RESPONSE OF MUNGBEAN TO DIFFERENT WEED CONTROL METHODS

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CERTIFICATE

*This is to certify that the thesis entitled, "**RESPONSE OF MUNGBEAN TO DIFFERENT WEED CONTROL METHODS**" 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 (M.S.) in AGRONOMY**, embodies the result of a piece of bona fide research work carried out by **PAVEL KHAN PAPPU**, Registration no. **09-03493** under my supervision and guidance. No part of the 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.

Date:
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DEDICATED TO

MY BELOVED FAMILY

&

FARMERS OF BANGLADESH

WHO WORK HARD TO FEED THE NATION

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RESPONSE OF MUNGBEAN TO DIFFERENT WEED CONTROL METHODS

ABSTRACT

A field experiment was conducted at the Agronomy field of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka during the period from March 2014 to May 2014 to study efficacy of different weed control methods on growth and yield of BARI mungbean 6. There were eight treatments viz. T_1= weedy check (control), T_2= two hand weeding at 15 and 25 DAS, T_3 = Quizalofop-p-ethyl 5 EC @ 600 ml /ha at 15 and 25 DAS, T_4 = Quizalofop-p-ethyl 5 EC @ 650 ml /ha at 15 and 25 DAS, T_5 = Quizalofop-p-ethyl 5 EC @ 700 ml /ha at 15 and 25 DAS, T_6 = Quizalofop-p-ethyl 5 EC @ 600 ml /ha at 15 DAS and one hand weeding at 25 DAS, T_7 = Quizalofop-p-ethyl 5 EC @ 650 ml /ha 15 DAS and one hand weeding at 25 DAS, T_8 = Quizalofop-p-ethyl 5 EC @ 700 ml /ha at 15 DAS and one hand weeding at 25 DAS**.** The highest weed population was recorded at 25 DAS (526) and 35 DAS (878) with control treatment. The tallest plant at harvest (35.98 cm), maximum weeds control efficiency (WCE) at 25 DAS (87.94 %), 35 DAS (93.91 %); number of pod plant^{-1} (80.33), longest pod (9.52 cm), highest yield (1.53 t/ha) were obtained from (T_2) hand weeding at 15 and 25 DAS. So, two hand weeding at 15 and 25 DAS is the best treatment followed by Quizalofop-p-ethyl 5 EC @ 650 ml /ha 15 DAS + hand weeding at 25 DAS.

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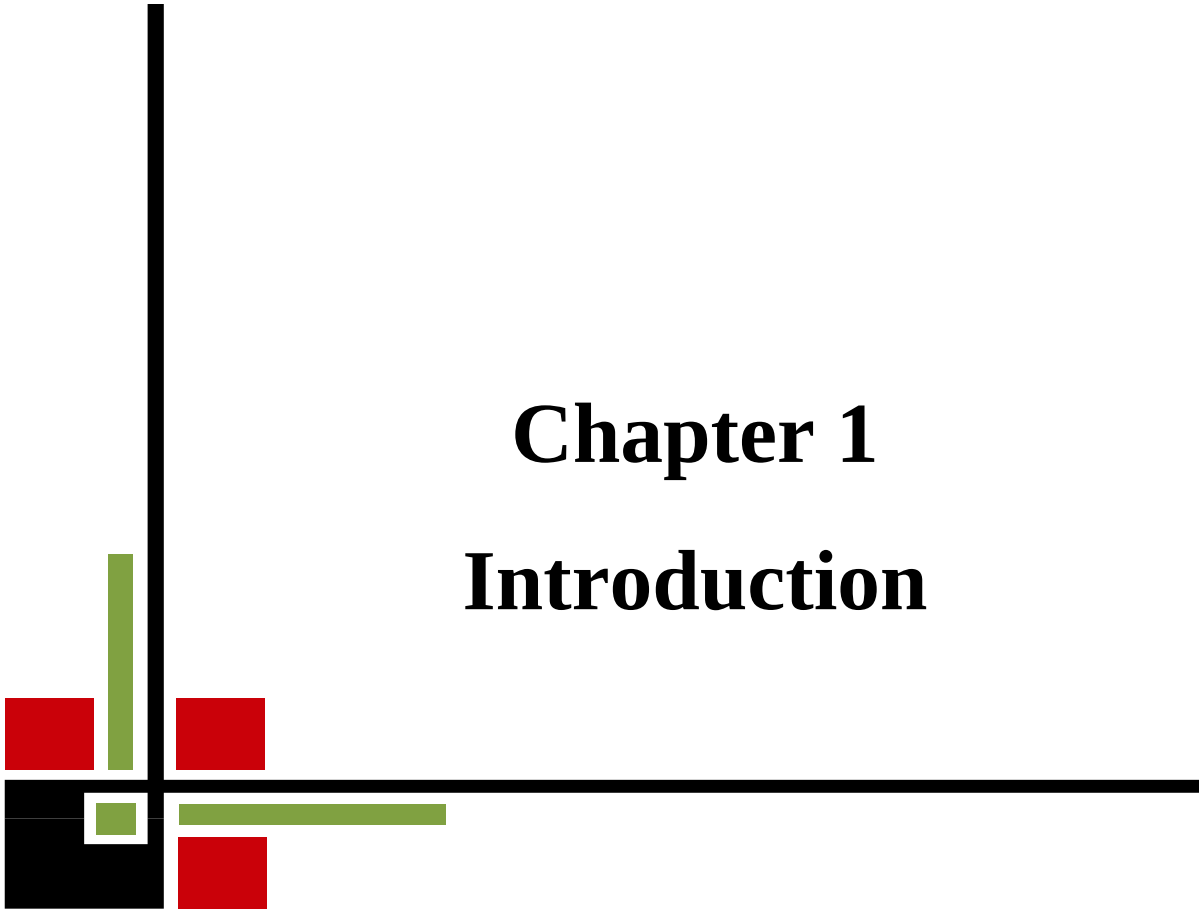
LIST OF ABBREVIATIONS

AEZ	Agro-Ecological Zone
Anon.	Anonymous
AIS	Agriculture Information Service
BARC	Bangladesh Agricultural Research Council
BAU	Bangladesh Agricultural University
BBS	Bangladesh Bureau of Statistics
BINA	Bangladesh Institute of Nuclear Agriculture
BNNC	Bangladesh National Nutrition Council
BARI	Bangladesh Agriculture Research Institute
CRRI	Central Rice Research Institute
CV %	Percent Coefficient of Variance
cv.	Cultivar (s)
DAT	Days After Transplanting
DRR	Directorate of Rice Research
eds.	Editors
et al.	et alii (and others)
etc.	et cetera (and other similar things)
FAO	Food and Agricultural Organization
IARI	Indian Agricultural Research Institute
ICAR	Indian Council of Agricultural Research
IRRI	International Rice Research Institute
L.	Linnaeus
LSD	Least Significant Difference
i.e.	id est (that is)
MoP	Muriate of Potash

SAU	Sher-e-Bangla Agricultural University
SRDI	Soil Resources and Development Institute
TDM	Total Dry Matter
TSP	Triple Super Phosphate
UNDP	United Nations Development Programme
var.	Variety
viz.	Namely



Chapter 1

Introduction

CHAPTER 1

INTRODUCTION

Mungbean is one of the most important and popular pulse crop and it ranks third position regarding area and production among the pulses of Bangladesh. Mungbean consists of 6% of annual pulse production (300000 metric tons) in Bangladesh (BBS, 2010). In Bangladesh, daily per capita consumption of pulses is only 10.96 g (BBS, 2007), while the World Health Organization (WHO) recommended 45g day^{-1} per capita for a balanced diet (BARI, 1998). So, the consumption status of pulses by our people in their daily diet is far below than the recommendation. Even to maintain the supply up to this level, the government of Bangladesh has to spend a huge amount of foreign currency every year. In the year of 2005–2006; 1, 95,000 tons of pulses were imported (BBS, 2007). So, to meet the suggested requirement of pulses of 45 g day^{-1} per capita, the production is to be increased even more than four folds (BBS, 2010).

The potential of the crop is not realized due to many factors. Pulses for long time have been grown with poor management practices resulting in poor yields. Proper seed bed and land preparation are important for adequate germination of seed, crop establishment and good yields. Moreover, weed infestation is one of the major factors lowering yield in pulses in Bangladesh. Weeds compete with main crop for space, nutrients, water, and light. It is also recognized that a low weed population can be beneficial to the crop as it provides food and habitat for a range of beneficial organisms (Bueren *et al*., 2002). Weed is an important factor responsible for low yield of crops (Islam *et al.,* 1989). Mungbean is very competitive to weed and, therefore, weed control is essential for mungbean cultivation (Moody, 1978). Yield losses due to uncontrolled weed growth in mungbean ranges from 27% to 100% (Madrid and Vega, 1971). The loss of mungbean yield due to weed infestation ranges from 65.4 % to 79.0% (Shuaib *et al*., 2001).

However, the aim of weed management should be to maintain weed population at a manageable level. Weeds above critical population thresholds can significantly reduce crop yield and quality. The weeds can be checked by adopting various methods like eco-physical, biological, chemical and recently through direct and indirect approach i.e. integrated weed management. In our country mungbean is not cultivated intensively so a considerable amount of yield loss occurs due to weed infestation. This is because of farmer's reluctance to control weed and unavailability of labors during critical weed control period.

The main objective of this experiment is to develop effective weed control method through physical, chemical or in combination of both so that farmer can effectively control weed infestation in mungbean field and can achieve higher yield at low cost. The experiment has following objectives

1. To study the yield and yield attributes of mungbean cultivated with different weed control methods.
2. To find out the best possible weed control method on the basis of weed killing efficacy in cultivating mungbean.

Chapter 2

Review of Literature

CHAPTER 2

REVIEW OF LITERATURE

The growth and development of mungbean is influenced by different weed control methods. Experimental results are available from home and abroad to reveal that weed control may improve the growth and yield of mungbean. Relevant reviews on the above aspects have been presented and discussed in this chapter.

2.1 Effect on plant morphological characters:

2.1.1 Plant height:

Akter *et al*. (2013) conducted an experiment at the agronomy field laboratory of Bangladesh Agricultural University, Mymensingh to assess the effect of weeding on growth, yield and yield contributing characters of mungbean (*Vigna radiata* L.) cv. BINA mung- 4 during October 2011 to February 2012. Plant height was significantly affected by weeding at the all sampling days (40 DAS, 50 DAS, 60 DAS and at harvest). At 40 DAS the tallest plant (25.31 cm) was obtained from T_7 where crop received three times weeding from emergence to maturity and shortest plant height (18.36 cm) was obtained from T_4 where crop received one time weeding from pod setting to maturity.

Kundu *et al*. (2009**)** observed that plant height at harvest varied significantly among various weed management practices in mungbean. The highest plant height was recorded in the treatment having quizalofop-p-ethyl @ 50 g a.i. ha^{-1} at 21 DAE + HW at 28 DAE. This was similar with treatments receiving quizalofop-pethyl @ 50 g a.i. ha^{-1} at 14 DAE + HW at 21 DAE and quizalofop-p-ethyl @ 50 g a.i. ha^{-1} at 7 DAE + HW at 14 DAE. Among the treatments, significantly lowest height of plant was observed in weedy check plot. Crop growth rate of mungbean showed similar trend as in plant height.

Khan *et al.* (2008) found that increase in plant height and number of pods plan^{-1} is inversely proportional to weeds density and dry weight and similar is the case with the number of seed pod^{-1}. Production capacity of mungbean can be determined by the number of pods plant^{-1}.

2.1.2 Plant dry matter:

The influence of weeding on dry weight plant^{-1} was found significant at 40 DAS, 50 DAS, and 60 DAS and at harvest. The highest dry weight plant^{-1} (0.79 g), (8.14 g), (12.38 g), (17.95 g) were obtained from T_7 at three times weeding (E-M) condition and the lowest amount of dry weights plant^{-1} (0.24 g), (4.13 g), (6.36 g) and (8.50 g) were obtained from the no weeding treatment at all sampling days. It was observed that increase in level of weeding increased plant dry weight and the decreased level of weeding reduced the plant dry weight. This indicates that weeding had a direct effect on dry weight of plant. Accumulation of lower dry weights for control treatment might be due to lack of internal nutrient of plant, which caused reduction in both cell division and cell elongation and reduced carbohydrate synthesis and hence the growth was reduced. Crop growth rate (CGR) varied significantly under different weeding condition. At 40-50 DAS, the highest crop growth rate (0.74) was found at T_7 where crop received three-stage weeding from emergence to maturity. The lowest CGR (0.39) was recorded from no weeding condition (T_1) and the CGR from T_2 and T_5 were found similar result. At 50-60 DAS the highest CGR (0.58) was recorded from T_2 and the lowest (0.22) from T_1. 60 DAS to at maturity the highest CGR (0.61) was recorded from T_6 and the minimum (0.21) was found from T_1 (Akter *et al*., 2013).

Total dry matter (TDM) accumulation in mungbean increased over time as influenced by different weed management methods (Khan *et al*., 2008).

Sangakkara *et al.* (1995) observed that the adverse effect of weeds was greatest on vegetative growth the study indicated vegetative phase as the critical competitive period. In a trial, Utomo (1988) noticed that the yield *Phaseolus*

radiatus cultivar PR74 was reduced from 112.11 to 51.16 g m^{-2} by continuous weed competition. The highest yield (125.84 g m^{-2}) was gained from continuous weed control initiated 1 week after sowing. Yield increases for weed control done up to 4 weeks after sowing did not differ significantly. He concluded that the critical time for weed control in this crop was up to 4 weeks after sowing. Crop biomasses and plant height were not affected by weeding.

2.2 Effect on weed attributes:

2.2.1 Weed Density:

According to Khan *et al*. (2013), weed species in number and their relative density as affected by different weed management methods at 25 and 45 DAE are presented in. It was observed that *Echinochloa crusgalli* (Shyma), *Digitaria sangunalis* (Anguli), *Cyperus rotundus* (Mutha) and *Alternanthera philoxeroides* (Maloncha) were the common weeds in mungbean field. Among the weed species, *Echinochloa crusgalli*, *Digitaria sangunalis* and *Cyperus rotundus* were the dominant weeds. Similar results were also reported by Khan *et al.* (2011). Density of grasses and sedges were significantly influenced by glyphosate spraying and tillage techniques. The highest number of grasses (318 m^{-2}) recorded from control treatment and the lowest (188 m^{-2}) from where glyphosate spraying on zero tillage conditions at 7 DBS, which was statistically similar to T_5 where two times tillage done with 7 days interval before sowing. But the highest number of sedges (128 m^{-2}) recorded from T_5, which was two times higher than control (T_7) and the lowest (34 m^{-2}) recorded in T_1. Weed density was significantly influenced by different weed management methods. The highest weed density 414 and 704 weeds m^{-2} was recorded in control plot at 25 and 45 DAE, respectively. The lowest weed density at 25 DAE recorded in T_6 (68 m^{-2}) which was followed by T_1 (216 m^{-2}). At 45 DAE the lowest weed density was also from T_6 (108 m^{-2}) but followed by T_5 (172 m^{-2}) and T_4 (220 m^{-2}).

Kundu *et al.* (2009) conducted an experiment and found that weed population in mungbean field differed significantly with the different weed management practices both at 30 and 45 days after sowing (DAS). Quizalofop-p-ethyl @ 50 g a.i. ha^{-1} at 21 DAE + HW at 28 DAE (T_8) showed the lowest population of grass, sedge and broad leaved weeds at both the stages. This was statistically at par with the treatment (quizalofop-p-ethyl @ 50 g a.i. ha^{-1} at 14 DAE + HW at 21 DAE). The weedy check treatment showed significantly highest population of grass weeds among all the treatments. However, sole herbicidal treatments were comparable with each other and at par with weedy check with respect to population of sedge and broad leaved weeds. The total weed population was significantly highest in weedy check treatment whereas, maximum reduction of total weed population was found in and T_5 treatments both at 30 and 45 DAS.

2.2.2 Effect on weed biomasses:

According to *Khan et al*. (2011), weed biomass was also significantly influenced by different weed management methods .The highest weed biomass 137.2 and 660 g m^{-2} were obtained from control plot at 25 and 45 DAE, respectively. The lowest weed biomass at 25 DAE obtained from (13.6 g m^{-2}) which was followed by (86 g m^{-2}). At 45 DAE the lowest weed biomass (35.8 g m^{-2}) obtained from treatment where Glyphosate spraying was done at minimum tillage condition before 7 days of sowing followed by hand weeding at 25 DAE, which was statistically similar to where Glyphosate spraying was done at no tillage condition before 7 days of sowing followed by hand weeding at 25 DAE. The weed control efficiency by different weed management methods ranged from 7 to 90% and 54 to 95% at 25 and 45 DAE, respectively. At 45 DAE, maximum weed control efficiency (95%) recorded in followed by treatment.

The percentage of reduction in weed dry weight per m^{-2} did not differ among Hammer (16.20 %), Topstar (17.58 %) and Paraxon (17.93 %) but Panida performed better by reducing 34.13 % dry weight over the unweeded control

treatment (BARI, 2011). Integrated approach of chemical weeding combined with hand weeding to minimize weed competition in potato field was suggested by Khan *et al.* (2008).

Chemical-weeding combined with hand-weeding was suggested (Buttar, 2004) to inhibit weeds growth more than their sole use. This is also true in case of present studies, because application of tribunal + hand-weeding checked weed growth more than hand-weeding and chemical-weeding alone. Combination of these weed control methods decreased more weed biomass suggesting that integrating the weed control strategies enhanced their weed inhibitory capability.

Nayak *et al.*, (2000) observed that weed dry matter was low in two hand hoeings and pendimethalin 1.25 kg/ha. According to Bhanumurthy and Subramanian (1989), weed dry matter is a better parameter to measure the competition than the weed number. Kundra *et al.*, (1989) recorded high weed control efficiency in two hoeings at 3 and 5 weeks after sowing. They also reported that pendimethalin at 0.5 and 0.75 kg/ha resulted in significant reduction in dry matter of weeds over the unweeded check.

A field experiment was undertaken by Kumar *et al.* (2004) during summer season under medium land situation of inceptisol at instructional farm, Bidhan Chandra Krishi Viswavidyalaya, Jaguli, Nadia, West Bengal to find out the effect of different weed management practices in mungbean .They found that dry weight of different categories of weeds significantly higher dry weight of grass weeds was recorded in weedy check treatment where as dry weight of sedge and broad leaved weeds in weedy check were at par with sole herbicidal treatments (viz. grass, sedge and broad leaf) and total weeds differed significantly among the treatments both at 30 and 45 DAS the lowest dry weight of grass, sedge and broad leaved weeds as well as of total weeds were observed in treatment (Quizalofop-p-ethyl @ 50 g a.i. ha^{-1} at 21 DAE + HW at

28 DAE). This was comparable with T_5 treatment receiving quizalofop-p-ethyl @ 50 g a.i. ha^{-1} at 14 DAE + HW at 21 DAE both at 30 and 45 DAS. Dry weight of total weeds followed the same trend as found in grass, sedge and broad leaved weeds separately. Similar result was also reported by Bedmar (1997).

2.3 Effect on yield and yield attributing parameters:

2.3.1 Number of pods per plant:

Rahman (2012) conducted an experiment, he found the highest number of pod per plant (30.80) was BINA moog-7 with weed free condition which was statistically similar with (30.67) at BINA moog-8 with weed free condition. The lowest number of pods $plant^{-1}$ (22.07) was found from the treatment combination of BINA moog-7 with no weeding condition. Similar BINA moog-7 was reported by Ahmed *et al.* (2003) and Taj *et al.* (2003).

Different weed control methods significantly affected plant height of mungbean as reported by Chattha *et al.* (2006). Number of pods per plant among the herbicidal treatments was statistically similar but unweeded control produced the least. They also observed that the number of pods per plant was significantly affected by different weed control. The number of pods per plant, seeds pod-1 as well as seed yield (1327 kg ha^{-1}) was highest in the treatment having quizalofop-p-ethyl @ 50 g a.i. ha^{-1} at 21 DAE + HW at 28 DAE. This was closely followed by the treatment with quizalofop-p-ethyl @ 50 g a.i. ha^{-1} at 14 DAE + HW at 21 DAE. Similar result was also reported by Singh *et al.*, (2001). The lowest number of pods per plant was recorded in weedy check.

2.3.2 Pod length:

Effect of interaction between variety and weeding on the pod length was statistically significant. Numerically, the highest length of pod (8.40 cm) was obtained from the treatment combination BINA moog-8 with weed free

condition which was statistically similar at BINA moog-8 with four times weeding and the lowest length of pod (5.20 cm) was obtained from the treatment combination VW BINA moog-8 with no weeding condition (Rahman, 2011). Pod length was recorded maximum in plots where treatments were *terphali* (9.9 cm) and hand weeding (9.7cm); while in plots with 45cm row spacing + tractor and 60cm + tractor, pod length was 9.2cm and 9.6 cm, respectively compared to control (9.0 cm). This might be due to weed suppression which resulted in more translocation and assimilation of photosynthates towards reproductive growth (Borras *et al.,* 2004).

2.3.3 1000 seed weight:

Yield and yield contributing characters of mungbean were significantly influenced by different weed management methods except 1000-seed weight (*Khan et al*., 2011).

Cheema and Akther (2005) found that 1000-grain weight increased with reduced weed infestation. In accordance with the result found by Borras *et al.,* (2004) thousand grain weight was also increased with reduction in weeds dry biomass and found to be maximum (55.0 g) in plots with row spacing 60 cm + tractor followed by 54.67 g in plots with spacing of 45 cm + tractor. Similarly, it was 51.67 g in case of hand weeding, 51.33 g in *terphali* driven plots and 50.67 g in case of control.

2.3.4 Yield:

About 69 % reduction in mungbean grain yield due to weeds was estimated by Yadav and Sing (2005).

According to Raman and Krishnamoorthy (2005) presence of weeds reduced the seed yield of mungbean by 35%. An experiment was conducted at PRS, BARI, Ishurdi with five herbicides viz.: Paraxon (27.6 % WV Paraquat dichloride salt), M-clor 5G (Butaclor), Topstar 40 WP (40%Oxadiargyl), Hammer 24 EC (Carfentrazone ethyl), and Panida 33 EC (Pendimethalin) with

one control (no herbicide and also no weeding) were applied in two leaf stage of mungbean as dose mentioned in treatment. Among the herbicides, Panida performed the best for reducing the number and dry weight of weeds. The maximum reduction of weed population, the highest weed control efficiency, seed yield (1222 kg ha-1), and maximum economic benefit were also obtained in the treatment receiving Panida 33 EC @ 2 ml L^{-1}.

A field experiment was undertaken by Kumar *et al*. (2004) during summer season of under medium land situation of inceptisol at Instructional Farm, Bidhan Chandra Krishi Viswavidyalaya, Jaguli, Nadia, West Bengal to find out the effect of different weed management practices in mungbean. They reported that yield attributes and seed yield Yield attributes (viz. number of pods plant-1, number of seeds pod-1) and seed yield of mungbean varied significantly with different weed management practices. The seed yield (1327 kg ha^{-1}) was highest in the treatment having quizalofop-p-ethyl @ 50 g a.i. ha^{-1} at 21 DAE + HW at 28 DAE. This was closely followed by the treatment with quizalofop-p-ethyl @ 50 g a.i. ha^{-1} at 14 DAE + HW at 21 DAE. Similar result was also reported by Singh result was also reported by Singh *et al*. (2001).

Seed yield of mungbean were significantly influenced by different weed management methods (*Khan et al*., 2011). The highest seed yield (937 kg per ha) was obtained from Glyphosate spraying on minimum (one) tillage condition at 7 DBS. The results were in agreement with the findings of Kumar *et al.* (2004). Weed competition with mungbean decreased grain yield by 81% and performance of triflualin (0.75 kg ha^{-1}), linuron (0.75 kg ha^{-1}) and acetachlor (1.0 kg ha^{-1}) each integrated with one hand- weeding at 30 DAS was superior to their alone application against weeds in mungbean (Malik *et al*., 2000).

According to Pandey and Mishra (2003) the decrease in mungbean productivity due to weed competition was 45.6%. Chemical + cultural, hand-weeding and chemical treatments significantly suppressed mungbean weeds and caused a

marked increase in grain yield. Seed yield of mungbean was maximum (2108 kg ha^{-1}) in the weed free treatment and decreased by 29.5%, 23.5% and 45.8% with 160 plants m^{-2} of *Trianthema portulacastrum*, *Echinochloa colona* and *Cyperus rotundus* , respectively (Punia *et al*., 2004). After the above discussion it may be hypothesized that integration of various weed control methods such as chemical, mechanical and hand-weeding may be more effective against weeds of mungbean instead of alone. In fact none of the weed control method is best under all conditions. So, there is a need to make a comparative study of different weed management techniques in mungbean and to develop an integrated approach, which should be cost effective and environmentally safe. Keeping these facts in view, a comprehensive study was planned to integrate different weed control methods in rain-fed mungbean crop to identify cost effective weed control methods in mungbean based cropping patterns in order to achieve sustainable rain-fed mungbean yield.

Chapter 3

Materials & Methods

CHAPTER 3

MATERIALS AND METHODS

This chapter deals with the materials and methods of the experiment with a brief description on experimental site, climate, soil, planting materials, experimental design, land preparation, fertilizer application, transplanting, irrigation and drainage, intercultural operation, data collection, data recording and their analysis. The details of investigation for achieving stated objectives are described below.

3.1 Site description

The experiment was conducted at the Sher-e-Bangla Agricultural University research farm, Dhaka, during the period from April 2015 to June 2015. The experimental site was located at 23°77′ N latitude and 90°37′ E longitudes with an altitude of 9 m.

3.2 Agro-ecological region

The experimental site belongs to the agro-ecological zone of "Madhupur Tract", AEZ-28 (Anon., 1988a). This was a region of complex relief and soils developed over the Madhupur clay, where floodplain sediments buried the dissected edges of the Madhupur Tract leaving small hillocks of red soils as 'islands' surrounded by floodplain (Anon., 1988b). For better understanding, the experimental site is shown in the AEZ Map of Bangladesh in Appendix I.

3.3 Climate and weather

The geographical location of the experimental site was under the sub-tropical climate characterized by three distinct seasons. The monsoon or rainy season extends from May to October which is associated with high temperature, high humidity and heavy rainfall; the winter or dry season exists from November to February which is associated with moderately low temperature and the pre-monsoon period and hot season continuously from March to April which is

associated with some rainfall and occasional gusty winds. Information regarding monthly maximum and minimum temperature, rainfall, relative humidity and sunshine during the period of study of the experimental site was collected from Bangladesh Meteorological Department, Agargaon and is presented in Appendix IV.

3.4 Soil

The experiment was carried out in a typical rice growing soil belonging to the Madhupur Tract. Top soil was silty clay in texture, red brown terrace soil type, olive–gray with common fine to medium distinct dark yellowish brown mottles. Soil pH was 5.6 and had organic carbon 0.45% (Appendix III). The land was well drained with good irrigation facilities. The experimental site was a medium high land. It was above flood level and sufficient sunshine was available during the experimental period. The morphological characters of soil of the experimental plots are as following - Soil series: Tejgaon, General soil: Non-calcareous dark grey (Appendix II). The physicochemical properties of the soil are presented in Appendix III.

3.5 Crop / Planting material:

BARI Mung-6 was used as planting materials. It was collected from Bangladesh Agricultural Research Institute, Joydebpur, Gazipur. This variety is suitable for summer season. The plant height of the variety ranges from 60-70 cm. It is resistant to *Cercospora* leaf spot and yellow mosaic diseases. Its life cycle ranges from 60-65 DAS and average yield is 1400-1600 kg ha^{-1}

3.6 Treatments under investigation:

T_1 = Weedy Check

T_2 = Two hand weeding at 15 and 35 DAS

T_3= Spraying of Quizalofop-p-ethyl 5 EC @600 ml/ha at 15 and 25 DAS

T_4= Spraying of Quizalofop-p-ethyl 5 EC @650 ml/ha at 15 and 25 DAS

T_5= Spraying of Quizalofop-p-ethyl 5 EC @700 ml/ha at 15 and 25 DAS

T_6= Spraying of Quizalofop-p-ethyl 5 EC @ 600 ml/ha at 15 DAS and on hand weeding at 25 DAS

T_7= Spraying of Quizalofop-p-ethyl 5 EC @ 650 ml/ha at 15 DAS and on hand weeding at 25 DAS

T_8= Spraying of Quizalofop-p-ethyl 5 EC @ 700 ml/ha at 15 DAS and on hand weeding at 25 DAS

3.7 Details of the experiment:

3.7.1 Experimental treatments:

Single factor experiment was conducted to evaluate the growth and yield of mungbean as influenced by different weed control methods.

3.7.2 Experimental design:

A single factor experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. The layout of the experiment was prepared for distributing the treatments. The experimental field was divided into 3 blocks. Each block was again divided into 8 plots. The total numbers of unit plots of the experiment were 24 (8 × 3). The size of the unit plot was 3 m × 2 m (6 m^2). There were 0.75 m width and 10 cm depth for drains between the blocks. Each treatment was again separated by drainage channel by 0.5 m

width and 10 cm depth. The treatments were randomly distributed to each block following the experimental design (Appendix XVI).

3.8 Growing of crops:

3.8.1 Seed collection

The seeds of BARI Mungbean 6 were collected from Bangladesh Agricultural Research Institute (BARI).

3.8.2 Land preparation:

The land was irrigated before ploughing. After having zoo condition, the land was conditioned opened first with disc plough. The first ploughing was done on 06 March, 2014 and final land ploughing was done on 08 March, 2014. The experiment field was divided and arranged according to experiment layout. The basal fertilizer dose was applied before land preparation on 08 March, 2014.

3.8.3 Fertilizer Application:

Urea, Triple Super Phosphate (TSP) and Muriate of Potash (MoP) were used as sources of nitrogen, phosphorus and potash. BARI (2005) recommended dose were applied. All the fertilizers were applied as a basal dose during final land preparation.

Nutrient	Source	Dose (kg ha^{-1})
N (Nitrogen)	Urea (46% N)	30
P (phosphorus)	TSP (20% P_2O_5)	48
K (potassium)	MoP (50% K_2O)	30

Source: BARI, (2005)

3.8.4 Seed sowing:

Seeds were sown on 09 March, 2014. The seed rate was maintained by 30 kg $ha^{1.}$ Seeds were treated with fungicide (Provex) to protect them from seed borne diseases. Seeds are placed in rows having distance of 30 cm and depth of 2-3 cm. Seed germination occurred on 12 March, 2014 and 50% seed germination was recorded on 14 March, 2014.

3.9 Intercultural operations:

3.9.1 Weeding and thinning:

Weeding was done as per treatments. Two thinning were done to maintain proper plant spacing. The first thinning was done at 8 DAS and second one was done at 15 DAS.

3.9.2 Irrigation and drainage:

Two irrigations of which were done at 10 DAS and 30 DAS. In the case of rainfall, a drainage system was maintained to drain out excess water.

3.9.3 Insect control:

The insecticide Malathion 57EC was sprayed @ 1.5 1 ha^{-1} at the time of 50% pod formation stage to control pod borer.

3.10 Determination of maturity:

The crops were frequently monitored to note any change in plant characters. The crops looked good since the initial stage and they maintained a satisfactory growth till harvest. At the time when 80% of the pods turned brown in color, the crop was assessed to attain maturity.

3.11 Harvesting and sampling

The crops were harvested from central 1.0 m^2 area of each plot for yield data on different dates as they attained maturity. Five randomly selected plants from

each plot were uprooted carefully for recording data on plant height, pods plant^{-1}, pod length and seed weight plant^{-1}.

3.12 Threshing

The crop bundles were sundried for two days by placing them on threshing floor. Seeds were separated from the plants by beating the bundles with bamboo sticks.

3.13 Drying, cleaning and weighing:

The collected seeds were dried in the sun for reducing the moisture. The dried seeds and stover were cleaned and weight of seeds plot^{-1} was recorded.

3.14 Recording of data

Data were recorded on the following characters

i. Plant height (cm)
ii. Plant dry weight (g)
iii. Days to seedling emergence
iv. Days to 50% seedling emergence
v. Days to 50 % weed emergence
vi. Days to 50% flowering.
vii. Days to harvesting
viii. Number of grass weeds plot^{-1}
ix. Number of sedge weeds plant^{-1}
x. Number of broad leaved weed plant $^{-1}$
xi. Total weed plot $^{-1}$
xii. Weed biomasses m^{-2} (g)
xiii. Number of pod plant^{-1}
xiv. Pod length (cm)
xv. Shell weight m^{-2} (g)
xvi. 1000 seed weight (g)
xvii. Yield hectare^{-1} (t/ha)

3.15 Outline of data recording

A brief outline of data recording procedure is given below:

i) Plant height

The height of plant was recorded in centimeter (cm) at the time of 30, 40, 50 DAS and at harvest. Data were recorded as the average of same 5 plant selected at random from the outer side rows (started after 2 rows from outside) of each plot. The height of the plant was determined by measuring the distance from the soil surface to the tip of the top leaf.

ii) Plant dry weight (g)

Total dry matter weight plant^{-1} was recorded at the time of 30, 40, 50 DAS and at harvest by drying plant samples. The plant samples were oven dried at 72 °C temperature until a constant level from which the weight of total dry matter were recorded. Data were recorded as the average of 5 sample plants plot^{-1} selected at random from the outer rows of each plot leaving the border line and expressed in gram.

iii) Days to seedling emergence:

It was taken by an overview to measure first germination of crops took places.

iv) Days to 50 % seedling emergence:

It was observed on 14 March, 2014 when 50% seed were germinated.

v) Days to 50 % weed germination:

It was taken by an overview to measure first germination of crops took places. It was recorded on 12 March, 2014.

vi) Days to 50% flowering:

Days to 50% flowering was considered when 50% of the plants within a plot were showed up with flowers. The number of days to 50% flowering was recorded from the date of sowing.

vii) Days to harvesting

Days to harvesting was considered when the 80% pod of the plants within a plot becomes blackish in color. The number of days to maturity was recorded from the date of sowing.

viii) Number of grass per plot:

The number of grass weed per plot was counted at 15, 25 and 35 DAS.

ix) Number of sedge weed per plot:

The number of sedge weed per plot was counted at 15, 25 and 35 DAS.

x) Number of broad leaf weed per plot:

The number of broad leaf weed per plot was counted at 15, 25 and 35 DAS.

xi) Weed biomass per plot (g):

Dry weight of all the weed population in a square meter from each plot was taken at 15, 25 and 35 DAS. The weed samples were oven dried at 72 °C temperature until a constant level from which the weight of total dry matter were recorded.

xii) Weed control efficiency:

The crop growth rate, weed population, weed dry weight and weed control efficiency were recorded at different stages of the crop. Weed control efficiency were obtained by using the following formula.

$$\mathbf{WCE} = \frac{(\text{Maximum number of weed found in a plot} - \text{Number of weed in treated plot})}{\text{Maximum number of weed found in a plot}} \times 100$$

xiii) Number of pods plant^{-1}

The number of pods from 5 randomly selected plants of each plot was determined at the time of harvest to find out the number of pods plant^{-1}

xiv) Pods length (cm)

Length of 30 pods from 5 randomly selected plants of each plot was measured with the help of a centimeter scale and their average value was recorded.

xv) Shell weight meter^{-2}(g):

Shell weight per square meter was taken from each plot.

xvi) Weight of 1000-seed (g)

One thousand cleaned dried seeds were counted randomly from the total cleaned harvested grains of each individual plot and then weighed with a digital electric balance at the stage the grain retained 14% moisture and the mean weight were expressed in gram.

xvii) Seed yield (t ha^{-1})

The grain of the whole plot, i.e. 4 m × 2.5 m = 10 m^2 excluding the border row was harvested, cleaned, threshed, dried and weighed. Finally, grain yield plot^{-1} was converted and expressed in t ha^{-1} on 14 % moisture basis. Grain moisture content was measured by using a digital moisture tester. Grain weight plot^{-1} was calculated by using following formula:

$$\text{Grain weight (final)} = \text{Initial weight} \times \frac{100 - \text{initial moisture content}}{100 - \text{final moisture content}}$$

3.16 Statistical analysis

The data obtained for different characters were statistically analyzed following the analysis of variance techniques to obtain the level of significance by using MSTAT-C computer package program (Fred, 1986). The significant differences among the treatment means were compared by Least Significant Difference (LSD) at 5 % levels of probability.

Chapter 4

Results and Discussion

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Effect of weeding methods on Growth attributes:

4.1.1 Plant height:

The results are shown in (Table 1). There were significant differences among the treatments at 30 DAS, 40 DAS, 50 DAS and at harvest.

At 30 DAS the highest plant height (20.03 cm) was observed with (T_2) Two hand weeding at 15 and 25 DAS. The smallest plant (16.27 cm) was found with (T_5) spraying of Quizalofop-p-ethyl 5 EC @ 700 ml/ha at 15 and 25 DAS (Table 1). At 40 DAS the tallest plant (31.57 cm) was found with T_7 and the smallest (29.12 cm) was observed T_5 (Table 1). At 50 DAS the tallest plant (35.98 cm) was observed with (T_2) Two hand weeding at 15 and 25 DAS and the shortest (32.47 cm) was found at (T_1) weedy check (Table 1).

There were significant differences among the treatments at harvest. At harvest the highest plant height (39.19 cm) was observed with T_2 which was statistically similar to T_3, T_4, T_6, T_7 and T_8. These results indicate that plant height increased with the application of different weed control methods. Decreased plant height in no weeding condition might be due to inhibition of cell division or cell enlargement. This is similar to the report of Khan *et al.* (2008) that is increase in plant height is inversely proportional to weeds density and dry weight.

Table 1: Effect of different weed control methods on plant height (cm) of mungbean

Treatment	Plant height (cm) at different DAS			
	30 DAS	**40 DAS**	**50 DAS**	**Harvest**
T_1	19.86 a	29.49 ab	32.47 c	34.64 d
T_2	20.03 a	31.35 ab	35.98 a	39.19 a
T_3	19.43 ab	31.18 ab	34.30 abc	37.13 bc
T_4	18.98 ab	29.28 ab	33.51 abc	35.83 cd
T_5	16.27 c	29.12 b	33.13 bc	35.93 cd
T_6	17.10 bc	29.21 ab	34.23 abc	38.35 ab
T_7	19.78 a	31.57 a	35.32 ab	37.92 ab
T_8	19.61 b	31.15 ab	33.84 abc	38.60 ab
LSD (0.05)	**2.49**	**2.38**	**2.67**	**1.75**
CV %	**7.95**	**4.49**	**4.46**	**2.68**

T_1 = Weedy check,

T_2 = Hand weeding at 15 and 25 DAS,

T_3 = Spraying of Quizalofop-p-ethyl 5 EC @ 600 ml /ha at 15 and 25 DAS,

T_4 = Spraying of Quizalofop-p-ethyl 5 EC @ 650 ml /ha at 15 and 25 DAS,

T_5= Spraying of Quizalofop-p-ethyl 5 EC @ 700 ml /ha at 15 and 25 DAS,

T_6 = Spraying of Quizalofop-p-ethyl 5 EC @ 600 ml /ha at 15 DAS + hand weeding at 25 DAS,

T_7 = Spraying of Quizalofop-p-ethyl 5 EC @ 650 ml /ha 15 DAS + hand weeding at 25 DAS,

T_8= Quizalofop-p-ethyl 5 EC @ 700 ml /ha at 15 DAS + hand weeding at 25 DAS

4.1.2 Plant dry matter (g):

The dry weight of a single mungbean plant was shown at (Table 2). There was no significant difference among the treatments at 30 DAS. At 40 DAS there were significant differences among the treatments (Table 2) as T_2 (Two hand weeding at 15 and 25 DAS) showed maximum biomass accumulation (8.95 g) on the other hand plants in T_1 weedy check showed minimum biomass (8.61 g) accumulation. At 50 DAS there were significant differences among the treatments (Table 2) as (T_8) spraying Quizalofop-p-ethyl 5 EC @ 700 ml /ha at 15 DAS + hand weeding at 25 DAS (17.98 g) showed maximum biomass

accumulation on the other hand plants in (T_1) weedy check showed minimum biomass accumulation (15.89 g).

At harvest there were significant differences among the treatments (Table 2) as (T_6) Spraying of Quizalofop-p-ethyl 5 EC @ 600 ml /ha at 15 DAS + Hand weeding at 25 DAS showed maximum biomass accumulation (21.78 g), on the other hand plants in (T_1) weedy check showed minimum (16.71 g) biomass accumulation.

This result indicates that removal of weeds helps plant to accumulate more weight. This is because of plant can get more nutrient and convert it towards the biomass accumulation. Similar results were found by Khan *et al*. (2011).

4.2 Effect of weeding methods on weed attributes:

There were some weed attributes were studied in this experiment such as number of grass weed per plot, number of sedge weed per plot, number of broad leaf weed per plot and weed biomass.

4.2.1 Number of grass weeds plot^{-1}:

All the grasses in a plot were counted at 15 DAS before the application of the treatments. The majority of the grass weeds were Bermuda grass (*Cynodon dactylon*). There was no significant difference among the treatments (Figure 1). At 25 DAS all the grass weed in a plot were counted before the application of the treatments the highest number of grass weeds was found in (T_1) weedy check (63). On the other hand the least grass weeds (20) were observed with (T_2) hand weeding at 15 DAS and 25 DAS (Figure 1). At 35 DAS the maximum grass population were found n (T_1) weedy check (99) and minimum were found with (T_8) spraying Quizalofop-p-ethyl 5 EC @ 700 ml /ha at 15 DAS + hand weeding at 25 DAS. But there were no significant differences among the treatments like (T_7) spraying Quizalofop-p-ethyl 5 EC 650 ml /ha 15 DAS + hand weeding at 25 DAS and (T_2) hand weeding at 15 and 25 DAS with the best treatment.

Table 2: Effect of different weed control treatments on plant dry matter of mungbean

Treatment	Plant dry matter at different DAS			
	30 DAS	**40 DAS**	**50 DAS**	**At harvest**
T_1	5.43	8.61ab	15.89 b	18.71 b
T_2	6.9	8.95 a	17.05 ab	21.27 a
T_3	5.9	8.48 ab	16.05 b	20.82 a
T_4	5.68	8.35 b	16.42 b	20.61 a
T_5	6.16	8.41 ab	16.55 ab	20.89 a
T_6	6.46	8.61 ab	16.57 ab	21.78 a
T_7	6.5	8.37 ab	17.03 ab	21.30 a
T_8	6.53	8.60 ab	17.98 a	21.68 a
LSD (0.05)	**NS**	**0.58**	**1.47**	**1.57**
CV (%)	**3.47**	**10.97**	**11.54**	**11.15**

T_1 = Weedy check,

T_2 = Hand weeding at 15 and 25 DAS,

T_3 = Spraying of Quizalofop-p-ethyl 5 EC @ 600 ml /ha at 15 and 25 DAS,

T_4 = Spraying of Quizalofop-p-ethyl 5 EC @ 650 ml /ha at 15 and 25 DAS,

T_5= Spraying of Quizalofop-p-ethyl 5 EC @ 700 ml /ha at 15 and 25 DAS,

T_6 = Spraying of Quizalofop-p-ethyl 5 EC @ 600 ml /ha at 15 DAS + hand weeding at 25 DAS,

T_7 = Spraying of Quizalofop-p-ethyl 5 EC @ 650 ml /ha 15 DAS + hand weeding at 25 DAS,

T_8= Quizalofop-p-ethyl 5 EC @ 700 ml /ha at 15 DAS + hand weeding at 25 DAS

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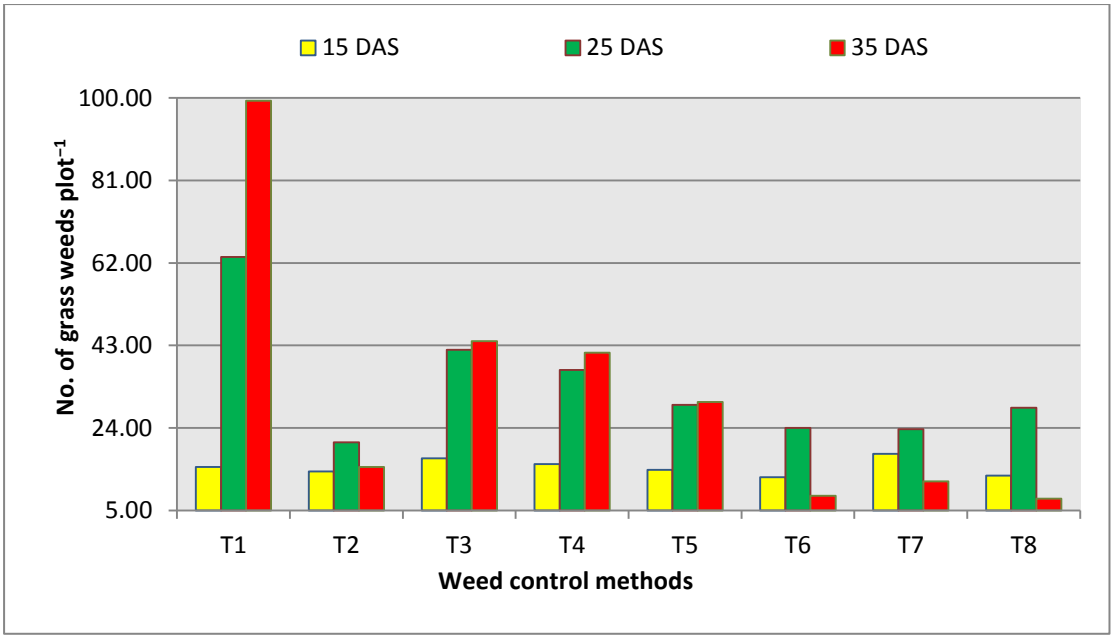


T_1 = Weedy check,

T_2 = Hand weeding at 15 and 25 DAS,

T_3 = Spraying of Quizalofop-p-ethyl 5 EC @ 600 ml /ha at 15 and 25 DAS,

T_4 = Spraying of Quizalofop-p-ethyl 5 EC @ 650 ml /ha at 15 and 25 DAS,

T_5= Spraying of Quizalofop-p-ethyl 5 EC @ 700 ml /ha at 15 and 25 DAS,

T_6 = Spraying of Quizalofop-p-ethyl 5 EC @ 600 ml /ha at 15 DAS + hand weeding at 25 DAS,

T_7 = Spraying of Quizalofop-p-ethyl 5 EC @ 650 ml /ha 15 DAS + hand weeding at 25 DAS,

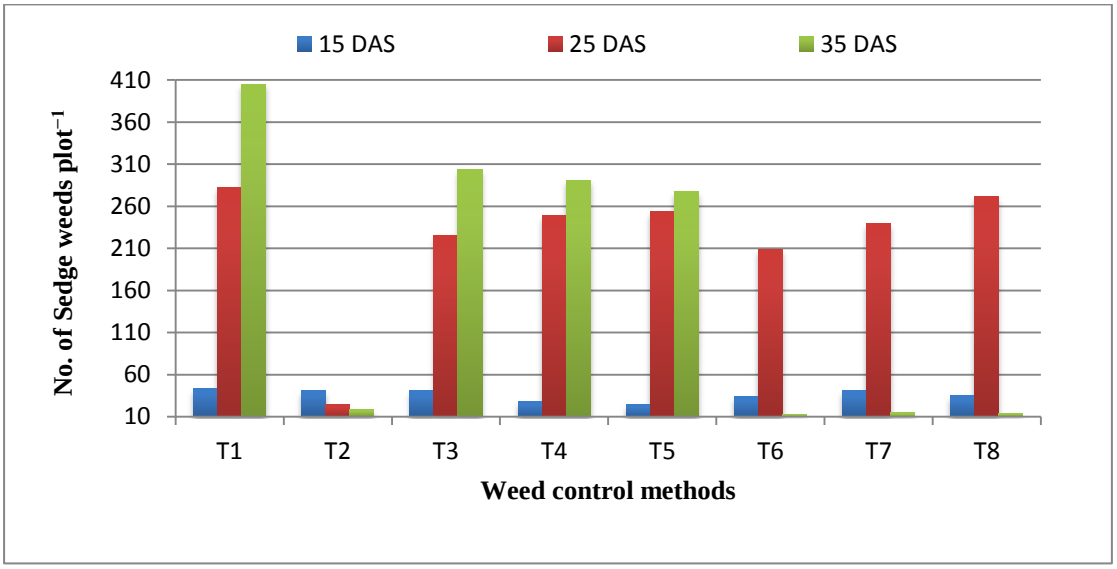
T_8= Quizalofop-p-ethyl 5 EC @ 700 ml /ha at 15 DAS + hand weeding at 25 DAS.

Figure 1: Effect of weed control methods on number of grasses per plot of mungbean at different days after sowing

4.2.2 Number of sedge weeds plot $^{-1}$:

At 15 DAS, there were no significant differences among the treatments. Among the sedge weeds prominent weed was Nutsedge (*Cyperus rotundus*). At 25 days maximum sedge weeds (282) were found with the treatment of (T_1) weedy check minimum sedge weeds (24) were found with (T_2) hand weeding at 15 DAS and 25 DAS. At 35 DAS maximum weed population (405) were found in (T_1) weedy check and minimum (13) were with (T_6) spraying of Quizalofop-p-ethyl 5 EC @ 600 ml /ha at 15 DAS + hand weeding at 25 DAS which is statistically similar to (T_2) Hand weeding at15 and 25 DAS, (T_7) spraying of Quizalofop-p-ethyl 5 EC @ 650 ml /ha 15 DAS + hand weeding at

25 DAS and (T_8) spraying of Quizalofop-p-ethyl 5 EC @ 700 ml /ha at 15 DAS + hand weeding at 25 DAS (Figure 2).



T_1 = Weedy check,

T_2 = Hand weeding at 15 and 25 DAS,

T_3 = Spraying of Quizalofop-p-ethyl 5 EC @ 600 ml /ha at 15 and 25 DAS,

T_4 = Spraying of Quizalofop-p-ethyl 5 EC @ 650 ml /ha at 15 and 25 DAS,

T_5= Spraying of Quizalofop-p-ethyl 5 EC @ 700 ml /ha at 15 and 25 DAS,

T_6 = Spraying of Quizalofop-p-ethyl 5 EC @ 600 ml /ha at 15 DAS + hand weeding at 25 DAS,

T_7 = Spraying of Quizalofop-p-ethyl 5 EC @ 650 ml /ha 15 DAS + hand weeding at 25 DAS,

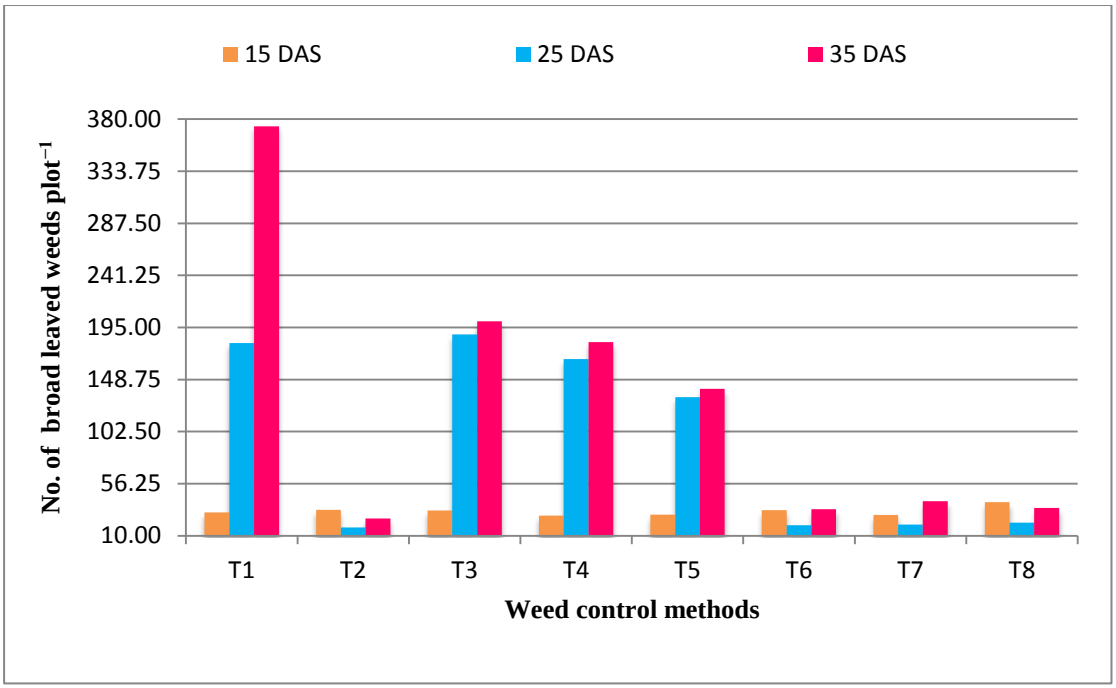
T_8= Quizalofop-p-ethyl 5 EC @ 700 ml /ha at 15 DAS + hand weeding at 25 DAS.

Figure 2: Effect of weed control methods on number of sedge weeds per plot of mungbean at different days after sowing

4.2.3 Number of broad leaved weeds plot^{-1}:

It was found that at 15 DAS there were no differences of weed number among the treatments (Figure 3). Prominent broad leaved were Wild radish (*Raphanus raphanistrum*) and Wild mustard (*Brassica kaber*). At 25 DAS maximum weed population were found in (T_3) spraying of Quizalofop-p-ethyl 5 EC @ 600 ml /ha at 15 and 25 DAS and minimum were in (T_2) hand weeding at 15 and 25 DAS (Figure 3). At 35 DAS maximum broad leaved weeds (373) were found in (T_1) weedy check and minimum broad leaved weeds (25) were found in (T_2) hand weeding at 15 and 25 DAS. But there were no significant differences among the treatments like (T_6) spraying of Quizalofop-p-ethyl 5 EC @ 600 ml

/ha at 15 DAS + hand weeding at 25 DAS, (T_7) spraying of Quizalofop-p-ethyl 5 EC @650 ml /ha at 15 DAS + hand weeding at 25 DAS, (T_8) spraying of Quizalofop-p-ethyl 5 EC @700 ml /ha 15 DAS + hand weeding at 25 DAS with the treatment had minimum weed population (Figure 3).



T_1 = Weedy check,

T_2 = Hand weeding at 15 and 25 DAS,

T_3 = Spraying of Quizalofop-p-ethyl 5 EC @ 600 ml /ha at 15 and 25 DAS,

T_4 = Spraying of Quizalofop-p-ethyl 5 EC @ 650 ml /ha at 15 and 25 DAS,

T_5= Spraying of Quizalofop-p-ethyl 5 EC @ 700 ml /ha at 15 and 25 DAS,

T_6 = Spraying of Quizalofop-p-ethyl 5 EC @ 600 ml /ha at 15 DAS + hand weeding at 25 DAS,

T_7 = Spraying of Quizalofop-p-ethyl 5 EC @ 650 ml /ha 15 DAS + hand weeding at 25 DAS,

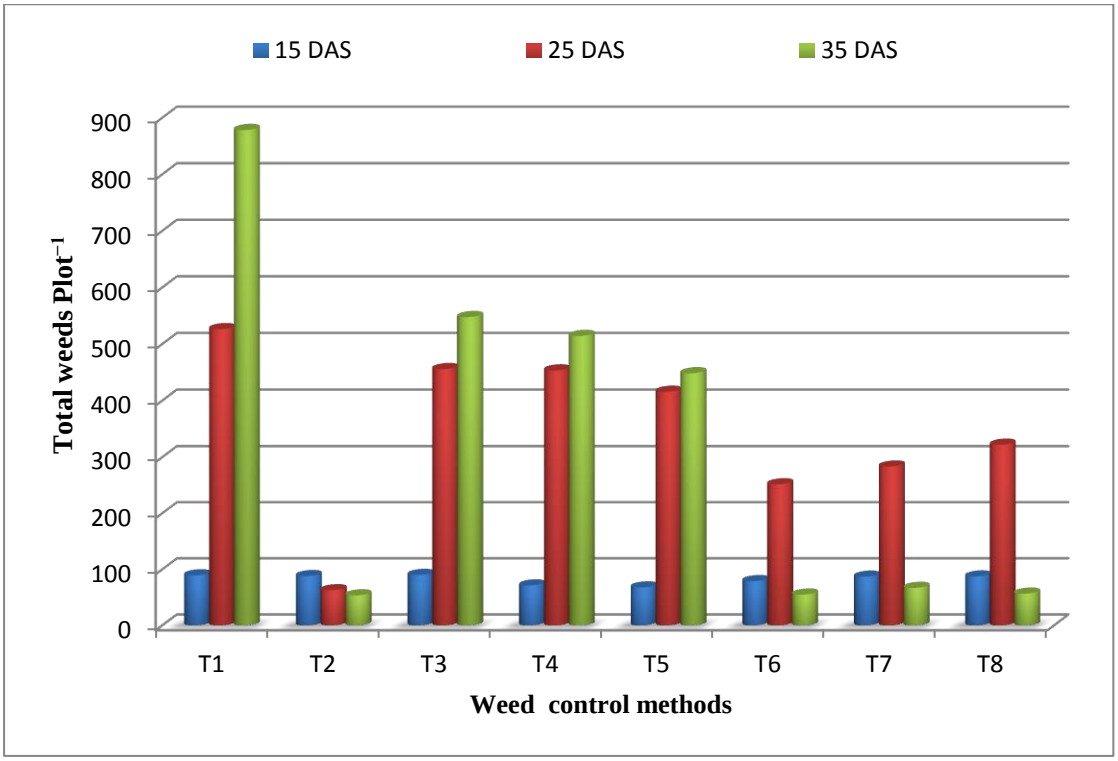
T_8= Quizalofop-p-ethyl 5 EC @ 700 ml /ha at 15 DAS + hand weeding at 25 DAS.

Figure 3: Effect of weed control methods on number of broad leaved weeds per plot of mungbean at different days after sowing

4.2.4 Total weeds plot^{-1}:

At 15 DAS there were no significant differences among the treatments (Figure 4). At 25 DAS maximum weed populations (526) were found in (T_1) weedy check and minimum (62) were found with the treatment of (T_2) hand weeding

at 15 and 25 DAS. At 35 DAS maximum weeds (878) were found in (T_1) weedy check and minimum weed population were found in (T_2) hand weeding at 15 and 25 DAS. But there were no significant differences among the treatments like (T_6) spraying of Quizalofop-p-ethyl 5 EC @600 ml /ha at 15 DAS + hand weeding at @25 DAS, (T_7) spraying of Quizalofop-p-ethyl 5 EC @650 ml /ha at 15 DAS + Hand weeding at @ 25 DAS, (T_8) spraying of Quizalofop-p-ethyl 5 EC @ 700 ml /acre 15 DAS + hand weeding at 25 DAS with the treatment had minimum weed population (Figure 4**)**



T_1 = Weedy check,

T_2 = Hand weeding at 15 and 25 DAS,

T_3 = Spraying of Quizalofop-p-ethyl 5 EC @ 600 ml /ha at 15 and 25 DAS,

T_4 = Spraying of Quizalofop-p-ethyl 5 EC @ 650 ml /ha at 15 and 25 DAS,

T_5= Spraying of Quizalofop-p-ethyl 5 EC @ 700 ml /ha at 15 and 25 DAS,

T_6 = Spraying of Quizalofop-p-ethyl 5 EC @ 600 ml /ha at 15 DAS + hand weeding at 25 DAS,

T_7 = Spraying of Quizalofop-p-ethyl 5 EC @ 650 ml /ha 15 DAS + hand weeding at 25 DAS,

T_8= Quizalofop-p-ethyl 5 EC @ 700 ml /ha at 15 DAS + hand weeding at 25 DAS.

Figure 4: Effect of weed control methods on number of total weed per plot of mungbean at different days after sowing

4.3 Effect of weeding methods on weed biomasses meter^{-2} (g):

The dry weight of all the weed population of per square meter was shown in (Table 3). At 15 DAS there were no significant differences among the treatments. At 25 DAS the maximum weed biomass (76 g) per square meter was recorded with weedy check and minimum (20.33 g) weed biomass was recorded with the treatment of hand weeding @15 and 25 DAS (Table 3). At 35 DAS the maximum weed biomass was recorded (108 g) in weedy check and minimum (10.33 g) was in hand weeding @15 and 25 DAS. But there were no significant differences among the treatments like (T_6) spraying of Quizalofop-p-ethyl 5 EC @ 600 ml /ha at 15 DAS + hand weeding at 25 DAS, (T_7) spraying of Quizalofop-p-ethyl 5 EC @ 650 ml /ha at 15 DAS + hand weeding at 25 DAS and (T_8) spraying of Quizalofop-p-ethyl 5 EC @ 700 ml /ha at 15 DAS + Hand weeding at 25 DAS with the best treatment (Table 3).

4.4 Weed control efficiency (WCE):

Weed control efficiency of the treatments were calculated at 25 DAS and 35 DAS (Table 4)

4.4.1 Weed control efficiency (WCE) for grasses:

On 25 DAS in case of grass weeds the highest weed control efficiency (67.96 %) was found in the treatment of (T_2) hand weeding at 15 and 25 DAS (Table 4). The maximum (93.32 %) WCE at 35 DAS for grasses was observed with (T_8) spraying of Quizalofop-p-ethyl 5 EC @ 650 ml /ha at 15 DAS + Hand weeding at 25 DAS , followed (T_2) hand weeding at 15 and 25 DAS (Table 4)**.**

Table 3 : Effect of different weed control methods on weed biomass (g/m^2)

Treatment	15 DAS	25 DAS	35 DAS
T_1	42.33	76.00 a	108.00 a
T_2	41.00	20.33 c	10.33 c
T_3	40.67	63.60 b	76.33 b
T_4	34.33	60.66 b	73.00 b
T_5	34.67	62.67 b	72.00 b
T_6	43.67	60.00 b	12.00 c
T_7	50.67	63.67 b	12.33 c
T_8	47.33	63.00 b	10.67 c
LSD $_{(0.05)}$	16.57	6.13	4.95
CV (%)	39.15	10.20	10.01

T_1 = Weedy check,

T_2 = Hand weeding at 15 and 25 DAS,

T_3 = Spraying of Quizalofop-p-ethyl 5 EC @ 600 ml /ha at 15 and 25 DAS,

T_4 = Spraying of Quizalofop-p-ethyl 5 EC @ 650 ml /ha at 15 and 25 DAS,

T_5= Spraying of Quizalofop-p-ethyl 5 EC @ 700 ml /ha at 15 and 25 DAS,

T_6 = Spraying of Quizalofop-p-ethyl 5 EC @ 600 ml /ha at 15 DAS + hand weeding at 25 DAS,

T_7 = Spraying of Quizalofop-p-ethyl 5 EC @ 650 ml /ha 15 DAS + hand weeding at 25 DAS,

T_8= Spraying of Quizalofop-p-ethyl 5 EC @ 700 ml /ha at 15 DAS + hand weeding at 25 DAS

4.4.2 Weed control efficiency (WCE) for sedge weed:

At 25 DAS the maximum WCE (91.41%) were found with the treatment of (T_2) hand weeding at 15 and 25 DAS (Table 4) and minimum in (T_1) weedy check (Table 4). At 35 DAS the maximum WCE (97.09%) were found with (T_6) Quizalofop-p-ethyl 5 EC@ 700 ml /ha at 15 DAS + hand weeding at 25 DAS and minimum in (T_1) weedy check (Table 4).

4.4.3 Weed control efficiency (WCE) for broad leaf weed:

At 25 DAS the highest WCE (90.14 %) was also found with (T_2) hand weeding at 15 and 25 DAS and the lowest was found (T_1) weedy check (Table 4). At 35 DAS the maximum (93.07%) WCE was found with (T_2) hand weeding at 15 and 25 DAS.

4.4.4 Weed control efficiency (WCE) for total weed population:

As weed control efficiency for total weed population was calculated there were clear differences among the treatments. On 25 DAS the maximum WCE (87.94%) was found with (T_2) hand weeding at 15 and 25 DAS and the minimum in (T_1) weedy check. At 35 DAS the weed control efficiency (WCE) was also highest (93.91%) with (T_2) hand weeding at 15 and 25 DAS and minimum was in (T_1) weedy check (Table 4).

This result indicated that two hand-weeding controlled maximum weed in the crop field but the combination of hand weeding with chemical weed control also showed better weed control efficiency. This is also similar as reported by Buttar (2004).

Table 4: Weed control efficiency (WCE) of different weed control methods at different days after sowing

Treatment	WCE for grass (%)		WCE for sedge (%)		WCE for broad leaf (%)		WCE for total weed (%)	
	25 DAS	35 DAS	25 DAS	35 DAS	25 DAS	35 DAS	25 DAS	35 DAS
T_1	0.00 b	0.00 d	0.00 h	0.00 g	0.00 c	0.00 c	0.00 g	0.00
T_2	67.96 a	84.96 ab	91.41 a	95.16 c	90.14 a	93.07 a	87.94 a	93.91 a
T_3	33.6 a	55.56 c	24.37 b	25.05 f	23.12 b	46.13 b	13.42 f	46.32 b
T_4	41.71 a	58.72 bc	21.07 c	28.07 e	15.98 b	50.76 b	13.28 f	41.84 bc
T_5	53.56 a	70.59 ab	15.00 d	31.13 d	22.33 b	62.81 ab	20.89 e	41.84 bc
T_6	63.37 a	91.20 a	12.23 e	97.09 a	24.08 b	90.33 a	51.72 b	92.51 a
T_7	62.21 a	88.40 a	10.05 f	96.79 ab	17.34 b	89.70 a	46.72 c	92 46 a
T_8	54.57 a	93.32 a	4.55 g	96.48 b	13.43 b	90.90 a	38.60 d	84.13 a
LSD (0.05)	41.00	29.26	2.16	0.53	13.38	35.96	1.07	9.91
CV %	49.58	2.96	5.5	0.51	15.24	31.29	1.78	9.25

T_1 = Weedy check,

T_2 = Hand weeding at 15 and 25 DAS,

T_3 = Spraying of Quizalofop-p-ethyl 5 EC @ 600 ml /ha at 15 and 25 DAS,

T_4 = Spraying of Quizalofop-p-ethyl 5 EC @ 650 ml /ha at 15 and 25 DAS,

T_5= Spraying of Quizalofop-p-ethyl 5 EC @ 700 ml /ha at 15 and 25 DAS,

T_6 = Spraying of Quizalofop-p-ethyl 5 EC @ 600 ml /ha at 15 DAS + hand weeding at 25 DAS,

T_7 = Spraying of Quizalofop-p-ethyl 5 EC @ 650 ml /ha 15 DAS + hand weeding at 25 DAS,

T_8= Spraying of Quizalofop-p-ethyl 5 EC @ 700 ml /ha at 15 DAS + hand weeding at 25 DAS.

4.5 Effect of weeding methods on yield and yield attributing characters:

4.5.1 Pod length (cm):

It was found to be significant among the treatments. The longest pod (9.52 cm) was observed with the treatment of (T_2) hand weeding at 15 and 25 DAS and the shortest pod (7.45 cm) was found in (T_1) weedy check. Here there was no significant differences the treatments of (T_2) hand weeding at 15 and 25 DAS and (T_8) Spraying of Quizalofop-p-ethyl 5 EC @ 700 ml /ha at 15 DAS + hand weeding at 25 DAS (Table 5).

4.5.2 Number of pods plant^{-1}:

The number of pod in per plant was counted. It was found that maximum number of pod plant^{-1} (80.33) were found in the treatment (T_2) hand weeding at 15 and 25 DAS and the minimum number of pod were (61.33) found in (T_1) weedy check (Table 5). The treatments like (T_3) spraying of Quizalofop-p-ethyl 5 EC @ 600 ml /ha at 15 and 25 DAS, (T_6) Spraying of Quizalofop-p-ethyl 5 EC @ 600 ml /ha at 15 DAS + hand weeding at 25 DAS, (T_7) Spraying of Quizalofop-p-ethyl 5 EC @ 650 ml /ha 15 DAS + hand weeding at 25 DAS and (T_8) spraying of Quizalofop-p-ethyl 5 EC @ 700 ml /ha at 15 DAS + hand weeding at 25 DAS had similarity with the best treatment i.e. (T_2) hand weeding at 15 and 25 DAS (Table 5).

4.5.3 Shell weight meter^{-2} (g):

The weight of shell of per square meter was taken. There were significant differences among the treatments. The maximum shell weight (79.60 g) was found in (T_1) weedy check and minimum shell weight (58.04 g) was found in (T_5) Spraying of Quizalofop-p-ethyl 5 EC @ 700 ml /ha at 15 and 25 DAS. There was no statistical dissimilarity found among the treatments except the weedy check. (Table 5)

4.5.4 1000 seed weight (g):

Weight of 1000 seeds was taken. There were no significant differences among the treatments. The highest result (66.42 g) was obtained from the treatment (T_8) spraying of Quizalofop-p-ethyl 5 EC 700 ml /ha 15 DAS + hand weeding at 25 DAS and the lowest 1000 seed weight (56.71 g) was found with the treatment of (T_6) spraying of Quizalofop-p-ethyl 5 EC 600 ml /ha 15 DAS + hand weeding at @ 25 DAS. Khan *et al*. (2011) also found similar result.

4.5.5 Yield (t /ha):

From the Table 5 it can easily be identified that there was a notable differences among the treatments as far as yield per square meter was concerned. The maximum yield (1.53 t/ha) was obtained from the treatment of (T_2) hand weeding at 15 and 25 DAS and the minimum yield (0.81 t/ha) was found in (T_1) weedy check.

There was a notable difference among the treatments with (T_2) hand weeding at 15 and 25 DAS. But there were no significant differences found with the treatments like (T_6) spraying of Quizalofop-p-ethyl 5 EC @ 600 ml /ha at 15 DAS + hand weeding at 25 DAS, (T_7) spraying of Quizalofop-p-ethyl 5 EC @ 650 ml /ha 15 DAS + hand weeding at 25 DAS, (T_8) spraying of Quizalofop-p-ethyl 5 EC @ 700 ml /ha at 15 DAS + hand weeding at 25 DAS. It was identified that there was about 47% yield loss in weedy check from the maximum yielded treatment. Similar result was also reported by Singh *et al*. (2001).

Table 5: Effect of different weed control methods on yield contributing attributes of mungbean

Treatment	No. of pod per plant	Pod length (cm)	Shell weight meter^{-2} (g)	1000 seed weight (g)	Yield (t/ha)
T_1	12.27 d	7.45 d	79.6 a	58.40	0.81 e
T_2	16.07 a	9.52 a	65.23 b	63.00	1.53 a
T_3	15.33 abc	8.02 c	60.53 b	59.17	1.32 c
T_4	14.67 c	8.65 b	59.23 b	61.82	1.31 c
T_5	14.83 bc	8.69 b	58.042 b	58.44	1.17 d
T_6	15.00 abc	8.85 b	65.31 b	56.71	1.39 bc
T_7	15.07 abc	8.99 b	64.81 b	63.18	1.44 b
T_8	15.87 ab	9.04 ab	63.23 b	66.42	1.38 bc
LSD (0.05)	**1.097**	**0.4891**	**8.258**	**Ns**	**0.08**
CV (%)	**4.21**	**3.22**	**7.31**	**5.69**	**3.77**

T_1 = Weedy check,

T_2 = Hand weeding at 15 and 25 DAS,

T_3 = Spraying of Quizalofop-p-ethyl 5 EC @ 600 ml /ha at 15 and 25 DAS,

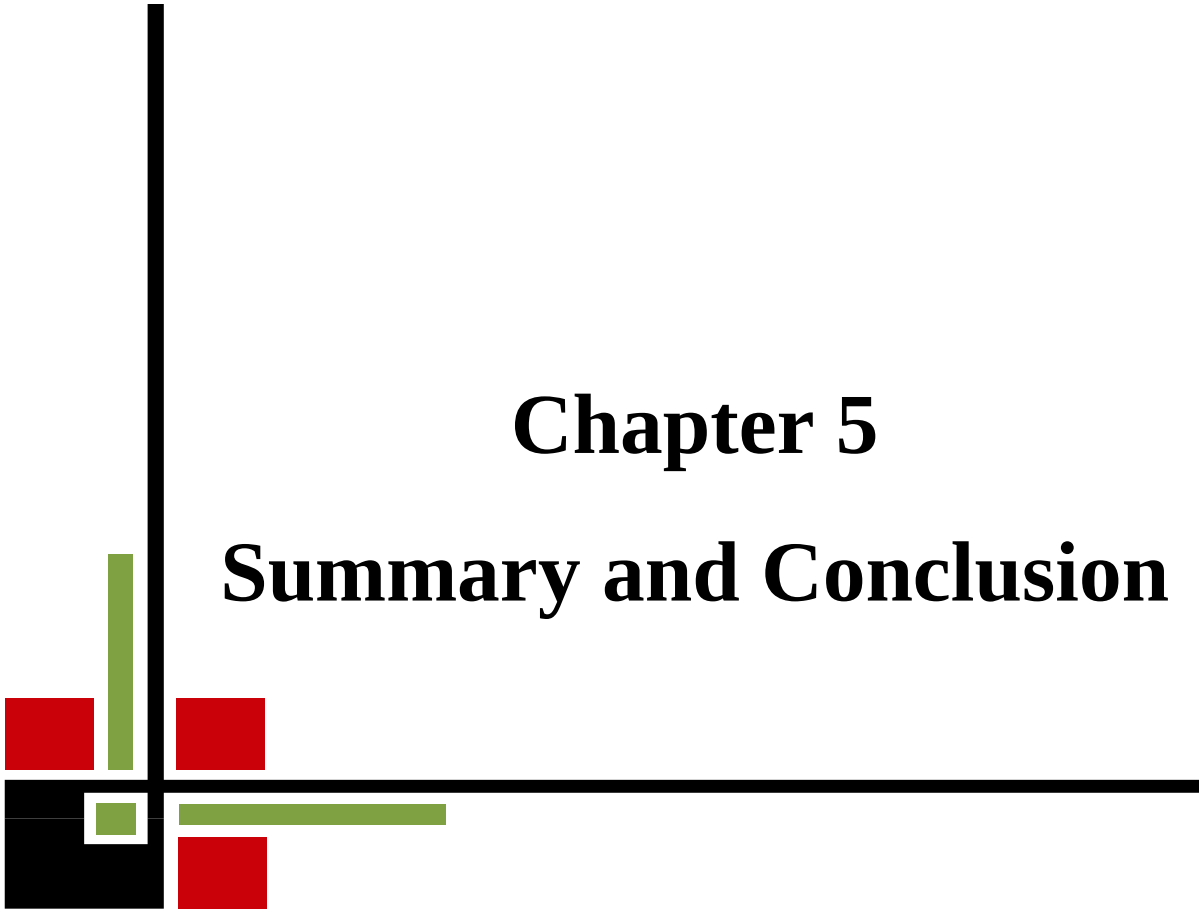
T_4 = Spraying of Quizalofop-p-ethyl 5 EC @ 650 ml /ha at 15 and 25 DAS,

T_5= Spraying of Quizalofop-p-ethyl 5 EC @ 700 ml /ha at 15 and 25 DAS,

T_6 = Spraying of Quizalofop-p-ethyl 5 EC @ 600 ml /ha at 15 DAS + hand weeding at 25 DAS,

T_7 = Spraying of Quizalofop-p-ethyl 5 EC @ 650 ml /ha 15 DAS + hand weeding at 25 DAS,

T_8= Spraying of Quizalofop-p-ethyl 5 EC @ 700 ml /ha at 15 DAS + hand weeding at 25 DAS.



Chapter 5

Summary and Conclusion

CHAPTER 5

SUMMARY AND CONCLUSION

The field experiment was conducted at the agronomy field of central research farm of Sher-e-Bangla Agricultural University, Dhaka, during the period from March 2014 to May 2014 to study efficacy of different weed control methods on growth and yield of BARI mungbean 6.

The experiment was conducted with eight treatments viz. (T_1) weedy check , (T_2) hand weeding at 15 and 25 DAS, (T_3) Spraying of Quizalofop-p-ethyl 5 EC @ 600 ml /ha at 15 and 25 DAS, (T_4) Spraying of Quizalofop-p-ethyl 5 EC @ 650 ml /ha at 15 and 25 DAS, (T_5)Spraying of Quizalofop-p-ethyl 5 EC @ 700 ml /ha at 15 and 25 DAS, (T_6) Spraying of Quizalofop-p-ethyl 5 EC @ 600 ml /ha at 15 DAS + hand weeding at 25 DAS, (T_7) Spraying of Quizalofop-p-ethyl 5 EC @ 650 ml /ha 15 DAS + hand weeding at 25 DAS, (T_8) Quizalofop-p-ethyl 5 EC @ 700 ml /ha at 15 DAS + hand weeding at 25 DAS**.**

The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. The layout of the experiment was prepared for distributing the variety. The experimental field was divided into 3 blocks. Each block was again divided into 8 plots. The total numbers of unit plots of the experiment were 24 (8 × 3). The size of the unit plot was 3 m × 2 m (6 m^2). There were 0.75 m width and 10 cm depth for drains between the blocks. Each treatment was again separated by drainage channel of 0.5 m width and 10 cm depth. The treatments were randomly distributed to each block following the experimental design.

Significant variation was recorded for data on growth, yield and yield contributing parameters of experimental materials. Seed and stover yields were recorded after harvest. The analysis was performed using the MSTAT–C (Version 2.10) computer package program developed by Russell (1986). The

mean differences among the treatments were compared by least significant difference test (LSD) at 5 % level of significance.

Records showed for plant height that at 30 DAS the highest plant height (20.03 cm) was observed with (T_2) hand weeding at 15 and 25 DAS ; at 40 DAS the tallest plant (31.35 cm) was found with (T_2) hand weeding at 15 and 25 DAS ; at 50 DAS the tallest plant (35.98 cm) was observed with (T_2) hand weeding at 15 and 25 DAS and finally at harvest the highest plant height (39.19 cm) was observed with (T_2) hand weeding at 15 and 25 DAS on the other hand (T_1) weedy check had shortest plant height at 50 DAS and at harvest.

Dry weight of individual plant was recorded which showed that the maximum dry matter accumulation of plant was observed with (T_2) hand weeding at 15 and 25 DAS. At 40 DAS the treatments as (T_2) hand weeding at 15 DAS and 25 DAS showed maximum biomass accumulation (8.95 g) on the other hand plants in (T_1) weedy check (8.61 g) showed minimum biomass accumulation. At 50 DAS (T_8) spraying Quizalofop-p-ethyl 5 EC @ 700 ml /ha at 15 DAS + hand weeding at 25 DAS (17.98 g) showed maximum biomass accumulation while plants in (T_1) weedy check showed minimum biomass accumulation (15.89 g). At harvest, (T_6) spraying of Quizalofop-p-ethyl 5 EC @ 600 ml /ha at 15 DAS + Hand weeding at 25 DAS showed maximum biomass accumulation (21.78 g) and on the other hand plants in (T_1) weedy check showed minimum (16.71 g) biomass accumulation.

Result indicated that different kinds of weeds were present in the experimental field. At 25 DAS all the grass weed in a plot were counted before the application of the treatments. The highest number of grass weeds was found in (T_1) weedy check (63). On the other hand the least grass weeds (20) were observed with (T_2) hand weeding at 15 DAS and 25 DAS. At 35 DAS the maximum grass population were found in (T_1) weedy check (99) and minimum were found with (T_8) spraying Quizalofop-p-ethyl 5 EC @ 700 ml /ha at 15 DAS + hand weeding at 25 DAS.

The result also showed that at 25 DAS maximum sedge weeds (282) were found with the treatment of (T_1) weedy check minimum sedge weeds (24) were found with (T_2) hand weeding at 15 DAS and 25 DAS. At 35 DAS Maximum weed population (405) were found in (T_1) weedy check and minimum (13) were with (T_6) spraying of Quizalofop-p-ethyl 5 EC @ 600 ml /ha.

As far as results of broad leaved weeds were concerned, at 25 DAS maximum weed population were found in (T_3) spraying of Quizalofop-p-ethyl 5 EC @ 600 ml /ha at 15 and 25 DAS and minimum were in (T_2) hand weeding at 15 and 25 DAS (Figure 3) . At 35 DAS maximum broad leaved weeds (373) were found in (T_1) weedy check and minimum broad leaved weeds (25) were found in (T_2) hand weeding at 15 and 25 DAS.

Result also indicated that at 25 DAS maximum weed populations (526) were found in (T_1) weedy check and minimum (62) were found with the treatment of (T_2) hand weeding at 15 and 25 DAS. At 35 DAS maximum weeds (878) were found in (T_1) weedy check and minimum weed population were found in (T_2) hand weeding at 15 and 25 DAS.

The dry weight of all the weed population per square meter was recorded . At 25 DAS the maximum weed biomass (76 g) per square meter was recorded with weedy check and minimum (20.33 g) weed biomass was recorded with the treatment of hand weeding @15 and 25 DAS. At 35 DAS the maximum weed biomass was recorded (108 g) in weedy check and minimum (10.33 g) was in hand weeding @15 and 25 DAS.

Result indicated that at 25 DAS in case of grass weeds the highest weed control efficiency (67.96%) was found in the treatment of (T_2) hand weeding at 15 and 25 DAS .The maximum (93.32%) WCE at 35 DAS for grass weeds was observed with (T_7) spraying of Quizalofop-p-ethyl 5 EC @ 650 ml /ha at 15 DAS + Hand weeding at 25 DAS.

WCE for sedge weed was recorded it was found that At 25 DAS the maximum WCE (91.41%) were found with the treatment of (T_2) hand weeding at 15 and

25 DAS (Table 4)**.**and minimum in (T_1) weedy check (Table 4). At 35 DAS the maximum WCE (97.09 %) were found with (T_8) Quizalofop-p-ethyl 5 EC@ 700 ml /ha at 15 DAS + hand weeding at 25 DAS and minimum in (T_1) weedy check.

For broad leaved weeds at 25 DAS the highest WCE (90.14 %) is also found with (T_2) hand weeding at 15 and 25 DAS and minimum was in (T_1) weedy check .At 35 DAS the maximum (93.07%) WCE was found with (T_2) hand weeding at 15 and 25 DAS.

As far as overall weed control efficiency is concerned that at 25 DAS the maximum WCE (87.94%) was found with (T_2) hand weeding at 15 and 25 DAS and minimum in (T_1) weedy check. At 35 DAS the weed control efficiency (WCE) was also highest (93.91%) with (T_2) hand weeding at 15 and 25 DAS and minimum was in (T_1) weedy check.

The number of pods plant^{-1} (16.07), longest pod (9.52 cm), highest yield (1.53 t/ha) was obtained from (T_2) hand weeding at 15 and 25 DAS.

From the above summary it can be concluded that (T_2) hand weeding at 15 and 25 DAS showed the best performances in maximum parameters. But as far as weed control and yield of mungbean was concerned (T_6) Spraying of Quizalofop-p-ethyl 5 EC @ 600 ml /ha 15 DAS + hand weeding at 25 DAS, (T_7) Spraying of Quizalofop-p-ethyl 5 EC @ 650 ml /ha at 15 DAS + hand weeding at 25 DAS also showed better result.

Conclusion:

Based on the experimental results, it may be concluded that-

i) Effective weed control increases growth and yield of mungbean.

ii) (T_2) hand weeding at 15 and 25 DAS can be treated as the best treatments among the eight treatments from the present study.

iii) For wider acceptability, the same experiment can be repeated at different agro-ecological zones of the country.

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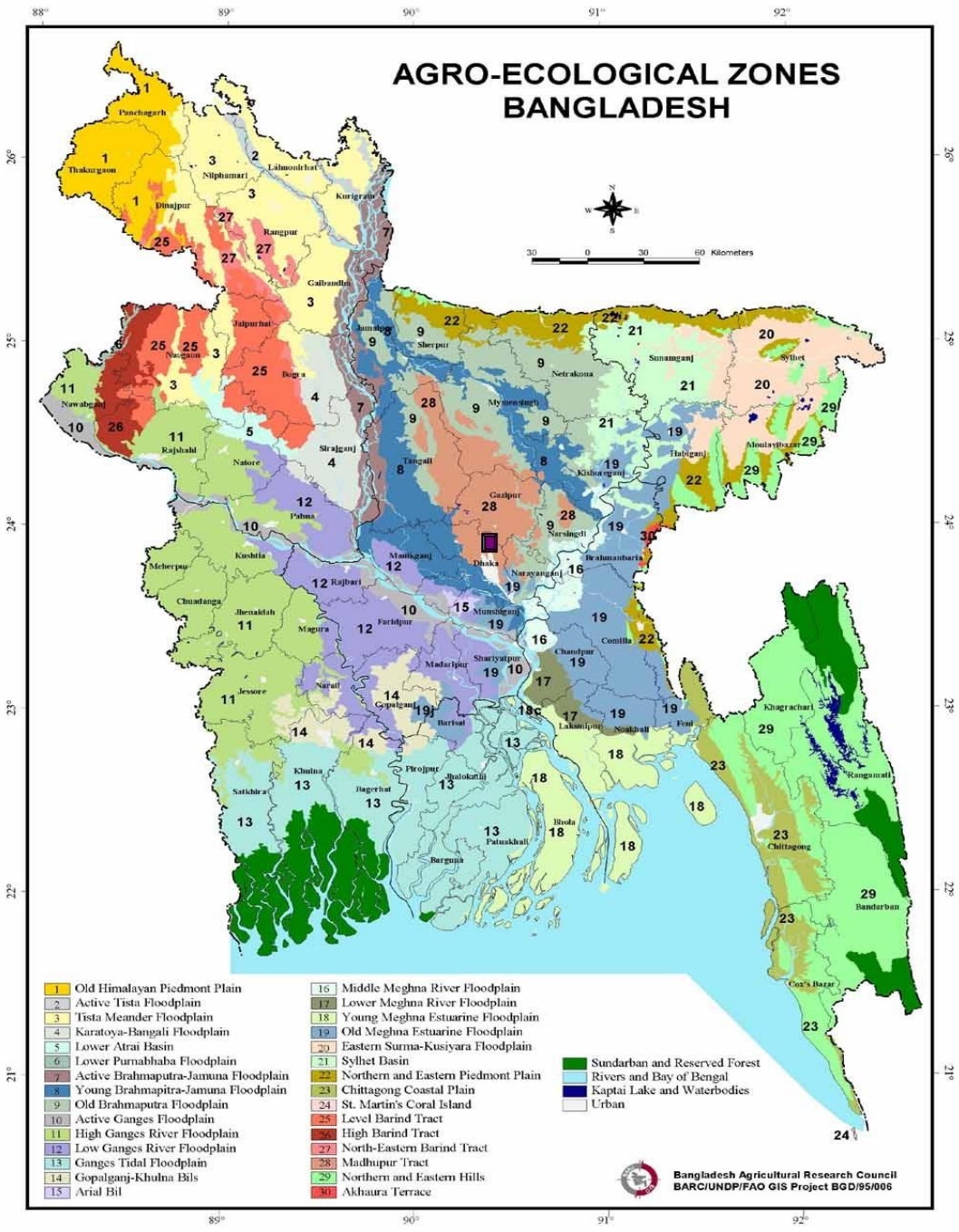
Appendices

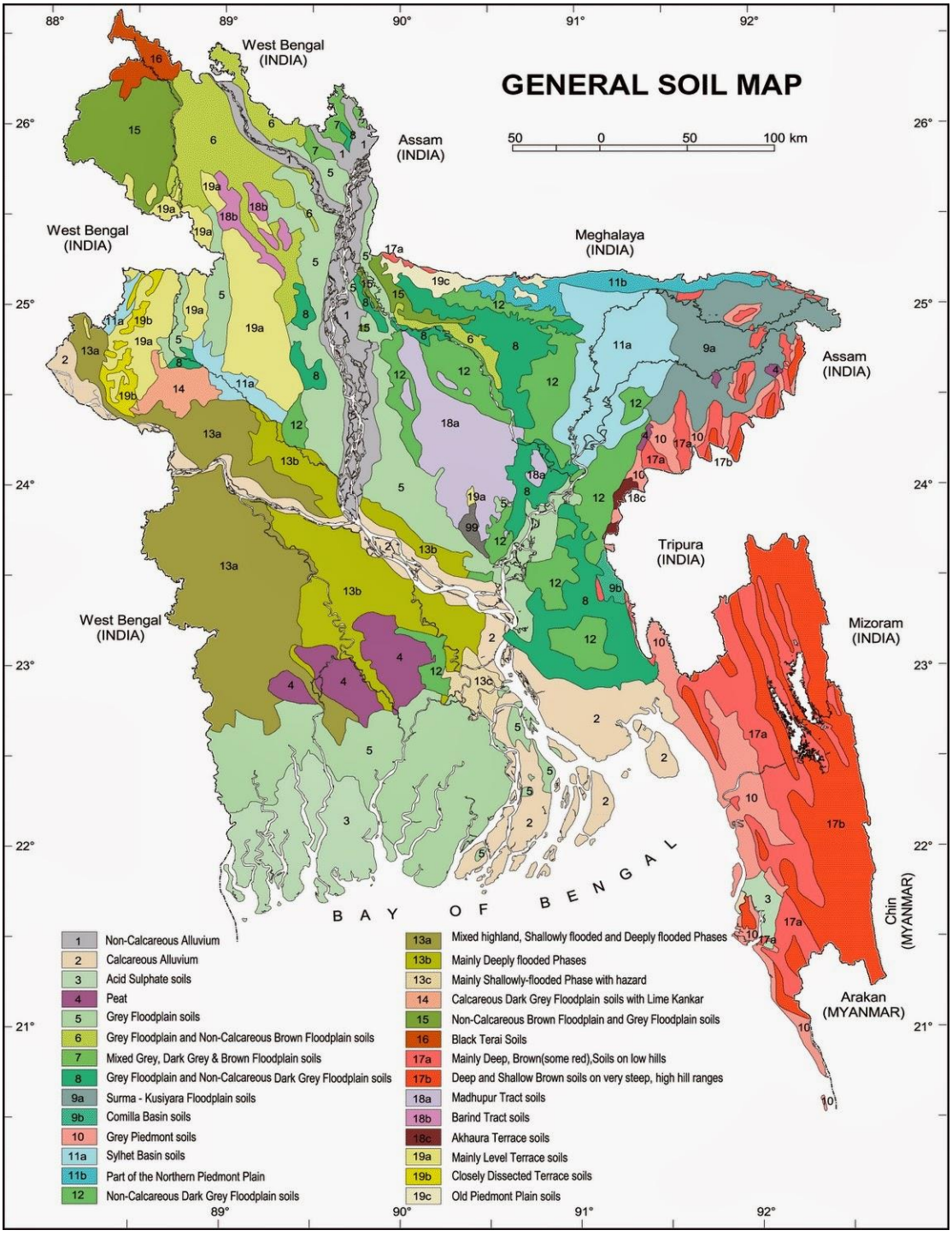
APPENDICES

Appendix I: Map showing the experimental sites under study



The experimental site under study

Appendix II: Map showing the general soil sites under study



Appendix III: Characteristics of soil of experimental site is analyzed by Soil Resources Development Institute (SRDI), Khamarbari, Farmgate, Dhaka

A. Morphological characteristics of the experimental field

Morphological features	Characteristics
Location	Experimental field, SAU, Dhaka
AEZ	Madhupur Tract (28)
General Soil Type	Shallow red brown terrace soil
Land type	High land
Soil series	Tejgaon
Topography	Fairly leveled
Flood level	Above flood level
Drainage	Well drained
Cropping Pattern	Cotton–Mungbean –Fellow

B. Physical and chemical properties of the initial soil

Characteristics	Value
%Sand	27
%Silt	43
%clay	30
Textural class	Silty-clay
pH	5.6
Organic carbon (%)	0.45
Organic matter (%)	0.78
Total N (%)	0.077
Available P (ppm)	20.00
Exchangeable K (mel 1.00 g soil)	0.10
Available S (ppm)	45

Source: SRDI, 2014

Appendix IV: Monthly average of Temperature, Relative humidity, total Rainfall and sunshine hour of the experiment site during the period from January 2014 to May 2014

Year	Month	Air temperature (°C)			Relative humidity (%)	Rainfall (mm)	Sunshine (hr)
		Maximum	Minimum	Mean			
2014	January	24.73	14.31	19.52	60.52	46	166.26
	February	28.59	17.16	22.88	50.96	3	205.05
	March	32.82	22.11	27.47	48.19	53	222.58
	April	33.45	23.63	28.54	61.87	106.2	241.40
	May	35.18	26.39	30.78	64.77	138.2	219.48

Source: Bangladesh Meteorological Department (Climate division), Agargaon, Dhaka-1212.

Appendix V : Analysis of variance (mean square) of plant dry weight of mungbean at different DAS

Sources of variation	Degrees of freedom	Mean Square			
		30 DAS	40 DAS	50 DAS	At harvest
Treatment	7	0.86	0.19**	0.57*	7.62
Replication	2	0.38	0.22*	0.41*	1.09
Error	14	0.43	0.07	0.18	0.99

* indicates significant at 5% level of probability

** indicates significant at 1% level of probability

Appendix VI : Analysis of variance (mean square) of number of grasses per plot at different DAS

Sources of variation	Degrees of freedom	Mean Square		
		15 DAS	25 DAS	35 DAS
Treatment	7	10.42	586.80**	2838.57*
Replication	2	2.167	1.62	43.04
Error	14	4.83	28.33	80.66

* indicates significant at 5% level of probability

** indicates significant at 1% level of probability

Appendix VII : Analysis of variance (mean square) of number of sedge weed per plot at different DAS

Sources of variation	Degrees of freedom	Mean Square		
		15 DAS	25 DAS	35 DAS
Treatment	7	142.38	20212.94*	83749.88**
Replication	2	255.79	22796.79	6153.87
Error	14	500.64	10023.12	3089.11

* indicates significant at 5% level of probability

** indicates significant at 1% level of probability

Appendix VIII : Analysis of variance (mean square) of number of broad leaf weed per plot at different DAS

Sources of variation	Degrees of freedom	Mean Square		
		15 DAS	25 DAS	35 DAS
Treatment	7	43.612	19517.04*	44753.23*
Replication	2	19.54	102.12	780.29
Error	14	53.77	80.601	412.43

* indicates significant at 5% level of probability

** indicates significant at 1% level of probability

Appendix IX : Analysis of variance (mean square) of number of total weed per plot at different DAS

Sources of variation	Degrees of freedom	Mean Square		
		15 DAS	25 DAS	35 DAS
Treatment	7	228.75	66256.95*	296507.93*
Replication	2	376.04	19825.16	5715.125
Error	14	727.32	9410.595238	3105.696429

* indicates significant at 5% level of probability

** indicates significant at 1% level of probability

Appendix X : Analysis of variance (mean square) of weed dry weight per square meter at different DAS

Sources of variation	Degrees of freedom	Mean Square		
		15 DAS	25 DAS	35 DAS
Treatment	7	129.23	142.38*	142.38*
Replication	2	134.37	255.79	255.79
Error	14	412.80	500.64	500.64

* indicates significant at 5% level of probability

** indicates significant at 1% level of probability

Appendix XI : Analysis of variance (mean square) of weed control efficiency for grass weeds at different DAS

Source of variation	Degree of freedom	Mean square	
		25 DAS	35 DAS
Treatment	8	458.79**	745.87*
Replication	3	122.55	146.34
Error	14	545.88	277.9037

* indicates significant at 5% level of probability

** indicates significant at 1% level of probability

Appendix XII : Analysis of variance (mean square) of weed control efficiency for sedge weeds at different DAS

Source of variation	Degree of freedom	Mean square	
		25 DAS	35 DAS
Treatment	8	2664.67*	4008.33*
Replication	3	0.6083	0.07
Error	14	1.51	0.096

* indicates significant at 5% level of probability

** indicates significant at 1% level of probability

Appendix XIII : Analysis of variance (mean square) of weed control efficiency for broad leaved weeds at different DAS

Source of variation	Degree of freedom	Mean square	
		25 DAS	35 DAS
Treatment	8	4807.41*	1300.06*
Replication	3	52.054	1068.914
Error	14	58.12	419.74

* indicates significant at 5% level of probability

** indicates significant at 1% level of probability

Appendix XIV: Analysis of variance (mean square) of weed control efficiency for total weeds at different DAS

Source of variation	Degree of freedom	Mean square	
		25 DAS	35 DAS
Treatment	8	1708.909*	213.0783*
Replication	3	0.660756	2.095074
Error	14	0.338661	0.58631

* indicates significant at 5% level of probability

** indicates significant at 1% level of probability

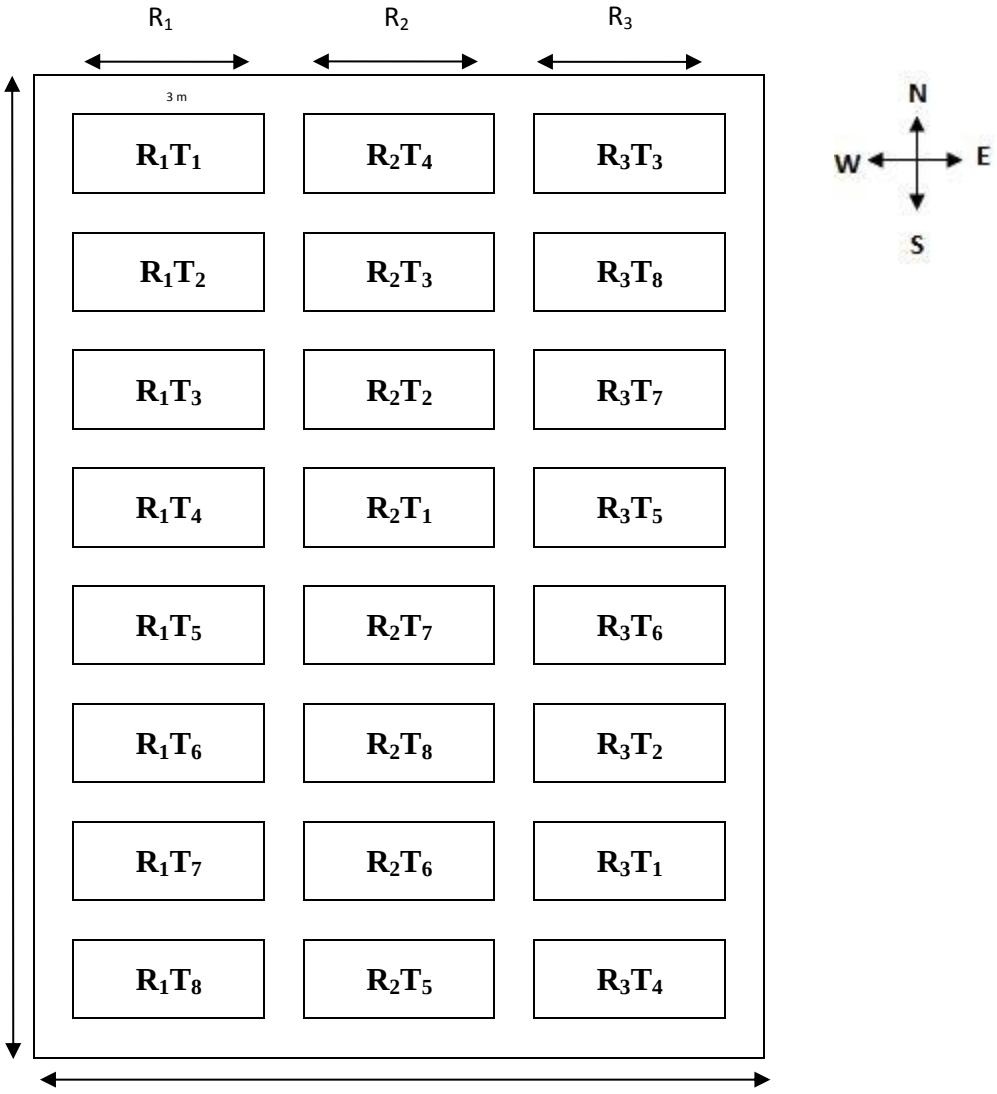
Appendix XV : Analysis of variance (mean square) of different yield contributing characters

Sources of variation	Degrees of freedom	Mean Square					
		No. of pod per plant	Pod length	Shell weight per square meter	1000 grain weight	Yield per square meter	Yield per hectare
Treatment	7	0.535*	2.493*	5.960*	3.647	3.891**	3.891**
Replication	2	0.085	6.089	3.907	3.854	3.191	3.191
Error	14	0.822	0.860	2.022	1.852	2.318	2.318

* indicates significant at 5% level of probability

** indicates significant at 1% level of probability

Appendix XVI: Experimental Layout



Number of treatment : 8
Replication : 3
Total Plot : 24
Plot to plot = 0.5 m
Block to block = 0.75 m
Plot Area : 3 × 2 = 6 m^2
Plant to plant = 10 cm
Row to row = 30 cm

R_1 = Block/ Replication 1
R_2 = Block/ Replication 2
R_3 = Block/ Replication 3

T_1 = Weedy check
T_2 = Hand weeding @15 DAS + Hand weeding @25 DAS
T_3 = Quizalofop-p-ethy l 5 EC 600 ml / ha 15 DAS + Quizalofop-p-ethyl 5 EC @ 600 ml / ha 25 DAS
T_4 = Quizalofop-p-ethyl 5 EC 650 ml /ha 15 DAS + Quizalofop-p-ethyl 5 EC @ 650 ml / ha 25 DAS
T_5 = Quizalofop-p-ethyl 5 EC 700 ml /ha 15 DAS + Quizalofop-p-ethyl 5 EC @ 700 ml / ha 25 DAS
T_6 = Quizalofop-p-ethyl 5 EC 600 ml /ha 15 DAS + Hand weeding @ 25 DAS
T_7 = Quizalofop-p-ethyl 5 EC 650 ml /acre 15 DAS + Hand weeding @ 25 DAS
T_8 = Quizalofop-p-ethyl 5 EC l 700 ml /acre 15 DAS + Hand weeding @ 25DAS

Picture 1: Land preparation

Picture 2: Germination of crop

Picture 3: Experimental field

Picture 4: Weed infested plot

Picture 5: Weed infested plot

Picture 6: Weed infested plot

Picture 7: Weeds found in plot

Picture 7: Experimental plot

Picture 8: Crop plant with pods