vol. **III**. pp. 27-29.

Madhu, M., Najappa, H. V. and Naik, H. R. (1996). Economics of weed control treatment in puddled seeded rice. *Crop Res*. **12**(2): 133-137.

Madhukumar, V., Kalyana, M. K. N., Prashanth, R., Basavarai, K. and Dinesha, M. S. (2003). Relative efficacy of different herbicides for weed control in aerobic rice (*Oryza sativa* L.). *Int. J. Sci . & Nature.* **4**(3): 473-477.

Madhukumar, V., Murthy, K. K. N., Sanjav, M. T. and Prashanth, R. (2013). Efficacy of pre and post emergent herbicides on growth and yield of kharif aerobic rice. *Intl .J.Advan.Biol.Res*. **3**(3): 360-363.

Mahadi, M. A., Dadari, S. A., Mahmud, M. and Babaji, B. A.(2006). Effect of hand weeding and pre-emergence herbicides on yield and yield component of rice. *Indian J. Food Agric. Environ.* **4**(2): 164-167.

Mahajan, G. and Chauhan, B. S. (2013). Herbicide Options for Weed Control in Dry- Seeded Aromatic Rice in India. *Weed Tech.* **27**: 682–689.

Mallikarjun, A. S. C., Sudheendra, S., and Shrinivas, C. S. (2014). Effect of Herbicides on Weed Control and Yield of Wet Seeded Rice (*Oryza sativa* L.). *Intl. J. Sci*. **9**(2): 581-583.

Mamun, A. A. (1990a). Agro-ecological studies of weeds and weed control in flood prone village of Bangladesh. JSARD pub. No. 17. JICA (Japan Intl. Co-op. Agency). Dhaka, Bangladesh. pp. 28-29, 129 and 165.

Mamun, A. A., Karim, S. M. R., Begum, M., Uddin, M. I. and Rahman, M. A. (1993). Weed survey in different crops under three agro-ecological zones of Bangladesh. *BAURES Prog*. **8**: 41-51.

Mamun, M.A.A., Shultana, R., Bhuiyan, M.K.A., Mridha, A.J. and Mazid, A. (2011). Economic weed management options in winter rice. *Pakistan J. Weed sci. Res.* **17**(4): 323-331.

Mamun, M.A.A., Shultana, R., Islam, S. A., Badshah, M. A., Bhuiyan, M. K. A. and Mridha, A. J. (2011). Bio-efficacy of bensulfuron methyl + pretilachlor 6.6% GR against weed suppression in transplanted rice. *Bangladesh J. Weed Sci.* **1**(1): 8-11.

Meier, J. R., Smith, K. L., Scott, R. C. and Norsworthy, J. K., (2011). Propanil Plus Thiobencarb Combinations with Imazethapyr for Improved Red Rice (*Oryza rufipogon*) and Barnyardgrass (*Echinochloa crus-galli*) Control in Imidazolinon toler Tropic. ET subtropic. **38**(3): 99-104.

Miah, M. N. H., Karim, M. A., Rahman, M. S. and Islam, M. S. (1990). Performances of Nigersail mutants under different row spacing. *Bangladesh J. Weed. Sci.* **25**(2): 166-172.

Mian, A.L. and Gaffer, M.A. (1968).Tokgranular as a weedicide in transplant *aman* rice in East Pakistan. *Pakistan J. Sci. Res*. **20**(3): 119-124.

Mian, M. A. K., Matin, M. A. and Hossain, M. A. (2007). Occurrence of weed species in transplanted *aman* rice field as affected by cultivar. *Bangladesh J. Bot.* **36**(1): 89-92.

Mitra, B. K., Karim, A. J. M. S., Haque, M. M., Ahmed, G. J. U. and Bari, M. N. (2005). Effect of weed management practices on transplanted *aman* rice. *J. Agron.* **4**(3): 238-241.

Mondal, I. and Nandal, D.P. (1995). Efficacy of Rilof and Rifit herbicide in comparison to hand weeding in BR11 variety of aman rice. *Haryana Agril. Univ. J. Res.* **24**(4): 154-157.

Mondal, M. R. I. (2013). Souvenir: Agronomic Research for Enhancing Sustainable Crop Production. Key note paper presented at the 12th conference on "Agronomic Research for Enhancing Sustainable Crop Production" organized by Bangladesh Society of Agronomy at Bangladesh Agricultural Research Council (BARC) Conference Centre, Farmgate, Dhaka on 20 September. P.13.

Mondal, M. R. I. and Choudhury, D. A. (2014). Souvenir: Agronomic Visions for sustainable food security. Key note paper presented at the 13th conference on "Agronomic Visions for sustainable food security" organized by Bangladesh Society of Agronomy at Bangladesh Rice Research Institute (BRRI) Conference Centre, Joydebpur, Dhaka on 20 September. P. 26.

Moody, K. and De Detta, S. K. (1998). Integrated Control of weeds in rice. Paper presented at the 7th session of FAO panel of Expert on Integrated

pest control and Resistance Breeding, April, 1997, Rome, Italy. pp. 21-28.

Moonmoon, J. F. (2015). Evaluation of herbicidal efficacy and residual activity on transplanted aromatic boro rice. MS. thesis, Departt of Agronomy. Sher-e-Bangla Agricultural University, Dhaka, Bangladesh.

Mukherjee, P. K. and Malty, S.K. (2007). Weed control in transplanted and wet seeded rainy season rice (*Oryza sativa*). *Indian J. Agric. Sci*. **81**(2): 134-139.

Nath, C. P., Saha, M., Pandey, Das, P. C., Meena, R. K. and Paul, T. (2014). Bio efficacy evaluation of different herbicides on weed population, grain yield and nutrient uptake in direct seeded puddled rice (*Oryza sativa* L.). *Ann. Agric. Res.* **35**(2): 217-223.

Parvez, M.S., Salam, M.A., Kato-Noguchi H., and Mahfuza, B. (2013). Effect of cultivar and weeding regime on the performance of transplant aman rice. *Intl. J. Agri. Crop Sci.* **6** (11): 654-666.

Patil, S.J., Nataraju, S.P. and Pahaushe hi, H.V. (1986). Herbicides for weed control in transplanted rice. *Intl. Rice Res. Newsl.* **11**(2): 28.

Phuhong, L. T., Denich, M., Vlek, P. L. G. and Balasubramanian, V. (2005). Suppressing weeds in direct seeded lowland rice: effects of methods and rates of seeding. *J. Agron. Crop Sci.* **191**: 185-194.

Poornima, Y. P. I., Elizabeth, K. S., Thomas, G. and Samuel, M. (2015). Studies on harvest time residue of Pyrazosulfuron ethyl, a new generation Herbicide, in transplanted rice in the Entisols of vellayani, south kerala. *Intl. J. Agric. Sc & Vet. Med.* **3**(3) : 48-54.

Rafiqudduallа, M. (1999). Effect of weeding regimes and time of harvesting on the yield and quality of fine rice cv. Kalizira. M.S. Thesis, Department of Agronomy, BAU, Mymensingh.

Rahamdad, K. and Khan, M. A. (2012). Weed Control Efficiency of Bioherbicides and Their Impact on Grain Yield of Wheat (*Triticum aestivum* L.). *European J. App. Sci*. **4** (5): 216-219.

Rahman, A. B. M. Z., Islam, M. A., Haque, M. A. and Karim, S.M.R. (2007). Economic study on use of different level of herbicide and hand weeding methods in controlling weeds in transplant Aman rice (*Oryza sativa* L.). *J. Socioecon. Res. Dev*. **3**(1): 66-73.

Ramesha, Y. M., Ajayakumar, M. Y., Manjunatha, B., Krishna, M. D. and Roopashree, D. H. (2015). Bio-Efficacy of Pyrazosulfuron Ethyl 10% Wp against Weeds in Transplanted Rice. *Acta Sci. Intl. J. Agric*. **1**(1): 6-11.

Ranasinghe, L. L. (2003). Evaluation of factors responsible for low efficacy of farmer's weeds management practices in rice cultivation. *Ann. Sri Lanka Dep. Agril***. 5**: 199-205.

Rao, A. N. (1985). Weed vegetation analysis.Lecture presented to participants attending the Weed Science Workshop, July-September, IRRI,Los Bonos,Phillippines.

Ronald, E. T., and Nilda, R. B. (2007). History and management of herbicide resistant Barnyardgrass (*Echinochloa Crussgali*) in Arkansas Rice. *Weed Tech.* **21**(2): 324-331.

Russell, D. F. (1986). MSTAT-C Pakage Programme. Crop and Soil Science Department, Michigan Univ, USA.

Saha, S. (2003). Efficiency of certain new herbicides formulation in transplanted rice under rainfed shallow lowland. *Indian J. Weed Sci*. **37** (1/2): 109-110.

Saha, S. (2005). Efficiency of certain new herbicides formulation in transplanted rice under rainfed shallow lowland. *Indian J. Weed Sci*. **37** (1/2): 109-110.

Saha, S., Moorthy, B.T.S and BeuraJayasree. (2003). Evaluation of certain new herbicides formulatios in direct seeded rice on puddle soil. In: Proceedings of Biennial Conference of Indian Society of Weed Science. 12-14 March, Pantnagar. pp. 71.

Sanjoy, S., Moorthy, B.T.S. and Jha, K.P. (1999). Influence of different productionfactors on the performance of rainfed upland rice. *Indian J. Agril. Sci*. **69**(6): 449-450.

Sawant, A. C. and Jadhav, S. N. (1985). Efficiency of different herbicides for weed control in transplanted rice in Konkan. Indian J. Weed Sci. **17**(3): 35-39.

Selvam, V., Boopathi, S. N. M. R., Ali, N., Poonguzhalan, R. and Narayan, A. (2001). Effect of time of sowing and weed management practices in some dry rice. *Madras Agril. J*. **88**(1-3): 12-16.

Shamim, M., Bhuiya, M. S. U., and Islam, N. (2008). Effect of time of herbicide application on weed and yield of boro rice cv. BRRI dhan29. *J. Agrofor. Environ.* **2**(2): 187-192.

Sharmin, T. (2014). Effect of different weed control methods on the yield of transplanted Aman rice varieties MS. Thesis (Abstract), Sher-e-Bangla Agricultural University, Dhaka, Bangladesh.

Shultana, R., Mamun, M. A. A., Rezvi, S. A. and Zahan, M. S. (2011). Performance of some pre emergence herbicides against weeds in winter rice. *Pakistan J. Weed Sci. Res.* **17**(4): 365-372.

Singh, G. and Singh, R. (1998). Evaluation of acetochlor for weed control in transplant rice and its residual effect on succeeding crop of wheat. G.B.

Plant University of Agriculture and Technology, Patnagar. Unpublished leaflet. pp. 1-8.

Singh, G., Singh, R.K., Singh, V.P., Nayak, R. and Singh, R.S.(1999). Weed management in transplanted rice (*Oryza sativa*) under rainfed, low and situation. *Indian J. Agron*. **44**(4): 7.

Singh, S.P. and Kumar, R.M. (1999). Efficacy of single and sequential application of herbicides on weed control in transplanted rice. *Indian J. Weed Sci*. **13**(3-4): 222-224.

Singh, S.P., Ladha, J.K., Gupta. R.K., and Kumar, R.M. (2014). Evaluation herbicide performance of transplanted rice under pre-emergence herbicides and hand weeding techniques. *Indian J. Weed Sci*. **13**(4): 22-27.

Singh, V.P., Govendra, S., Singh, R.K., Singh, S.P., Abneils, K., Dhyani, V.C., Kumar, M. and Sharma, G. (2006). Effect of herbicides alone in combination on direct seeded rice. *Indian J. Weed Sci*. **37**(3/4): 197-201

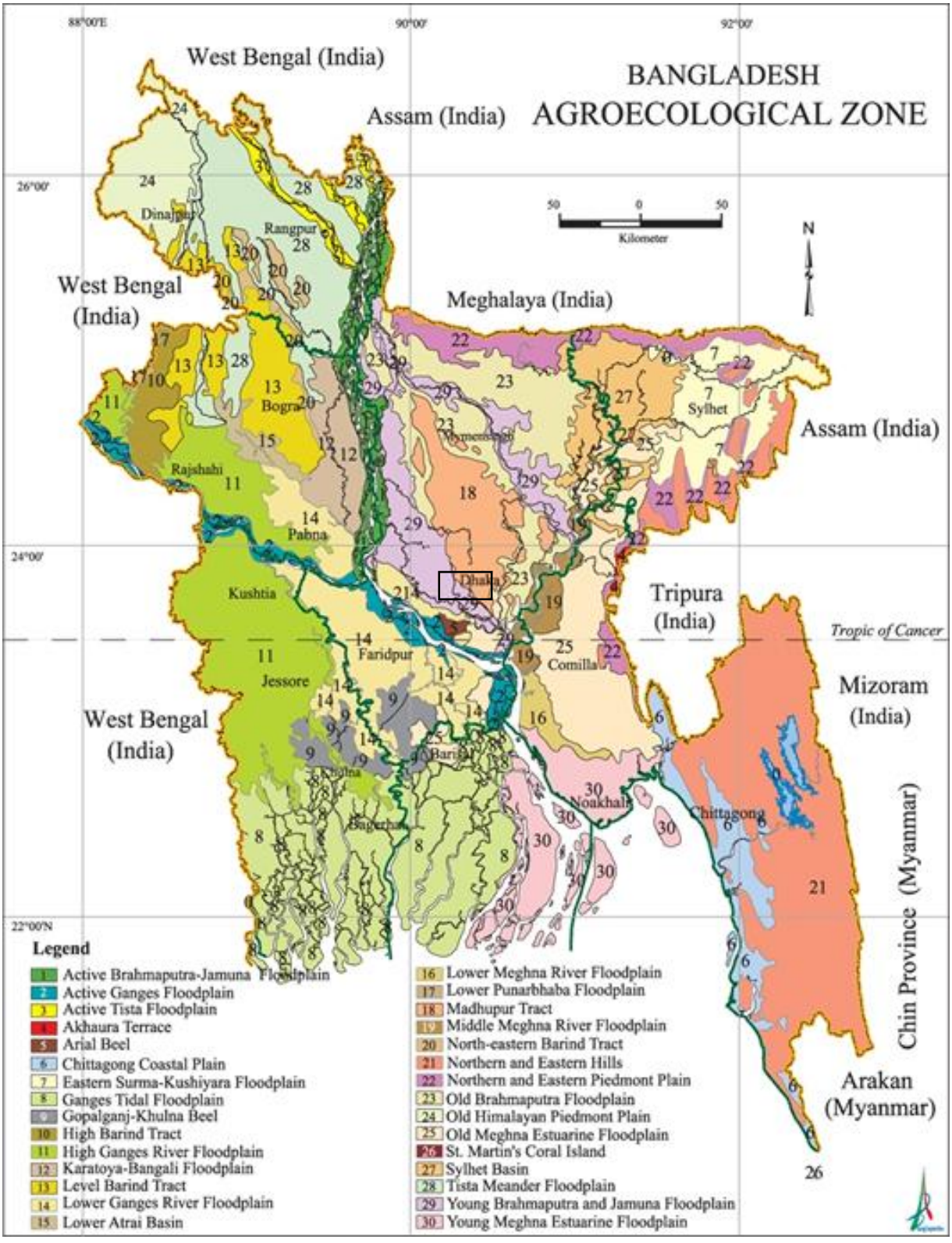
Tamilselvan, N. and Budhar, M.N. (2001). Weed control in direct seeded puddled rice. *Madras Agril. J*. **88**(10-12): 745-746.

Yadav, D. B., Yadav, A. and Punia, S. S. (2009). Evaluation of bispyribac sodium for weed control in transplanted rice. Indian J. of Weed Sci. **41** (1 & 2): 23-27.

Zannat, S. T. (2014). Effect of weeding regim and nitrogen management from prilled urea and USG on the performance of aromatic rice. M.S. Thesis. Department of Agronomy, Bangladesh Agricultural University, Mymensingh. Bangladesh. p. 25.

APPENDICES

Appendix I: Map showing the experimental site under study



Appendix IIa. Monthly record of air temperature, relative humidity and rainfall of the experimental site during the period of April to August, 2015

Month	Air temperature (^{0}C)		Relative humidity (%)		Rainfall (mm) (total)
	Maximum	Minimum	Maximum	Minimum	
April, 2015	39.10	20.00	81.00	38.90	68.60
May, 2015	37.90	19.50	88.90	40.80	205.00
June, 2015	37.70	18.00	88.40	46.80	280.50
July, 2015	35.90	18.40	88.60	56.40	110.00
August, 2015	33.00	22.20	76.00	67.00	104.50

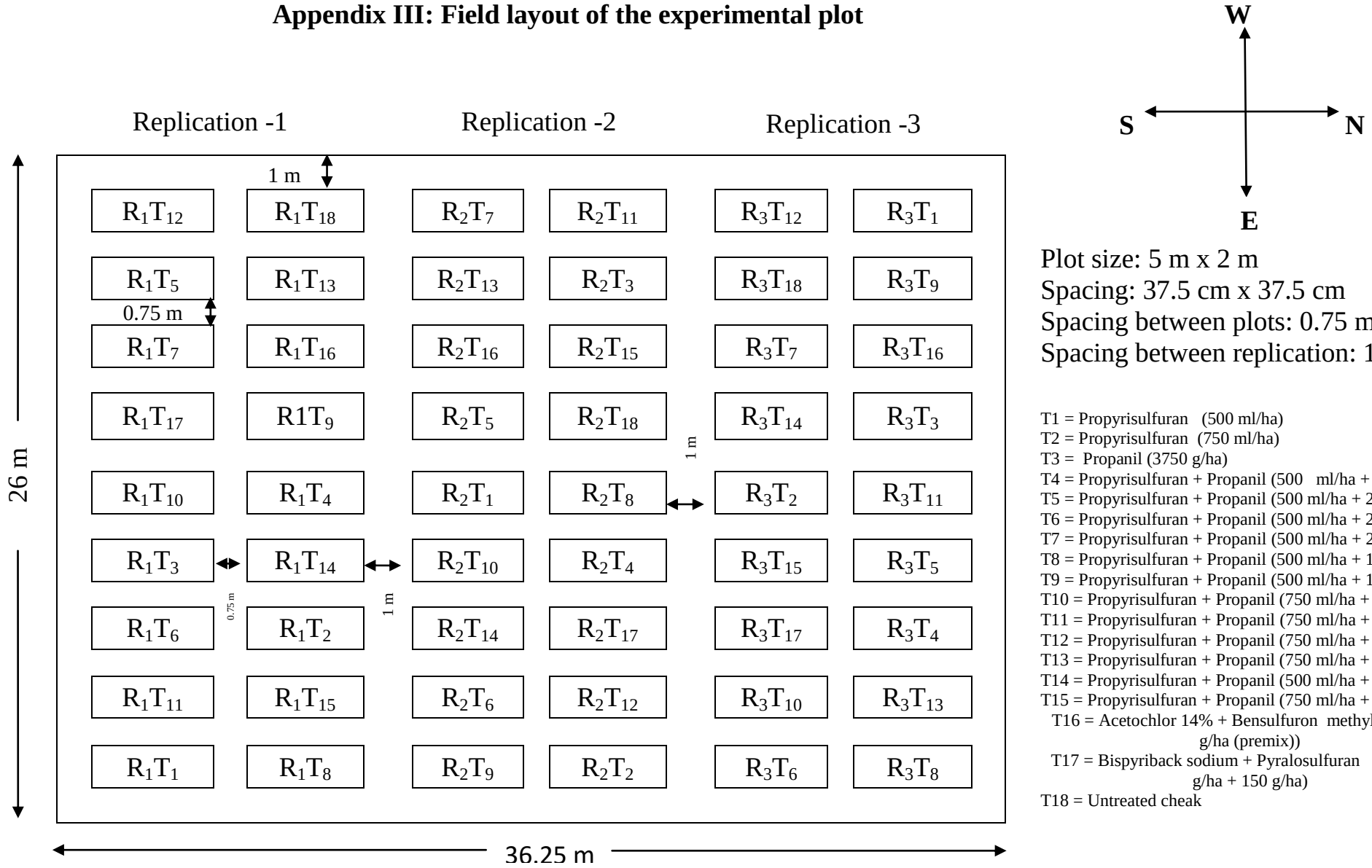
Source: Sher-e-Bangla Agricultural University mini weather station.

Appendix IIb: Physical and chemical properties of soil of experimental field analyzed at Soil Resources Development Institute (SRDI), Farmgate, Dhaka.

Characteristics	***Value***
Partical size analysis	
% Sand	27.78
%Silt	42.40
% Clay	29.82
Textural class	Silty-clay
pH	5.6
Organic carbon (%)	0.50
Organic matter (%)	0.75
Total N (%)	0.03
Available P (ppm)	20.80
Exchangeable K (me/100 g soil)	0.10
Available S (ppm)	40

Source: SRDI (Soil Resources Development Institute), Farmgate, Dhaka

Appendix III: Field layout of the experimental plot



Plot size: 5 m x 2 m
Spacing: 37.5 cm x 37.5 cm
Spacing between plots: 0.75 m
Spacing between replication: 1 m

T1 = Propyrisulfuran (500 ml/ha)
T2 = Propyrisulfuran (750 ml/ha)
T3 = Propanil (3750 g/ha)
T4 = Propyrisulfuran + Propanil (500 ml/ha + 3750g /ha)
T5 = Propyrisulfuran + Propanil (500 ml/ha + 2916.7g/ha)
T6 = Propyrisulfuran + Propanil (500 ml/ha + 2500 g/ha)
T7 = Propyrisulfuran + Propanil (500 ml/ha + 2083.3 g/ha)
T8 = Propyrisulfuran + Propanil (500 ml/ha + 1666.7 g/ha)
T9 = Propyrisulfuran + Propanil (500 ml/ha + 1250 g/ha)
T10 = Propyrisulfuran + Propanil (750 ml/ha + 3750 g/ha)
T11 = Propyrisulfuran + Propanil (750 ml/ha + 3125 g/ha)
T12 = Propyrisulfuran + Propanil (750 ml/ha + 2500 g/ha)
T13 = Propyrisulfuran + Propanil (750 ml/ha + 1875 g/ha)
T14 = Propyrisulfuran + Propanil (500 ml/ha + 900g/ha)
T15 = Propyrisulfuran + Propanil (750 ml/ha + 900 g/ha)
T16 = Acetochlor 14% + Bensulfuron methyl 4% (2000 g/ha (premix))
T17 = Bispyriback sodium + Pyralosulfuran ethyl(150 g/ha + 150 g/ha)
T18 = Untreated cheak

Appendix IV. Analysis of variance of the data on number of specific weeds on rice field in T_1 treatment

Source of variation	df	Mean square of number of specific weeds at different days						
		3 DBA	3 DAA	7 DAA	14 DAA	21 DAA	28 DAA	45 DAA
Replication	2	1.171	2.082	2.626	0.020	0.011	0.002	0.002
Factor A (Different weed species)	21	6135.01*	7471.88*	5306.14*	15.33*	4.87*	4.46*	6.71*
Error	42	0.923	1.919	2.465	0.006	0.002	0.002	0.001

*Significant at 5% level of significance, ^{NS} Non significant

Appendix V. Analysis of variance of the data on number of specific weeds on rice field in T_2 treatment

Source of variation	df	Mean square of number of specific weeds at different days						
		3 DBA	3 DAA	7 DAA	14 DAA	21 DAA	28 DAA	45 DAA
Replication	2	0.374	0.56	0.313	0.015	0.003	0.002	0.006
Factor A (Different weed species)	21	2795.62*	2313.80*	1026.11*	21.80*	16.72*	16.57*	9.22*
Error	42	0.442	0.47	0.295	0.010	0.003	0.003	0.004

*Significant at 5% level of significance, ^{NS} Non significant

AppendixVI. Analysis of variance of the data on number of specific weeds on rice field in T_3 treatment

Source of variation	df	Mean square of number of specific weeds at different days						
		3 DBA	3 DAA	7 DAA	14 DAA	21 DAA	28 DAA	45 DAA
Replication	2	1.48	0.685	0.760	0.007	0.006	0.001	0.00
Factor A (Different weed species)	21	3693.84*	3099.50*	2059.87*	7.43*	7.21*	6.04*	7.14*
Error	42	1.27	0.545	0.590	0.003	0.003	0.003	0.002

*Significant at 5% level of significance, ^{NS} Non significant

Appendix VII. Analysis of variance of the data on number of specific weeds on rice field in T_4 treatment

Source of variation	df	Mean square of number of specific weeds at different days						
		3 DBA	3 DAA	7 DAA	14 DAA	21 DAA	28 DAA	45 DAA
Replication	2	1.255	0.931	0.715	0.001	0.004	0.001	0.009
Factor A (Different weed species)	21	3963.94*	3037.64*	1815.37*	31.85*	5.32*	19.61*	0.03*
Error	42	1.533	0.929	0.592	0.01	0.002	0.004	0.002

*Significant at 5% level of significance, ^{NS} Non significant

AppendixVIII. Analysis of variance of the data on number of specific weeds on rice field in T_5 treatment

Source of variation	df	Mean square of number of specific weeds at different days						
		3 DBA	3 DAA	7 DAA	14 DAA	21 DAA	28 DAA	45 DAA
Replication	2	1.353	1.825	1.538	0.016	0.007	0.005	0.002
Factor A (Different weed species)	21	4525.82*	9346.08*	5277.63*	40.81*	18.40*	14.98*	11.37*
Error	42	1.989	2.034	1.477	0.014	0.005	0.004	0.005

*Significant at 5% level of significance, ^{NS} Non significant

Appendix IX. Analysis of variance of the data on number of specific weeds on rice field in T_6 treatment

Source of variation	df	Mean square of number of specific weeds at different days						
		3 DBA	3 DAA	7 DAA	14 DAA	21 DAA	28 DAA	45 DAA
Replication	2	1.465	0.964	0.563	0.001	0.017	0.004	0.005
Factor A (Different weed species)	21	4393.37*	2173.39*	1164.93*	17.55*	6.67*	7.45*	5.63*
Error	42	1.190	0.737	0.374	0.007	0.002	0.003	0.002

*Significant at 5% level of significance, ^{NS} Non significant

Appendix X. Analysis of variance of the data on number of specific weeds on rice field in T_7 treatment

Source of variation	df	Mean square of number of specific weeds at different days						
		3 DBA	3 DAA	7 DAA	14 DAA	21 DAA	28 DAA	45 DAA
Replication	2	1.307	1.607	0.368	0.051	0.004	0.001	0.001
Factor A (Different weed species)	21	4442.36*	3917.51*	2514.15*	92.21*	16.36*	8.35*	2.73*
Error	42	1.007	1.564	0.387	0.035	0.006	0.003	0.001

*Significant at 5% level of significance, ^{NS} Non significant

Appendix XI. Analysis of variance of the data on number of specific weeds on rice field in T_8 treatment

Source of variation	df	Mean square of number of specific weeds at different days after application						
		3 DBA	3 DAA	7 DAA	14 DAA	21 DAA	28 DAA	45 DAA
Replication	2	2.302	1.945	1.687	0.038	0.001	0.013	0.003
Factor A (Different weed species)	21	11027.01*	8153.96*	3500.35*	42.02*	22.15*	16.99*	4.49*
Error	42	2.579	1.961	1.655	0.020	0.006	0.006	0.002

*Significant at 5% level of significance, ^{NS} Non significant

Appendix XII. Analysis of variance of the data on number of specific weeds on rice field in T_9 treatment

Source of variation	df	Mean square of number of specific weeds at different days						
		3 DBA	3 DAA	7 DAA	14 DAA	21 DAA	28 DAA	45 DAA
Replication	2	4.605	3.463	3.775	0.013	0.002	0.003	0.001
Factor A (Different weed species)	21	15486.34*	15597.70*	12038.77*	25.35*	12.57*	12.25*	6.62*
Error	42	4.945	3.764	4.227	0.008	0.005	0.005	0.002

*Significant at 5% level of significance, ^{NS} Non significant

Appendix XIII. Analysis of variance of the data on number of specific weeds on rice field in T_{10} treatment

Source of variation	df	Mean square of number of specific weeds at different days						
		3 DBA	3 DAA	7 DAA	14 DAA	21 DAA	28 DAA	45 DAA
Replication	2	1.134	1.898	0.839	0.019	0.019	0.002	0.001
Factor A (Different weed species)	21	3811.54*	4070.34*	2911.28*	38.62*	15.67*	13.42*	15.07*
Error	42	1.492	1.968	0.871	0.015	0.004	0.005	0.006

*Significant at 5% level of significance, ^{NS} Non significant

Appendix XIV. Analysis of variance of the data on number of specific weeds on rice field in T_{11} treatment

Source of variation	df	Mean square of number of specific weeds at different days after application						
		3 DBA	3 DAA	7 DAA	14 DAA	21 DAA	28 DAA	45 DAA
Replication	2	1.744	1.220	1.143	0.001	0.017	0.001	0.003
Factor A (Different weed species)	21	6154.15*	6323.64*	3881.30*	20.12*	21.76*	6.02*	7.23*
Error	42	1.367	1.251	1.141	0.005	0.007	0.002	0.003

*Significant at 5% level of significance, ^{NS} Non significant

Appendix XV. Analysis of variance of the data on number of specific weeds on rice field in T_{12} treatment

Source of variation	df	Mean square of number of specific weeds at different days						
		3 DBA	3 DAA	7 DAA	14 DAA	21 DAA	28 DAA	45 DAA
Replication	2	0.419	0.302	0.453	0.023	0.001	0.004	0.001
Factor A (Different weed species)	21	1534.28*	1682.44*	1406.94*	35.50*	12.00*	13.56*	8.05*
Error	42	0.319	0.326	0.477	0.017	0.003	0.003	0.003

*Significant at 5% level of significance, ^{NS} Non significant

Appendix XVI. Analysis of variance of the data on number of specific weeds on rice field in T_{13} treatment

Source of variation	df	Mean square of number of specific weeds at different days						
		3 DBA	3 DAA	7 DAA	14 DAA	21 DAA	28 DAA	45 DAA
Replication	2	1.080	1.833	0.609	0.005	0.000	0.004	0.000
Factor A (Different weed species)	21	5906.00*	6415.04*	3961.45*	17.71*	11.46*	11.03*	27.22*
Error	42	1.209	1.696	0.564	0.009	0.005	0.005	0.008

*Significant at 5% level of significance, ^{NS} Non significant

Appendix XVII. Analysis of variance of the data on number of specific weeds on rice field in T_{14} treatment

Source of variation	df	Mean square of number of specific weeds at different days						
		3 DBA	3 DAA	7 DAA	14 DAA	21 DAA	28 DAA	45 DAA
Replication	2	27.224	0.919	0.491	0.132	0.057	0.023	0.003
Factor A (Different weed species)	21	6154.15*	4548.62*	1817.27*	139.00*	57.69*	43.36*	14.33*
Error	42	0.925	0.741	0.476	0.059	0.027	0.021	0.006

*Significant at 5% level of significance, ^{NS} Non significant

Appendix XVIII. Analysis of variance of the data on number of specific weeds on rice field in T_{15} treatment

Source of variation	df	Mean square of number of specific weeds at different days						
		3 DBA	3 DAA	7 DAA	14 DAA	21 DAA	28 DAA	45 DAA
Replication	2	2.163	0.862	0.612	0.042	0.041	0.029	0.009
Factor A (Different weed species)	21	6387.76*	3165.86*	1721.89*	178.96*	84.75*	40.82*	9.99*
Error	42	2.109	0.913	0.548	0.058	0.025	0.015	0.003

*Significant at 5% level of significance, ^{NS} Non significant

Appendix XIX. Analysis of variance of the data on number of specific weeds on rice field in T_{16} treatment

Source of variation	df	Mean square of number of specific weeds at different days						
		3 DBA	3 DAA	7 DAA	14 DAA	21 DAA	28 DAA	45 DAA
Replication	2	1.458	0.696	0.728	0.003	0.015	0.002	0.005
Factor A (Different weed species)	21	6231.54*	2606.29*	3499.23*	67.26*	25.76*	12.56*	16.09*
Error	42	1.127	0.480	0.800	0.023	0.008	0.004	0.007

*Significant at 5% level of significance, ^{NS} Non significant

Appendix XX. Analysis of variance of the data on number of specific weeds on rice field in T_{17} treatment

Source of variation	df	Mean square of number of specific weeds at different days						
		3 DBA	3 DAA	7 DAA	14 DAA	21 DAA	28 DAA	45 DAA
Replication	2	1.428	1.495	3.576	0.104	0.029	0.010	0.017
Factor A (Different weed species)	21	10091.76*	9429.80*	7462.46*	343.92*	132.02*	53.10*	23.54*
Error	42	1.525	1.697	3.408	0.130	0.051	0.029	0.011

*Significant at 5% level of significance, ^{NS} Non significant

Appendix XXI. Analysis of variance of the data on number of specific weeds on rice field in T_{18} treatment

Source of variation	df	Mean square of number of specific weeds at different days after application						
		3 DBA	3 DAA	7 DAA	14 DAA	21 DAA	28 DAA	45 DAA
Replication	2	1.291	1.219	7.571	2.080	6.854	6.655	1.836
Factor A (Different weed species)	21	9724.52*	8740.43*	12959.83*	7460.69*	11776.91*	11991.18*	8315.68*
Error	42	1.532	1.644	4.965	2.076	4.976	4.152	2.873

*Significant at 5% level of significance, ^{NS} Non significant

Appendix XXII. Analysis of variance (mean square) of the data for weed population (No. m^{-2}) after 28 days of spray

Source of variation	df	*Marsilea quadrifolia*	*Cyperus diformis*	*Cyperus esculentus*	*Cynodon dactylon*	*Echi. crusgalli*	*Echi. colona*	*Eclipta alba*	*Alternanthera philoxeroides*	*Alternan. sessilis*	*Monochoria vaginalis*	*Ludwigia sp.*
Replication	2	2.688	2.164	0.099	0.036	0.062	0.00	0.00	0.002	0.001	0.001	0.004
Herbicides	17	8348.28*	7159.07*	210.92*	41.56*	66.30*	0.60*	0.67*	1.73*	0.39*	3.93*	3.45*
Error	34	3.340	1.841	0.075	0.023	0.043	0.00	0.00	0.001	0.00	0.001	0.001

Source of variation	*Sagittaria guyanensis*	*Leersia hexandra*	*Spilanthes acmella*	*Vallisneria spiralis*	*Fimbristylis miliacea*	*Leptocloa sp.*	*Cyperus irria*	*Commelina benghalensis*	*Sphenoclea zhilanica*	*Hedyotis corymbosa*
Replication	0.012	0.003	0.00	0.00	0.00	0.070	0.00	0.00	0.001	0.00
Herbicides	17.27*	2.27*	0.91*	0.07*	0.31*	30.26*	0.11*	0.07*	7.19*	0.05*
Error	0.004	0.001	0.00	0.00	0.00	0.033	0.00	0.00	0.002	0.00

*Significant at 5% level of significance, ^{NS} Non significant

Appendix XXIII. Analysis of variance of the data on number of total weed species on rice field at different days

Source of variation	df	Mean square of number of Total weeds at different days						
		3 DBA	3 DAA	7 DAA	14 DAA	21 DAA	28 DAA	45 DAA
Replication	2	73.853	393.550	538.862	15.631	22.297	143.227	78.713
Herbicides	17	9247.26*	16107.34*	23714.62*	38809.56*	29278.28*	47211.97*	50809.04*
Error	34	322.780	319.811	241.303	90.666	57.025	81.007	98.212

*Significant at 5% level of significance, ^{NS} Non significant

Appendix XXIV. Analysis of variance of the data on growth characteristics of weeds in rice field

Source of variation	df	Mean square Value				
		Fresh weight of weed/m^2 at harvesting (g)	Dry weight of weed/m^2 (g)	Dry matter content of weed (%)	Weed control efficiency (%)	Importance value of weed (%)
Replication	2	17.212	9.107	0.474	40.342	0.887
Herbicides	17	4204.28*	1084.63*	218.93*	1265.82*	63.78*
Error	34	61.867	10.006	8.493	38.215	0.257

*Significant at 5% level of significance, ^{NS} Non significant

Appendix XXV. Analysis of variance of the data on growth characteristics of Plants in rice field

Source of variation	df	Mean square Value						
		Plant height at different days after transplanting (cm)			Total tiller No. hill^{-1}	No. of Effective tiller hill^{-1}	No. of ineffective tiller hill^{-1}	Tiller length (cm)
		30 DAT	60 DAT	90 DAT				
Replication	2	57.051	4.342	6.840	0.114	1.783	0.002	9.734
Herbicides	17	73.06*	10.13^{NS}	10.95^{NS}	2.61*	3.22*	1.04*	49.07^{NS}
Error	34	12.802	68.991	72.128	1.014	0.656	0.027	71.831

*Significant at 5% level of significance, ^{NS} Non significant

Appendix XXVI. Analysis of variance of the data on yield characteristics of Plants in rice field

Source of variation	df	Mean square Value				
		Panicle length (cm)	**Number of Spike panicle^{-1}**	**Number of spikelet panicle^{-1}**	**Number of filled grains panicle^{-1}**	**Number of Unfilled grains panicle^{-1}**
Replication	2	9.460	0.234	3.608	43.736	0.286
Herbicides	17	1.46*	0.63*	20.30*	217.86*	1.94*
Error	34	3.636	0.373	2.348	80.326	0.445

Source of variation	df	Mean square Value					
		Number of total grains panicle^{-1}	**Thousand (1000) grain weight (g)**	**Grain yield (t/ha)**	**Straw yield (t/ha)**	**Biological yield (t/ha)**	**Harvest index (%)**
Replication	2	78.169	1.510	0.131	0.180	1.113	58.049
Herbicides	17	225.8*	16.519*	1.148*	1.563*	5.251*	5.571*
Error	34	62.662	4.737	0.071	0.123	0.390	14.766

*Significant at 5% level of significance, ^{NS} Non significant