ALLELOPATHY AS A POSSIBLE STRATEGY FOR WEED CONTROL IN MUNGBEAN

A THESIS

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CERTIFICATE

This is to certify that thesis entitled, **"ALLELOPATHY AS A POSSIBLE STRATEGY FOR WEED CONTROL IN MUNGBEAN"** 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,** embodies the result of a piece of bona fide research work successfully carried out by **ABU NESAR MD. ANSARY** bearing Registration No. **07-02638** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

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

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Dedicated to

My

Departed Father

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The Author

ABASTRACT

The field experiment was conducted at the Agronomy Farm of Sher-e-Bangla Agricultural University (SAU), Dhaka to investigate the performance of different weed control strategies for controlling weeds growth in mungbean plots during the period from March to June 2008. The experiment was carried out in split-plot design with three replications accommodating the varieties in main plot and weed control strategies in the sub plot. The varieties were BARI mung 6 and BU mung 2 and weed control strategies were no weeding, hand weeding, herbicide application, acassia extract application, sorghum extract application, Brassica extract application and sunflower extract application. Between the varieties BARI mung 6 was better performer in reduing weed density (3.73%), weed biomass (3.21%) and increasing weed control efficiency (8.38%) at 15 DAS than BU mung 2. Allelopathic plant extracts inhibited weeds but less than hand weeding. Hand weeding and acassia extract application significantly reduced weed density by 50.39% and 40.16% with their corresponding weed control efficiency by 54% and 50% respectively. BU mung 2 and hand weeding, BARI mung 6 and acassia extract combination and also combination of variety and other plant extract showed the higher weed control efficiency. Minimum number of weeds at 15 DAS and at 45 DAS was found in the interaction of BARI mung 6 and hand weeding (7.31 weeds/m^2). Variety, weed control strategies and their interaction significantly influenced the crop, yield and other crop characters like number of pods per plant, pod length, number of seeds per pod and thousand seed weight of mungbean. Plant height was highest in acassia extract application (40.62 cm) at harvest. The highest number of pods per plant (11.34 and 14.99) was recorded from BARI mung 6 at 45 DAS and at harvest respectively. Yield of mungbean was higher in hand weeding followed by acassia extract application; herbicide application and sorghum extract application respectively. The combination of BARI mung 6 and hand weeding showed the highest grain yield (1501.00 kg ha^{-1}) that followed by the same variety with acassia extract (1402.00 kg ha^{-1}) and herbicide (1321.00 kg ha^{-1}).The grain yield increase over control by the variety BARI mung 6 with hand weeding, acassia extract and herbicide were 157.46%, 140.48% and 126.58% respectively.

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LIST OF ABBREBIATIONS

%	=	Percent
°C	=	Degree Celsius
AEZ	=	Agro-ecological Zone
B	=	Boron
BARI	=	Bangladesh Agricultural Research Institute
BBS	=	Bangladesh Bureau of Statistics
BINA	=	Bangladesh Institute of Nuclear Agriculture
BSMRAU	=	Bangabandhu Sheikh Mujibur Rahman Agricultural University
cm	=	Centimeter
CV	=	Co-efficient of variation
DAS	=	Days after sowing
DMRT	=	Duncan Multiple Range Test
et al.	=	and others
g	=	gram
K	=	Potassium
kg ha^{-1}	=	Kilogram per hectare
m	=	Meter
MP	=	Muriate of Potash
N	=	Nitrogen
P	=	Phosphorus
p^{H}	=	Hydrogen ion concentration
S	=	Sulphur
SE	=	Standard Error
TSP	=	Triple Super Phosphate

CHAPTER 1
INTRODUCTION

CHAPTER 1

INTRODUCTION

Pulse is an important food crop grown all over the country round the year. It occupies a unique position in agriculture due to its high protein content in seed and capacity of fixing atmospheric nitrogen. Legumes have been playing a vital role in conserving and maintaining soil fertility since the beginning of agriculture. Mungbean is emerging to be an important pulse crop, as it is one of the best substitutes to meet the food needs of the large population of the developing countries. Among pulse crops, Mungbean (*Vigna radiata* L.) is a good source of vegetable protein and can play vital role in the national economy.

Mungbean ranks 2nd position in price but in respect of acreages and production it ranks 3rd position in Bangladesh (BBS, 2008). According to FAO (1999) recommendation, per capita requirement of pulse is 80g/head/day whereas it is only 10.0 g/head/day in Bangladesh (BBS, 2006).

In Bangladesh, the source of protein is not sufficient for the large population. The source of animal protein is very limited for the population but the plant protein can be obtained very easily and economically. Mungbean is one of the most important pulse crops in the country for its high digestibility, good flavor and high protein content. Mungbean seeds contain 51 % carbohydrate, 26% protein, 3% minerals and 3% vitamins (Kaul, 1982). Mungbean covered an area of 59717 acres and production was about 20628 metric tons (BBS, 2008). Mungbean has special importance in intensive crop production system of the country for its short growing period.

As such of the approaches to increasing protein intake by Asian people is to increase the production & consumption of mungbean. Moreover, cultivation of mungbean can improve the physical, chemical and biological properties of soil as well as increase soil fertility status. In spite of short duration, nutritional superiority and nitrogen fixing character, it faces the weeds as main competitor when cultivated in Kharif-1& kharif-2 seasons. Weeds are the most serious pests reducing the growth and yield of crop. Modern agricultural practices contribute mostly on protection of the crop against competition from weeds. Weeds reduce yield by competing with crop plants for space, light, nutrients and carbon dioxide. There are different views about the intensity of weed losses but it is established fact that weeds cause great losses to crops, depending upon the degree of weed infestation, duration of weed competition, and soil and climatic conditions. Weeds also deteriorate the quality of farm produce and hence reducing the market value. Season long crop-weed competition reduces the green pod yield by 44.6-55.6% (Khan *et al.*, 1999).

There is no specific way to control weeds of all types because of different kinds of social, economical and environmental factors influence the choice of control method to be used. Weed could be controlled by manual, cultural and chemical methods. Although weed management practices like hand weeding and herbicide application are effective in weed control but are uneconomical due to higher costs (Cheema *et al.*, 2003). Moreover the chemical weed control method is hazardous for health and causes environmental pollution. Nowadays, allelopathy is concerned in research involving sustainable agriculture, also referred to as organic, low input, biodynamic or resource conserving. Allelopathy has been used in agricultural practices, such as weed control, intercroppings, nutrient recycling, and low-external input farming practices (Rice, 1984). The allelopathic plant products are known to offer a vast array of secondary compounds which have the potential to be used directly as herbicide substitutes or as structural leads for new bio-herbicides.

Allelopathy can be defined as an important mechanism of plant interference mediated by the addition of plant-produced secondary products to the soil rhizosphere. Allelochemicals are present in all types of plants and tissues and are released into the soil rhizosphere by a variety of mechanisms, including decomposition of residues. Allelopathic interference mechanisms are particularly difficult, if not impossible, to separate from interference due to competition under field conditions. Plant interference can be defined as any physical or chemical mechanism that results in reduction of plant growth over time due to the presence of another plant. Competition is usually described as the process whereby plants interfere with the growth of neighboring plants by utilization or competition for growth-limiting resources, including space, light, nutrients or moisture. Both competition and allelopathy as mechanisms of plant interference have been well-documented under controlled conditions. The appropriate design of laboratory bioassays to assess allelopathic activity will continue to aid in the development of our understanding of the mechanisms underlying growth inhibition and modes of action of novel allelochemicals (Inderjit and Weston, 2000).

Allelopathic chemicals for weed management in agricultural systems reduced by 40% weed when winter rape was used as an intermediate crop, and 48% weed when grown in spring. It was also found post harvest cropping of cruciferous plants in corn fields reduced weeds by up to 96%. One approach to utilize this phenomenon is suggested to screen accessions of allelopathic crops for their ability to reduce weeds, and a few crops have been evaluated in this aspect (Weston, 1996).

Sorghum (*Sorghum bicolor*) is known to provide a good weed killing capacity and showed that it is also autotoxic and should be rotated with their crops for maximum yield (Bhatti *et al*., 2000). Tawaha and Turk (2003) found that black mustard [*Brassica nigra* (L.) Koch.] contains water-soluble allelochemicals that inhibit the germination and growth of other species. This characteristic could be used in weed management programmes. Use of *sorgaab* (sorghum water extract) for weed suppression and increase in crop yield has been reported in field studies by Cheema and Khaliq (2000). Ali *et al*. (2004) reported that allelopathic plants containing allelochemicals in low quantity act as hormones and in high amount act as herbicides. Therefore, allelopathy has emerged as an important area of weed control research and has been accepted very recently as important ecological phenomena. The evidence of Allelopathic compounds in sorghum (*Sorghum bicolor*) and their subsequent effects on other plants inspired the idea of conducting field study to explore the feasibility of using Eucalyptus (*Eucalyptus camaldulensis*) and Acacia (*Acacia nilotica*) water extracts also as natural herbicides to control weeds in mungbean crop and to study their effects on growth and yield of mungbean in comparison with hand weeding and herbicides. Cheema *et al.* (2002) reported that sorghum water extract application reduced fresh weight of weeds by 48%. Cheema (1998) also reported that extract application reduced dry weight of weed by 50%. It is possible to utilize a companion plant that is selectively allelopathic against certain weeds and does not interfere appreciably with crop growth (Putnam and Duke, 1978). Rice (1984) lists a number of crop species whose presence or leachates have been shown to have inhibitory effects on a number of weeds. Leather (1986) reported that Sunflower has the ability to suppress weed. The weed biomass was reduced in plots planted with sunflowers, whether no herbicide was applied. The allelopathic properties of plants can be exploited successfully as a tool for weed reduction. So crop allelopathy can be better utilized for weed control and yield enhancement. Recent research suggests that allelopathic properties can render one species more invasive to native species and thus potentially detrimental to both agricultural and naturalized settings. In contrast, allelopathic crops offer strong potential for the development of cultivars that are more highly weed suppressive in managed settings. As experiment is therefore designed with the following objectives:

1. To identify the performance of acassia, sorghum, Brassica, sunflower extracts and herbicide for controlling weed in mungbean field.
2. To study the performance of BARI mung6 and BU mung2 at different weed controlling treatment.
3. To know the weed species and their density associated in the mungbean field.

CHAPTER 2

REVIEW OF LITERATURE

CHAPTER 2

REVIEW OF LITERATURE

Research on mungbean is being carried out extensively in many countries including Bangladesh and the South East Asian countries specially Pakistan, India for its improvement of yield and quality. More recently the Pulse Research Centre at Ishurdi, under Bangladesh Agricultural Research Institute (BARI), Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU) and Bangladesh Institute of Nuclear Agriculture (BINA) have started research for improvement of this crop. The effects of variety and weed control strategies of mungbean (*Vigna radiata* L. Wilczek) have been reviewed below in this chapter.

2.1 Effect of different weed control strategies

Mansoor *et al.* (2003) conducted an experiment to investigate the efficacy of various weed management strategies in mungbean. They had used water extracts of Sorghum, Eucalyptus and Acassia in comparison with hand weeding and pre-emergence herbicide. Mature sorghum herbage, ground leaves of Eucalyptus and pods of Acassia were used for preparing water extract in 1:5 ratios. Water extracts and hand weeding were applied twice i.e., 10 days after sowing and 35 days after sowing and found the following results. The analyzed data of Weed parameters (Weed density $m^{-2,}$ fresh weed biomass and dry weed biomass) at 20 and 45 *days* after sowing of mungbean and yield parameters revealed that all the weed management strategies had significant effect on the fresh weight of weeds. The lowest weed density m^{-2}, fresh weed biomass and dry weed biomass was recorded in plots sprayed with Acassia water. In case of yield parameters the highest number of branches/plant, pods/pant and highest grain yield/ha was obtained from the Acassia extract application treatment.

Cheema *et al.* (2001 a) also reported that with the application of water extracts number of branches per plant and number of pods per plant was increased.

Jones *et al.* (1998) reported that some crop residues were known to have a chemical (allelopathic) as well as physical effect on the growth of subsequent crops and weeds consisted of plots planted to barley, canola, chickpea, fieldpea, mungbean, sorghum and a fallowed control. Four target weed species were planted following these crops. Barley was found to be the most inhibitory (64% and 47% of the fallow treatment for incorporated residue and surface residue treatments respectively). Fieldpea was found to have a significant stimulatory effect on overall weed dry matter production (127%), on incorporated plots, yet did not affect the survival rate of target weeds.

Khaliq *et al.* (2003) explored selective allelopathic character of sorghum water extract alone and in combination with two herbicides for controlling weeds in mungbean. Two hand weedings reduced dry weight of all weeds by 79% (maximum) which was at par with combined pre-em sprays of s. metolachlor @ 1.15 kg a.i. ha^{-1}+sorgaab (conc.) @ 10 L ha^{-1} (78%) and Pendimethalin @ 165 g a.i. ha^{-1}+sorgaab (conc.) @ 10 L ha^{-1} with 78 and 75% weed dry weight reduction, respectively, over control. Maximum plant height and number of grains per pod were recorded in plots with two hand hoeings at 15 and 30 days after sowing (DAS) and were at par with s. metolachlor @ 2.3 kg a.i. ha^{-1} and Pendimethalin @ 330 g a.i. ha^{-1} alone and with combination of both of these herbicides @ 1.15 kg and 165 g a.i. ha^{-1}, respectively with sorgaab. Hand hoeing also resulted in highest 1000-grain weight and was followed by Pendimethalin @ 165 g a.i. ha^{-1}+sorgaab (conc.) @ 10 L ha^{-1} that was at par with s. metolachlor alone @ 2.3 kg a.i. ha^{-1} and @ 1.15 kg a.i. ha^{-1} in combination with sorgaab.

Cheema *et al.* (2001 b) carried out to examine the feasibility of using sorgaab (sorghum water extract) as a natural weed inhibitor in spring mungbean. Sorgaab sprays (1-4) were tested and compared with one hand weeding and pre-emergence application of pendimethalin @ 1.0 kg a.i. ha^{-1}. Results of the study showed that three foliar sprays of sorgaab (20 + 30 + 40 DAS), one hand weeding (30 DAS) and pendimethalin spray (1.0 kg a.i. ha^{-1}) inhibited the total weed density by 31.58, 22.81 and 35.96%, respectively. An inhibition of 44.11, 28 and 43% in total weed dry weight was noticed by three sorgaab sprays, one hand weeding and pendimethalin treatment, respectively. Three sorgaab sprays enhanced grain yield of mungbean by 18%, while hand weeding and pendimethalin treatment increased grain yield by 10% and 13%, respectively.

Hussian (2002) sparyed various combination of sorgaab with different crop extracts at sowing and 15 days after sowing (DAS) while sorgaab combined with lower doses of pendimethalin and full dose of pendimethalin were sprayed only at sowing with the help of knapsack hand sprayer. Sorgaab @ 10 L ha^{-1} + 2/3 pendimethalin @ 1.0 kg a.i. ha^{-1} reduced total weed population by 92.57% and was statistically on par with full dose of pendimethalin @ 1.5 kg a.i. ha^{-1} (93.33%). Sorgaab @ 10 L ha^{-1} + 1/3 pendimethalin @ 0.5 kg a.i. ha^{-1} and sorgaab @ 10 L ha^{-1} + 1/2 pendimethalin @ 0.75 kg a.i. ha^{-1} reduced total weed density by 74 and 79% respectively which were statistically different from each other. Sorgaab @ 10 L ha^{-1} + 2/3 pendimethalin @ 1.0 kg a.i. ha^{-1} reduced total fresh and dry weight by 80-96% and was on par with full dose of herbicide. Sorgaab + eucalyptus extracts each @ 10 L ha^{-1} and sorgaab + sunflower + eucalyptus extracts each 10 L ha^{-1} increased total weed fresh and dry weights indicating that these interacted with each other to nullify their allelopathic effects. Maximum grain yield was obtained in T8 i.e. sorgaab @ 10 L ha^{-1}, + 2/3 pendimethalin @ 1.0 kg a.i. ha^{-1} (23%) followed by sorgaab @ 10 L ha^{-1} + 1/2 pendimethalin @ 0.75 kg a.i. ha^{-1} (22%) which were statistically on par while only 14% increase was noted in case of full dose of pendimethalin and it was on par with s orgaab @ 10 L ha^{-1} + 1/3 pendimethalin @ 0.5 kg a.i. ha^{-1} which enhanced grain yield by 13% over control.

Cheema *et al.* (2008) investigate that inclusion of allelopathic crops in rotation systems for weed suppression by early post-emergence application of the mixture of sorghum, sunflower, brassica or mulberry water extracts suppressed total weed dry weight by 40 to 75% and enhanced yield of wheat, maize, cotton and rice by 15 to 25%. Combined application of these water extracts reduced the herbicide(s) dose by 50 to 75%. The intercropping of mungbean in maize was effective to control weeds by 55% and was economical in terms of net benefits. Sorghum and berseem in rotation settings decreased weeds by 85%.

Younesabadi *et al.* (2008) tested herbicidal effects of 6 plant species water extract on germination and growth of *Phalaris minor* Root length of *Phalaris minor* had no change by treatments, although a little decrease was observed in generally. 75% and 100% concentration of all extracts had significant reduction on stem length of *Phalaris minor* but lower doses had no effects on stem length.

Ramanujam *et al.* (2008) investigated by exposing green gram seeds and seedlings to 0, 1.0, 2.5 and 5% concentrations of the aqueous leaf extract adversely affected germination and seedling growth (length, and biomass of shoot, root and plant) lateral root development and nodulation. Besides nodule number and size, the activity of nitrate reductase was inhibited too.

Cheema et *al.* (2002) reported that extract application decreased the weed population, reduced fresh weight of weeds by 48% and dry weight of weed by 50%.

Teasdale (2008) has shown that phytotoxins might be more effective at suppressing weeds when combined synergistically with the etiolating influence of surface mulch; this was a potentially important area for future investigation. As a result of these multiple stimulatory and inhibitory effects, it might be difficult to predict weed suppression by a leguminous cover crop such as hairy vetch. Clearly, more research was needed to optimize management of these complex interactions to selectively promote crop production and limit weed interference.

Canola extract at 0.1% concentration stimulated redroot pigweed shoot growth compared to water. Germination of redroot pigweed was only inhibited by lentil extracts at 1 and 2%. Root growth was reduced by all extracts at 1 and 2% compared to water but was only reduced by lentil extract at 0.1%. Shoot growth was only reduced compared to water by lentil extract at 2% .Green foxtail germination was not suppressed by any of the extracts. Root growth was suppressed by lentil, canola, and oat extracts at 0.1 %. At 1 % and 2% all extracts suppressed root growth. Shoot growth was not affected by any plant extracts at 0.1% and was only suppressed by lentil extract at 1%. Lentil, canola, and barley extracts at 2% suppressed green foxtail shoot growth (Smith *et al.*, 1999).

Pegeonpea *(Cajanus cajan)* and velvet bean *(Mucuna deeringiana)* reduced weeds to the level where farmers do not weed at all. These legumes have even controlled Purple nutsedge *(Cyperus rotundus),* the most damaging weed world wide (White *et al.*, 1989).

Javid and Shafiqe (2006) reported that root and shoot extract of three allelopathic crop viz. sunflower *(Helianthus annuus L.)*, sorghum *(Sorghum bicolor L.)* and rice *(Oryza sativa L.)* have strong inhibitory effect on germination and growth of the noxious alien weed *Parthenium hysterophorus L. Parthenium hysterophorus* belongs to the family Asteracaeae (compositae), many plants of which are capable of causing allergic contact dermatitis. Applications of aqueous root and shoot extract [5, 10, 15, 20 and 25 % (wlv)] of the fresh plant material had insignificant effect on shoot length and seedling biomass while germination and root length were significantly reduced by extracts of all the test crops. In a foliar spray bioassay the root biomass of *Parthenium* plants was significantly suppressed by 50 and 100% (w/v) extracts of both sunflower and sorghum. Both concentrations of sorghum extracts significantly reduced shoot biomass, but sunflower extract was effective only at the lower concentration.

Leather (1986) reported that Sunflower had the ability to suppress weed. The weed biomass was reduced in plots planted with sunflowers, whether no herbicide was applied. Auto toxicity of sunflower crop residues remains after the first-year harvest.

Alfalfa (*Medicago sativa* L.) was reported to contain allelopathic chemicals that inhibit the growth of weeds. The results indicated that alfalfa pellet significantly inhibited germination and growth of 4 weed species, viz., *Echinochloa orygicola, Digitaria ciliaris, Cyperus difformis and Monocholia vaginalis* in rice paddies. Among the 4 tested weeds, the maximum inhibitory effect of alfalfa pellet was seen against Cyperus difformis. The degree of inhibition of weed growth by alfalfa pellet became stronger as the application of concentration increased (Xuan and Tsuzuki, 2001).

Rotation with sorghum (*Sorghum bicolor* L.) suggested that this species was allelopathic. This phytotoxicity is associated with a group of lipid benzoquinones called sorgoleone that exude from the root hairs of sorghum. Sorgoleone is released directly in the soil and acts like a pre-plant incorporated herbicide. Therefore, the allelopathic effect of sorgoleone strong on young developing plants, which might take up sufficient amount of sorgoleone (Dayan, 2008).

Rye (*Secale cereale*) is used as a winter cover crop, often for the allelopathic weed suppression provided by the mulch. Rye produces several allelochemicals, the principle allelochemical group include the benzoxazinone (BX), represented by DIBOA (Burton *et al.*, 2008).

Rice allelopathic activity is variety dependent and origin dependent, where Japonica rice shows greater allelopathic activity than Indica and Japonica-Indica hybrid. More recently, critical review on rice allelopathy and the possibility for weed management of Khanh *et al.* (2007) reported that allelopathic characteristics in rice were quantitatively inherited and several allelopathy-involved traits had been identified.

Olofsdotter (2001) revealed that allelopathy accounted for 34% of overall competitive ability in rice. For strongly allelopathic cultivars, allelopathy was the dominant factor determining competitive ability (Olofsdotter *et al.*, 2002). Rice allelopathy played role in field condition and allelopathic rice could suppress mono and dicot weed species.

Parthenium (*Parthenium hysterophorus* L.) an annual invasive weed native to tropical America, is rapidly spreading in many parts of the world. Javaid *et al.* (2008) designed to manage this weed by exploiting allelopathic potential of rice (*Oryza sativa* L.). In a laboratory bioassay, effect of aqueous, methanol and hexane shoot extracts of 0, 2, 4 and 10% concentrations of three rice varieties viz. Basmati-385, Basmati-386 and Basmati Super was tested against germination and seedling growth of parthenium. Aqueous and methanol extracts exhibited phytotoxicity against the test weed species.

Rice allelopathy has received much attention, and may be an alternative to the chemical and mechanical control of weeds to reduce use of chemical herbicides. It was therefore of interest to assess the allelopathic potential of Bangladesh rice cultivars for weed control purposes. The allelopathic potential of 102 Bangladesh rice (42 high yielding and 60 traditional cultivars) was determined against the seedling growth of cress, lettuce, *Echinochloa crusgalli* and *E. colonum.* High yielding rice cultivars, BRRI dhan37, BRRI dhan30 and BRRI dhan38, respectively, had the most significant inhibiting effect on the growth of cress, lettuce and *E. colonum,* and traditional rice cultivar, Kartikshail had the most significant inhibiting effect on barnyard grass. The high yielding rice cultivar, BR 17 marked the greatest inhibitory activity with an average of 39.5% of the growth inhibition on roots and hypocotyls/shoots of cress, lettuce, barnyard grass and *E. colonum* (Noguchi and Salam, 2008).

Rehman *et al.* (2008) investigate the effect of plant population (0.20, 0.25 and 0.30 million plants ha^{-1}) against sorghum, sunflower and rice water extracts each at 15 and 18 L ha^{-1} (20, 40 and 60 DAT) and a post-emergence herbicide Nominee (bispyribac-sodium 100 SC) at 21 g a.i. ha^{-1} 20 days after transplanting (DAT), on weeds in rice. On an average, 45 and 52% reduction in total weed dry weight during three years of experimentation was recorded at 75 DAT. Foliar spray of allelopathic extract mixtures at 15 and 18 L significantly suppressed (46 to 61%) total weed dry matter production.

Kong and Xu (2008) indicated that allelopathic rice seedlings could establish weed defense mechanism through the production and release of 3-isopropyl-5 acetoxycyclohexene-2-one-1, momilactone B and 5, 7, 4 trihydroxy-3, 5-dimethoxyflavone. These results suggested that allelochemicals involved in rice allelopathy from living and dead plants are substantially different.

Moyer and Huang (1993) conducted an experiment to observe the effect of crop residue on germination and growth of weeds. In this experiment they used the aquas extract of six different crop residue which were Canola (*Brassica napus* L.), Rye (*Secale cereale* L.), Barley (*Hordeum vulgare* L.), Oats (Avena sativa L.), Indian Head lentil (*Lens culinaris* Medic), and Wheat (*Triticum aestivum* L.). They noticed that crop extract also reduce germination and growth of other crops. Wheat germination was reduced by lentil, oat, and canola extracts at 4% (Fig. 5a). Wheat root growth was suppressed by all plant extracts except wheat at 1 %. None of the extracts inhibited shoot growth at 1 %. At 2% extracts of lentil, oat, and canola inhibited wheat shoot growth, and at 4% all plant extracts inhibited shoot growth.

Khan *et al.* (2004) reported the inhibitory effect of tree extracts on the germination of weeds of wheat crop. Ali *et al.* (2004) reported that water extract application increased the grain yield of crops.

Wheat is frequently affected by weeds that cause about 20 to 30% yield reduction. A two year research project was initiated at Agronomy department, Sher-e-Bangla Agricultural University, Bangladesh to study the allelopathic effects of *Brassica spp.* to control weeds in wheat. *Brassica* crops were uprooted at initiation of flowering and applied in the same field. *Amaranthus spinosus, Amaranthus viridis, Heliotropium indicum, Polygonum hydropiper, Celosis argentina, Ageratum conyzoides, Brassica kaber and Digitaria ischaemum* were not found to the wheat field. The highest weed dry matter yields was recorded in *Brassica juncea* plots (1.72 g/m^2) at 30 DAS and in *Brassica napus* field (1.44 g/m^2) at 50 DAS. The lowest weed dry matter (0.89 g/m^2) was recorded when total *Brassica* biomass was incorporated into the soil 30 DAS and 50% incorporation plus 50% spreading 50 DAS. Weed population densities were not affected by *Brassica* species 30 and 50 DAS and by the incorporation methods 50 DAS, although the lowest weed population (15.33/m^2) was recorded in spreading between lines that were similar to complete incorporation and 50% spreading plus 50% incorporation 30 DAS. Interaction of *Brassica* species and incorporation methods showed lowest weed dry matter (0.74 g/m^2) 30 DAS in *Brassica napus* biomass incorporated into the soil (Biswas *et al.*, 2008).

Saeed *et al.* (2008) conducted a field experiment to assess the efficacy of water extract of allelopathic crops, sorghum and sunflower, in combination with reduced doses of some post emergence herbicides. It was found that sorghum and sunflower extracts in combination with reduced herbicide doses of all herbicides effectively controlled the weeds of wheat and at the same time 20-36% increase in grain yield was obtained, which was equal to the grain yield achieved with application of recommended doses of herbicides.

Kamal and Bano (2008) studied the allelopathic potential of root extract from sunflower and its effect at different concentrations were applied to determine their effect on two wheat varieties cv-Margalla 99 and cv-Chakwall 97 seed germination rate, fresh weight, dry weight, shoot length, hormonal analysis (IAA, GA and ABA). Water extract of sunflower root significantly inhibited germination rate, seedling growth, fresh weight, dry weight, root length, shoot length, IAA, and GA.

Allelochemicals extracted from various plant species could act as natural weed inhibitors. In a laboratory experiment, four allelopathic plant extracts (sorghum (*Sorghum bicolor* L.), mulberry (*Morus alba* L.), barnyard grass (*Echionoachloa crusgalli* L.) and winter cherry (*Withania somnifera* L.) were tested for the inhibition of most problematic weed of wheat, canarygrass (*Phalaris minor* Ritz.) (Jabran *et al.*, 2008).

Mahmood *et al.* (2008 a) explore possibilities of reducing herbicide dose in combination with different allelopathic plant water extracts for weed management in maize by applying Atrazine (Atrazine 38SC) at 0.167 kg a.i. ha^{-1} was tank mixed with 18 L ha^{-1} water extracts each of sorghum + brassica + mulberry, sorghum + brassica + sunflower, sorghum + sunflower + rice, sorghum+ sunflower + maize and sorghum + maize + rice as early post-emergence, i.e., 15 days after sowing (DAS).Weed species present in the experimental area were *Trianthema portulacastrum, Cyprus rotundus, Dactyloctenium aegyptium, Cynodon dactylon* and *Cleome viscosa.* Combination of sorghum + sunflower + brassica each at 18 L ha^{-1} and 1/3 dose of atrazine (0.167 kg ha^{-1}) reduced total weed dry weight by 86 to 75% at 45 DAS respectively. Maize yield increased by 48 to 51 % by the combination treatment of sorghum + sunflower + brassica water extracts each at 18 L ha^{-1} and with 1/3 dose of atrazine (0.167 kg ha^{-1}) as early post emergence (15 DAS) over the control, respectively, and yields were equal to the yields obtained from the recommended rate of S-metolachlor + atrazine and atrazine alone.

Mahmood *et al.* (2008 b) evaluate the allelopathic influence of mulches of different plant residues as sorghum *(Sorghum bicolor),* sunflower *(Helianthus annus),* rice *(Oryza sativa)* and maize *(Zea mays)* applied in a combination of three each at 6.0 Mg ha^{-1} as surface application at sowing. Combination of rice + sunflower + maize each at 6.0 Mg ha^{-1} was relatively better in reducing the total weed dry weight by 70 to 85% and was followed by treatment combination of sorghum + sunflower + maize each at 6.0 Mg ha^{-1} with 58 to 81% reduction. The combination of rice + sunflower + maize each at 6.0 Mg ha^{-1} increased maize yield by 54 to 69% as compared to the control and yield was similar to the yield obtained from Smetolachlor + atrazine treatment.

Allelopathy had shown its potential for biological weed control in a study conducted to determine the phytotoxic effect of wheat straw (burned and unburned) on *Chenopodium album* L., *Boerhaavia diffusa* L. and *Parthenium hysterophorus* L. (Jayakumar and Meena, 2008).

Cheema *et al.* (1998) conducted a series of field experiments to test allelopathic effects of this crop on weed control and yield of wheat and found that 10% w/v water leachate of aerial parts of sorghum (also called sorgaab) applied at 30 and 60 days after sowing can reduce weed biomass by as much as 49% with concomitant increase of wheat yield over 20% compared to control. Furthermore, use of sorgaab in combination of herbicides can significantly reduce the amount of herbicide use (by 50%) and get comparable grain yield of wheat as obtained by using the recommended dose of the herbicides.

Davasagayam and Ebenezar (1996) conducted an experiment onallelopathic effect of eucalyptus on arable crop and found that seed germination was decreased in all crops by eucalyptus leaf extract. Groundnut and cowpeas were the most tolerant (4 and 6%) decrease in germination, respectively, compared with the control where as inhibition was high in sorghum (16.3%), soyabean (10.9%), maize (8.9%) and blackgram (7.1%).

Khan *et al.* (1999) conducted an experiment on allelopathic effect of eucalyptus on maize crop and found that eucalyptus extract reduced the germination percentage of maize and delayed germination compared with control, while dry matter production was increased.

Cheema *et al.* (2003) revealed that atrazine (150 g a.i. ha^{-1}) in combination with sorgaab (12 L ha^{-1}) gave 39% maize grain yield increase over control while atrazine alone (300 g a.i. ha^{-1}) gave 41% higher yield than control in maize.

Tawaha and Turk (2003) observed that soil incorporation of fresh black mustard roots and both roots and shoots reduced wild barley germination, plant height and weight when compared with a no-residue control. In bioassays, black mustard extracts reduced wild barley hypocotyl length, hypocotyl weight, radicle weight, seed germination, and radicle length by as much as 44, 55, 57, 63 and 75 %, respectively, when compared with a water control. Increasing the water extract concentrations from 4 to 20 g per 100 ml of water of all black mustard parts significantly increased the inhibition of wild barley germination, seedling length and weight.

Norsworthy (2003) reported that, wild radish (*Raphanus raphanistrum* L.) aqueous extract or incorporated residues (or both) suppress seed germination, radicle growth, seedling emergence, and seedling growth of certain crops and weeds and these responses were attributed to an allelochemical effect. The emergence and shoot fresh weight of the bioassay plants were reduced by wild radish residue incorporated into soil, with the level of suppression dependent on the quantity of residue incorporated. Sicklepod (*Senna obtusifolia* L.) and prickly sida (*Sida spinosa* L.) were extremely sensitive to incorporated wild radish residues, with > 95% fresh weight reduction at 0.5% (wt/wt) residue, compared with an untreated control.

Crop water extracts (sorghum, sunflower and Brassica) @ 12 and 15 L ha^{-1} in different combinations were tank mixed with reduced rates of glyphosate at 67% (767 g a.e. ha^{-1}) of label rate (2.3 kg a.e. ha^{-1}) and sprayed as directed post emergence at 40 days after sowing (DAS). Purple nutsedge density was decreased by 59-99% and dry weight by 66-99% as compared to control. The high rate of crop water extracts (15 L ha^{-1}) significantly reduced the growth of purple nutsedge more than the lower rates (12 L ha^{-1}). Seed cotton yield in these treatments was comparable to herbicide applied at recommended rates (Igbal and Cheema, 2008).

Boydston (2008) observed that brassicaceae cover crops suppress weeds due to fast emergence and vigorous competitive growth during fall establishment and allelopathic substances released during degradation of the cover crop residues. Early season weed emergence was often suppressed following fall-planted *S. alba* or *B. napus* cover crops. The mechanisms of weed suppression with Brassicaceae cover crops were not completely understood, but breakdown products of glucosinolates, such as isothiocyanates and ionic thiocyanate (SCN) are believed to contribute to weed suppression.

Singh *et al.* (1971) stated that while early weed competition was prevented the subsequent vigorous stands of the crop smothered out the late emerging; weeds. Somehow or others, if weeding operation in kharif mungbean was neglected or deffered for a fortnight or so, it would be rather impossible to compensate the losses already taken place.

Madrid and Vega (1971) conducted an experiment to study the effect of the duration of weed control and weed competition on the yield of mungbean for two successive seasons. Optimum yield of mungbean was obtained when the fields were kept weed free for 5 weeks from seeding during the wet season and 3 weeks during the dry season. An yield of 1020.83 kg ha^{-1} was obtained from the 5 weeks weed free period in wet season. If weeds were left uncontrolled, the yield of mungbean was reduced by as much as 90%.

Singh (1975) observed that mungbean plants grown in two weeded plots were taller and had maximum number of branches and pods $plant^{-1}$ but the yields from the two weeded plots were identical to that of one weeded plots. Singh *et al.* (1975) also found that plant productivity (pods $plant^{-1}$) improved markedly due to reduction in weed infestation in cowpea. Similarly, Pahuja *et al.* (1975) reported that weeding had a significant influence on plant height, number of pods plant' and seed yield.

Enyi (1973) suggested that in mungbean weeding 2 weeks after sowing was significantly superior to that at either 4 or 8 weeks after sowing. Plants in the plots weeded 5 weeks after sowing and in the unweeded plots had few or no branches. Late weeding and no weeding reduced the proportion of dry matter diverted into the side stems. The number of pods $plant^{-1}$ at harvest was the highest (30) in the plots where two weeding, 2 and 4 weeks after sowing were done and was the lowest in the unweeded plots. Grain yield was also to highest (967 kg ha^{-1}) in plots that received weeding 2 and 4 weeks after sowing and the lowest (278 kg ha^{-1}) in the unweeded plots.

Retinahm *et al.* (1974) observed that grain, yield and yield attributes were inversely correlated with dry matter of weeds. The highest dry matter (43 8 g m^{-2}) of weeds resulted in the lowest grain yield (192 kg ha^{-1}) and reduced the number of seeds pod^{-1} (7) and number of pods $plant^{-1}$ (4), while the highest seed yield (480 kg ha^{-1}) and increased seeds pod^{-1} (9) and number of pods $plant^{-1}$ (11) were recorded where weed dry matter was minimum (138 g m^{-2}).

In a study on the competition of weeds in mungbean, Castin *et al.* (1976) observed that dry matter content of weeds in the unweeded, one hand weeded and two hand weeded plots were 2539, 1147 and 716 kg ha^{-1}, respectively and the seed yields were 154, 292 and 325 kg ha^{-1}, respectively. Similar effect of weeds on the yield of mungbean was observed by Singh *et al.* (1971). Seed yields of 876 kg ha^{-1} and 1455 kg ha^{-1} were obtained from the unweeded control and the two weeded treatment, respectively.

Vat and Sidhu (1976) reported that higher grain yield under weed free treatment can be ascribed for better crop growth since the weed population remained lower at 30 days of crop stage which was considered to be the critical for controlling weeds.

Singh and Faroda (1977) reported that weeds were serious problem in green gram *(Vigna radiata)* during kharif season. Most of the weeds emerged in the early stages along with crop seedlings and competed with them for nutrients and they concluded that yield reduction as a result of crop weed competition was one of the important features in green gram production.

Vat and Sidhu (1977) observed that weeds reduced the yield of mungbean by 50%. One weeding at 4 weeks after sowing was quite effective in controlling weeds. Weed free condition of 2 or 4 weeks after sowing and throughout the crop season gave comparable results. From this study, they concluded that in the case of mungbean critical period of crop weed competition was 4 to 6 weeks after sowing.

Panwar and Pandey (1977) conducted an experiment on weed control in Bengal gram in which seed yields of 1.63 t ha^{-1}, 2.72 t ha^{-1} and 3.25 t ha^{-1}, respectively were obtained from no weeding, two hand weeding and weed free condition, respectively.

The maximum plant height, maximum number of pods plant' and the highest grain yield were obtained from weed free treatment and the lowest from no weeding control (Naseem, 1995).

At Gazipur, Talukder *et al.* (1993) reported that the highest yield (1762 kg ha^{-1}) of mungbean was obtained in plots of 33 plants m^{-2} that was emergence and the lowest yield (1137 kg ha^{-1}) in plots of 50 plants m^{-2} that remained unweeded. Delay in weeding decreased seed yield and yield attributes of mungbean but increased the dry biomass of weeds. The critical period of weed control appeared to be between 7 and 14 DAE. Unrestricted of weeds reduced mungbean seed yield by 30% to 33%.

Sangakkara *et al.* (1995) observed that the adverse effect of weeds was greatest on vegetative growth. The influence on yield components decreased with time. The study indicated vegetative phase as the critical competitive period.

In Bihar, India, Jha *et al.* (1997) conducted a field experiment during summer of 1994 to study the crop weed associations in mungbean and determine the occurrence and frequency distribution of weed species at different time intervals during the crop season.

Singh *et al.* (1996) carried out a field experiment on green gram cultivar k851 to determine the crop weed competition in summer green gram and they found that seed yield was decreased by 35% when the crop was infested for the first 30 DAS. Yield increased with increase in weed free duration to the first 45 DAS (0.81 t ha^{-1}) compared with (0.88 t ha^{-1}) in free plots.

Riaz *et al.* (2006) conducted a field study to determine the effect of different weed control methods on the yield and yield components of mungbean (*Vigna radiata* L.). Among different weed control methods, use of herbicide tribunal 70 WP (methabenzthiazuron) @ 2 kg ha^{-1} at 2 - 3 leaf stage of weeds + hand-weeding at 50 DAS gave promising results in terms of weed reduction. This was closely followed by mechanical weeding after 20 days of crop sowing with a follow-up hand-weeding after 50 days of crop sowing and/or two hand-weeding after 20 and 40 days of crop sowing. Maximum reduction in density and biomass of the weeds was observed by chemicalweeding at 2 - 3 leaf stage of weeds + hand-weeding at 50 DAS. There was a significant increase (50%) in grain yield of mungbean due to chemicalweeding at 2 - 3 leaf stage of weeds + hand-weeding at 50 DAS. Similarly, this treatment out yielded other treatments in terms of number of pods per plant, number of seeds per pod, 1000 grain weight, grain yield and net benefits. The economic analysis of these weed control methods also showed better performance of chemical-weeding at 2 - 3 leaf stage of weeds + handweeding at 50 DAS as compared to rest of the treatments.

2.2 Effect of Variety

Mitra and Bhattacharya (1999) conducted a field experiment in India during the kharif (rainy) seasons of 1996 and 1997 to study the effects of cultivars on the growth and seed yield of mungbean. They observed that mungbean cv. GM9002 had greater dry matter (at harvest), number of pods plant^{-1}, number of seeds pod^{-1}, 1000-seed weight, seed yield and total biomass yields than cv. UPM-12 or MH-309.

BINA (1998) reported that MC-18 (BINA mung5) produced higher seed yield over BINA mung2. Field duration of BINA mung5 is about 78 days to mature while 82 days for BINA mung2.

Mohanty *et al.* (1998) observed that among nine mungbean (*Vigna radiata*) cultivars, Kalamung was the best performing cultivar, with a potential seed yield of 793.65 kg ha^{-1}, the highest number of pods plant^{-1} (18.67) and highest number of seeds pod^{-1} (10.43).

Sinha *et al.* (1996) conducted a field experiment in Bihar with 40 mungbean cultivars. They found that significant variation existed among the cultivars for plant height, pods plant^{-1} and single plant yield.

In a field experiment, carried out by Nayak and Patra (2000) eight improved and 4 local mungbean cultivars were evaluated. Results of their study revealed that yield was 0.45-0.63 t ha^{-1} in the improved cultivars and 0.61-1.01 t ha^{-1} in the local cultivars.

Santella *et al.* (2001) evaluated the performance of 7 mungbean cultivars (Testigo, VC 1973C, VC 4443 A, VC 2768 A, VC 1973 A, ML 267 and NM 94) in a field experiment conducted in Venezuela. They reported that the number of pods plant^{-1}, pod length, number of seeds pod^{-1}, 1000-seed weight and yield ranged from 31.75 to 53.00, 7.48 to 9.58 cm, 8.59 to 9.85 cm, 34.18 to 63.23 g and 1175.05 to 1815.05 kg ha^{-1}, respectively.

Ahmed *et al.* (2003) conducted a pot experiment in Bangladesh on the growth and yield of mungbean cultivars Kanti, BARImung4, BARI mung5, BU mung1 and BINA mung5. The seed yield of Kanti, BARI mung3 and BARI mung4 were higher than those of the rest of the cultivars.

It was reported that in Bangladesh condition BARImung 2 contributed higher seed yield than BARI mung5. BINA mung2 had the highest number of branches plant'. The highest number of pods plant' was recorded for BARI mung3. Pod length was greatest in BARI mung5. The highest 1000 seed weight was obtained by BARI mung5. BARI mung2 produced the highest seed yield and harvest index. The lowest seed yield and harvest index were recorded for BARI mung3 (Sarkar *et al.*, 2004).

An experiment was conducted to study and select good varieties of mungbean that have high yields and suitable agronomic. A total of 20 mungbean varieties from AVRDC were evaluated for their yields and other agronomic characters. KPS-2 served as the check. VC 1973 A gave the highest yield at 1,281 kg/ha, significantly higher than the check. It also exhibited good agronomic characters (Hun, 1999).

CHAPTER 3
MATERIALS AND METHODS

CHAPTER 3

MATERIALS AND METHODS

In this chapter, details of different materials used and methodology followed during the experimental period are described.

3.1 Experimental site

The research work was carried out at the experimental field of The Department of Agronomy, Sher-e-Bangla Agricultural University, Dhaka during the period from March to June 2008. The experimental field was located at 90° 33' E longitude and 23° 71' N latitude at a height of 9 m above the sea level. The land belonges to the Agro-ecological zone "Madhupur Tract" (AEZ-28) of Nodda soil series which have been presented in Appendix I.

3.2 Soil

The experimental site was situated on medium high with well drained soil. The physical and chemical properties of soil of the experimental site were examined prior to experimentation from 0-15 cm depth. The soil was sandy loam in texture and having soil pH 5.55. Organic matter content was very low (0.83%). The physical composition such as sand, silt, clay content were 40%, 40% and 20%, respectively. The chemical properties of the experimental soil have been presented in Appendix II.

3.3 Climate

The climate of the experimental field was sub-tropical and was characterized by high temperature, heavy rainfall during Kharif-l season (March - June) and scanty of rainfall during Rabi season (October - March) associated with moderately low temperature. The mean average temperature during the experimentation was 26.37°- 28.36°C. The prevailing weather data during the study period have been presented in Appendix III.

3.4 Planting material

Two Mungbean varieties viz. BARImung 6 and BUmung 2 were used as planting materials for the investigation. The salient features of these varieties are described as below:

a) **BARI mung6**: BARI mung6 released in Bangladesh in 2003 for stable and high yield with combined resistance to Mungbean Yellow mosaic virus (MYMV) and Cercospora Leaf spot (CLS). BARI mung6 (NM 94) was introduced from Asian Vegetable Research and Development Center (AVRDC). Plant height was 40-45 cm and days to maturity were 55-60 days after emergence. Seeds were drum shaped, dull and greenish, 1000 seed weight was 45.5 g and finally yield was 1500 kg ha^{-1}.

b) **BU mung2**: BU mung2 was developed jointly by Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur -1703, and Lentil Blackgram Mungbean Development Pilot Project (LBMDPP), BARI, Gazipur-1701, Bangladesh. Plant height was 30-35 cm and days to maturity were 55-60 days after emergence. Seed color was green and 1000 seed was 55.0 g.

3.5 Land preparation

The land was first opened with the tractor drawn disc plough. Ploughed soil was then brought into desirable fine tilth by 4 operations of ploughing and harrowing with country plough and ladder. The stubble and weeds were removed. The first ploughing and the final land preparation were done on 15 March and 23 March 2008, respectively. Experimental land was divided into unit plots following the design of experiment. The plots were spaded one day before planting and the basal dose of fertilizers was incorporated thoroughly before planting.

3.6 Fertilizer application

Urea, triple super phosphate (TSP) and muriate of potash (MP) were used as source of nitrogen, phosphorus and potassium, respectively. Whole amount of Urea, TSP, MP and Boric acid were applied at the time of final land preparation. The rate of urea, TSP, MP and Boric acid was 45, 100, 50 and 1 kg ha^{-1}, respectively.

3.7 Treatments of the experiment

Main Plot (Variety)

1. BARI mung 6 -V_1
2. BU mung 2 -V_2

Sub Plot (Weed control strategies)

1. Control (No weeding) -W_1
2. Hand weeding -W_2
3. Herbicide (Basta) -W_3
4. Sorghum extract -W_4
5. Acassia extract -W_5
6. Sunflower extract -W_6
7. Brassica extract -W_7

3.8 Collection and preparation of different plant extract

The sorghum, acassia, sunflower and Brassica plant parts (leaf, stem, root and shoot) separately used in the present study was collected from Farm Division of Sher-e-Bangla Agricultural University. These plant parts were chopped into small pieces and were used for preparing water extract in 1: 2.5 ratios. The materials were soaked in water for 24 hours and then sprayed in the respective treatments at the rate of 5 litre per 45 m^2 area (Mansoor *et al.*, 2003).

3.9 Experimental design and lay out

The experiment was laid out in a Split Plot Design with three replication. The size of a unit plot was 3 m x 2.5 m. The distance between two adjacent replications (block) was 1.5 m and distance between two plots within replication was 1 m. The inter block and inter row spaces were used as footpath and irrigation/drainage channels.

3.10 Sowing of seeds

Seeds were sown by hand on 24 March, 2008 continuously maintaining the spacing as 30 cm row distance.

3.11 Intercultural operations

3.11.1 Weeding

Hand weeding was done on the assigned plots (W_2 treatment) twice of which were at 15 DAE and at 30 DAE (Days after emergence). Demarcation boundaries and drainage channels were also kept weed free.

3.11.2 Thinning

Thinning was done once in all the unit plots with care to maintain plant spacing as 10 cm in each plot at 10 DAE (Days after emergence).

3.11.3 Irrigation

Pres-owing irrigation was done to maintain equal germination. After sowing two irrigations were done during the life cycle. First irrigation and second irrigation were done at 15 DAE and 30 DAE, respectively.

3.11.4 Application of pesticides

The pre-emergence herbicide Basta (Glufosinate Ammonium) was sprayed at the rate of 4 litres per ha in the respective plot as per treatment before sowing. The crop was attacked by pod borer and was controlled by the application of Malathion 57 EC @ 1.5 l ha^{-1} at the time of 50% pod formation stage (55 DAS).

3.12 Determination of maturity

When 80% of the pods turned brown color, the crop was assessed to attain maturity.

3.13 Harvesting and sampling

The crop was harvested on 10 June, 2008 from prefixed (1.5 m^2) areas from centre of a plot for recording yield data. Before harvesting ten plants were selected randomly from each plot and were uprooted for recording data for yield contributing characters. The plants of prefixed were harvested plot wise and were bundled, tagged and brought to the threshing floor of Agronomy Field Laboratory.

3.14 Threshing

The crop was sun dried for three days by placing them on the open threshing floor. Seeds were separated from the plants by beating the bundles with the help of bamboo stick.

3.15 Drying, cleaning and weighing

The seeds were dried in the sun for reducing the moisture in the seeds to maintain the desired moisture level. The dried seeds and straw were cleaned and weighed.

3.16 Recording of data

The following data were recorded from each treatment.

A. Growth parameters:

I) Plant height (cm) at 30, 45 DAS and at harvest

II) No. of leaves per plant at 30 and 45 DAS

III) No. of branches per plant at 30 and 45 DAS

IV) Dry weight per plant (g) at 15, 30, 45 DAS and at harvest

B. Yield contributing parameters:

I) No. of pods per plant

II) Length of pod

III) No. of seeds per pod

IV) Weight of thousand seeds

C. Yield parameters:

I) Seed yield

II) Straw yield

D. Weed parameters

I) Weed density at 15 and 45 DAS

II) Weed biomass at 15 and 45 DAS

III) Weed control efficiency at 15 and 45 DAS

3.17 Outline of data recording

A. Growth parameters

Data on growth parameters were recorded from ten selected plants from each plot.

i) Plant height (cm)

The plant height was measured from the ground level to the tip of the selected plant. Then the average plant height was recorded.

ii) Number of leaves plant^{-1}

Number of leaves of individual plant was recorded from the selected plants and determined the average number of leaves per plant.

iii) Number of branches plant^{-1}

The number of branches plant^{-1} was counted from pre-selected ten plants and mean values were taken.

iv) Dry weight per plant (g)

Ten plants from each plot were collected for each of data recording. The plants were kept in the oven at 80^0 C for 2 days to reach a constant weight. Then total dry weight of plant parts were taken with an electric balance. The mean values were determined using the replicated values of each parameter.

B. Yield contributing characters

i) Number of pods plant^{-1}

Number of pods were counted from randomly selected 10 plants and then the mean value was computed and recorded.

ii) Pod length (cm)

The pod length was measured from the ten selected plant. Then the average plant height was recorded.

iii) Number of seeds pod^{-1}

Number of seeds pod^{-1} was counted from twenty randomly selected pods and then the average seed number was calculated.

iv) Weight of 1000 seeds (g)

The 1000 seeds were counted at random which were taken from the seed sample of each plot separately, then weight was taken with an electrical balance and data were recorded.

C. Yield parameters

i) Seed yield (kg ha^{-1})

Seeds obtained from 1.5 m^2 area of each unit plot were dried in the sun and weighed it out. The seed weight was then converted as kg ha^{-1}. The grain moisture content was measured by using a digital moisture meter. Seed yield was adjusted to 12% moisture content.

ii) Straw yield (kg ha^{-1})

Straw obtained from 15 m^2 area of each unit plot were dried in the sun and weighed it out. The straw weight was expressed as kg ha^{-1}.

D. Weed parameters

i) Weed density (no. per m^2)

The numbers of weeds from pre-selected 1 m^2 areas of each unit plot were determined.

ii) Weed biomass (g per m^2)

The weeds collected from $1m^2$ areas of each unit plot were kept in the oven at 80^0 C for 2 days to reach a constant weight. Then total dry weight of weeds was taken with an electric balance.

iii) Weed control efficiency (%)

Weed control efficiency was calculated with the following formula developed by Sawant and Jadav (1985):

$$WCE\ (\%) = \frac{DWC}{DWC - DWT} \times 100$$

WCE = Weed control efficiency

DWC = Dry weight of weed in unweeded treatment

DWT = Dry weight of weed in weed control treatment

3.18 Analysis of data

The data collected on different parameters were statistically analyzed to obtain the level of significance using the MSTAT-C computer package program developed by Russel (1986). Mean difference among the treatments were tested with Duncan's Multiple Range Test (DMRT) at 5% level of significance.

CHAPTER 4

RESULTS AND DISCUSSION

CHAPTER 4

RESULTS AND DISCUSSION

The results of the experiment have been presented, discussed and tried to compare with those of related results of the published so far.

4.1 WEED DENSITY (No. m^{-2})

4.1.1 Effect of Variety

At 15 DAS, the two varieties (BARI mung6 and BU mung2) played a significant role on weed density m^{-2} (Appendix iv and Fig. 1). The higher weed density m^{-2} was obtained from BARI mung6 (10.98 weeds/m^2) compared to BU mung2 (10.57 weeds/m^2) at 15 DAS. The variety BARI mung6 showed higher weed density m^{-2} by 3.73% than BU mung2. But at 45 DAS, there is no significant difference observed in weed density m^{-2} between BARI mung6 and BU mung2. The possible reason of dissimilar weed density in two growth durations might be due to the increased canopy of BARI mung6 at 45 DAS compared to that of BU mung2, which showed initial higher canopy. The weed species found in the experimental plot are shown in Table 1.

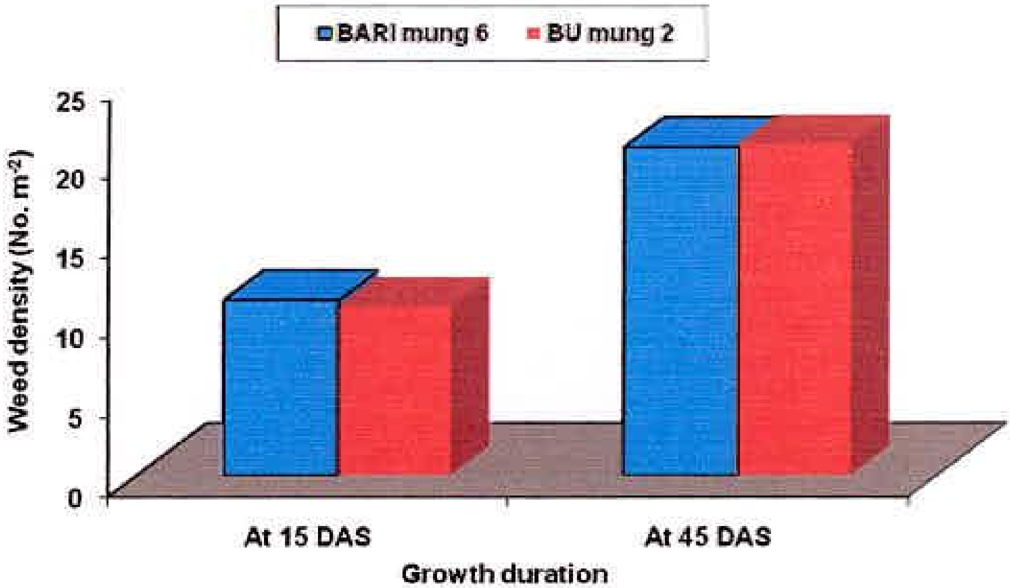

Fig.1: Effect of variety on weed density per m^2 at different DAS

4.1.2 Effect of Weed Control Strategies

It was observed that mean data regarding weed density m^{-2} were significantly affected by various weed management strategies (Appendix iv and Fig. 2). At 15 DAS, the lowest weed density m^{-2} was shown by hand weeding (8.29 weeds/m^2) which was statistically similar to acassia extract application (8.43 weeds/m^2) and herbicide application (8.73 weeds/m^2), followed by Brassica extract (10.83 weeds/m^2). Control treatment had the highest weed population of (14.38 weeds/m^2) at 15 DAS which was statistically similar to sunflower extract application (13.76 weeds/m^2) at 15 DAS. The weed density m^{-2} was decreased by 42.35% in hand weeding, 23.43% in sorghum extract over highest weed density m^{-2} in Control at 15 DAS. These results are in agreement with the findings of Putnam and Duke (1978), Bhowmik and Dolt (1982) and Parvis and Jessop (1985), they reported that sorghum water extract suppressed weeds germination and growth more than that of wheat.

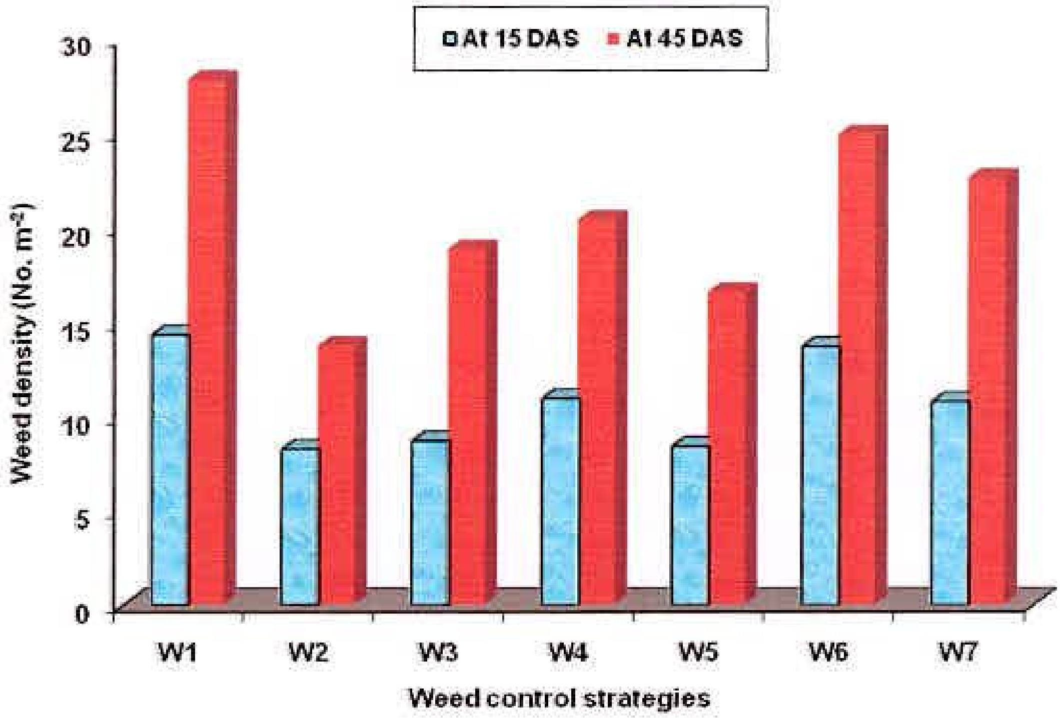

Fig.2 : Effect of different weed control strategies on weed density per m^2 at different DAS

Here

W_1 = Control
W_2 = Hand weeding
W_3 = Herbicide
W_4 = Sorghum extract
W_5 = Acassia extract
W_6 = Sunflower extract
W_7 = Brassica extract

At 45 DAS, the performance of hand weeding was the best among all weed management strategies in respect of weed population, with the lowest value of 13.82 weeds m^{-2} followed by acassia extract (16.67 weeds/m^2) and herbicide (18.93 weeds/m^2) application. The highest weed population of (27.86 weeds/m^2) at 45 DAS was found in control treatment. The weed density m^{-2} was decreased by 50.39% in hand weeding, 40.16% in acassia extract, and 32.05 % herbicide application over highest weed density m^{-2} in Control at 45 DAS. Cheema *et al.* (2002) reported similar results that sorghum extract application decreased the weed population. Similar results were obtained by Cheema *et al.* (2003) who noted that sorghum extract application gave better weed control. Khan *et al.* (2004) also reported the inhibitory effect of plant extracts on the germination of weeds of wheat crop.

Table 1: Weed species found in the experimental plot

Bengali Name	Scientific Name	Family
Anguli ghas	*Digitaria sanguinalis*	Gramineae
Khudey shama	*Echinochloa colonum*	Gramineae
Durba	*Cynodon dactylon*	Gramineae
Shama	*Echinochloa crusgalli*	Gramineae
Chapra	*Elusine indica*	Gramineae
Ban sharisha	*Brassica kaber*	Crusiferae
Mutha	*Cyperus rotundus*	Cyperaceae
Nakphulee	*Cyperus michelianus*	Cyperaceae
Kata begoon	*Solanum carolinense*	Solanaceae
Ban masur	*Vicia sativa*	Leguminosae
Bathua	*Chenopoduin album*	Chenopodiaceae
Kanaibashi	*Commelina bengalensis*	Commeliaceae
Chanchi	*Alternanthera sessilis*	Amaranthaceae
Malancha	*Alternanthera pungens*	Amaranthaceae

4.1.3 Interaction of Variety and Weed Control Strategies

Data recorded on weed density m^{-2} presented in (Appendix iv and Table 2) revealed that all weed control treatments significantly affected the weed density. Minimum number of weeds at 15 DAS was noted in the interaction of BARI mung6 and hand weeding (7.31 weeds/m^2) which was statistically similar to the interaction of BARI mung6 and herbicide (7.47 weeds/m^2), BARI mung6 and acassia extract (8.16 weeds/m^2) application followed by BU mung2 and acassia extract (8.70 weeds/m^2), BU mung2 and hand weeding (9.27 weeds/m^2) application. At 15 DAS, BARI mung6 and sunflower extract combination produced highest number of weeds (15.10 weeds/m^2) which was statistically similar to BARI mung6 and control (14.95 weeds/m^2) combination. It was noted that the number of weeds per m^2 were reduced accordingly by 51.58% in BARI mung6 and hand weeding, 42.38% in BU mung2 and acassia extract, 38.60% in BU mung2 and hand weeding application over higher number of weeds m^{-2} at BARI mung6 and sunflower extract combination at 15 DAS.

At 45 DAS, the lowest weed density m^{-2} was shown by the interaction of BU mung2 and hand weeding (13.57 weeds/m^2) combination which was significantly lowest than BARI mung6 and hand weeding (14.07 weeds/m^2), BARI mung6 and acassia extract (16.19 weeds/m^2), BU mung2 and acassia extract (17.16 weeds/m^2) combination respectively. BARI mung6 and control combination resulted the highest weed density m^{-2} (28.24 weeds/m^2) at 45 DAS. Weed density m^{-2} was shown to be decreased by 51.77% in BU mung2 and hand weeding combination, 50.00% in BARI mung6 and hand weeding combination, 42.46% in BARI mung6 and acassia extract combination , 39.02% in BU mung2 and acassia extract combination over the highest weed density m^{-2} in BARI mung6 and control combination.

4.2 WEED BIOMASS (g per m^2)

4.2.1 Effect of Variety

Analysis of the data showed that the two varieties BARI mung6 and BU mung2 had significant effect on weed biomass (Appendix iv and Fig. 3). The lowest dry weights of weeds (12.35 g m^{-2}) were recorded from BU mung2 compared to that of BARI mung6 (12.76 g m^{-2}) at 15 DAS. BU mung2 had 3.21% reduced dry weight of weeds than that of BARI mung6 at 15 DAS.

Similarly at 45 DAS, the lowest dry weights of weeds obtained from BU mung2 (25.52 g m^{-2}) compared to BARI mung6 (25.71 g m^{-2}). The dry weight of weeds was 0.74% lower in BARI mung6 than BU mung2 at 45 DAS.

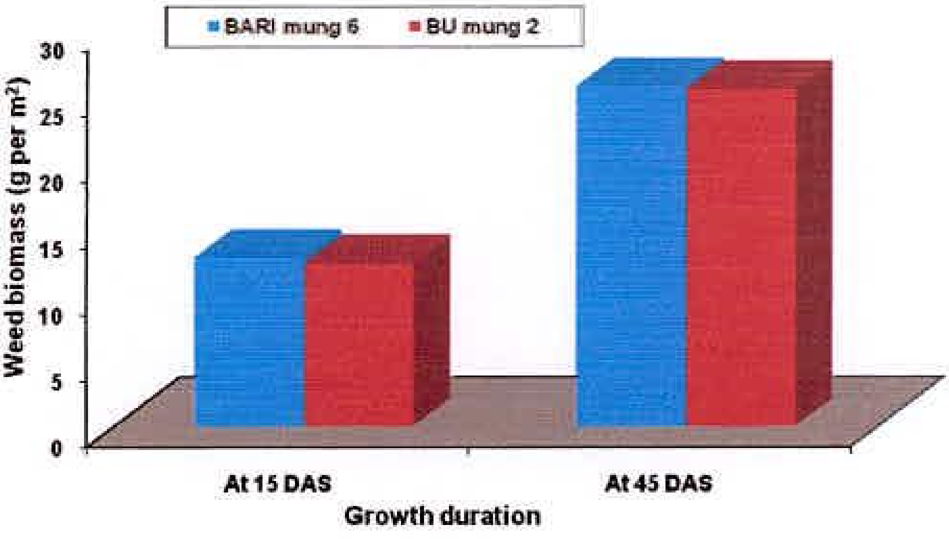

Fig. 3: Effect of variety on weed biomass at different DAS

4.2.2 Effect of Weed Control Strategies

The analyzed data on weed biomass revealed that the differences among weed management strategies were significant (Appendix iv and Fig. 4). The lowest dry weight of weeds (7.07 g m^{-2}) was recorded in hand weeding treatment followed by 8.97, 10.00 and 12.46 g m^{-2} in the plots which were sprayed with acassia extract, herbicide and sorghum extract respectively at 15 DAS. The highest dry weight of weeds (17.02 g m^{-2}) was obtained from control which was statistically similar to sunflower extract (16.90 g m^{-2}) treatment at 15 DAS. The dry weight of weeds was reduced by 58.46% in hand weeding treatment, 47.30% in acassia extract treatment, 41.24% in herbicide treatment and 26.79% in sorghum extract treatment over control treatment at 15 DAS. Cheema *et al.* (2002) also reported that extract application reduced dry weight of weed by 50%.

At 45 DAS, the lowest dry weeds weight of 16.20 g m^{-2} was recorded from hand weeding treatment followed by 18.23, 20.73 and 23.50 g m^{-2} in the plots which were sprayed with acassia extract, herbicide and sorghum extract respectively at 45 DAS. The highest dry weight of weeds (35.79 g m^{-2}) was obtained from control treatment at 45 DAS. The dry weight of weeds was reduced by 54.73% in hand weeding treatment, 49.06% in acassia extract treatment, 42.07% herbicide treatment and 34.33% sorghum extract treatment over control treatment at 45 DAS. Extracts in aquas solution resulted in reduction of weed biomass in the presence of either phytotoxic or allelopathic compounds. So the results might have value in enabling weed control based on natural plant extracts. Similar results were obtained by Cheema *et al* (2002) who reported reduction of dry weed biomass in treatments where water extracts were applied.

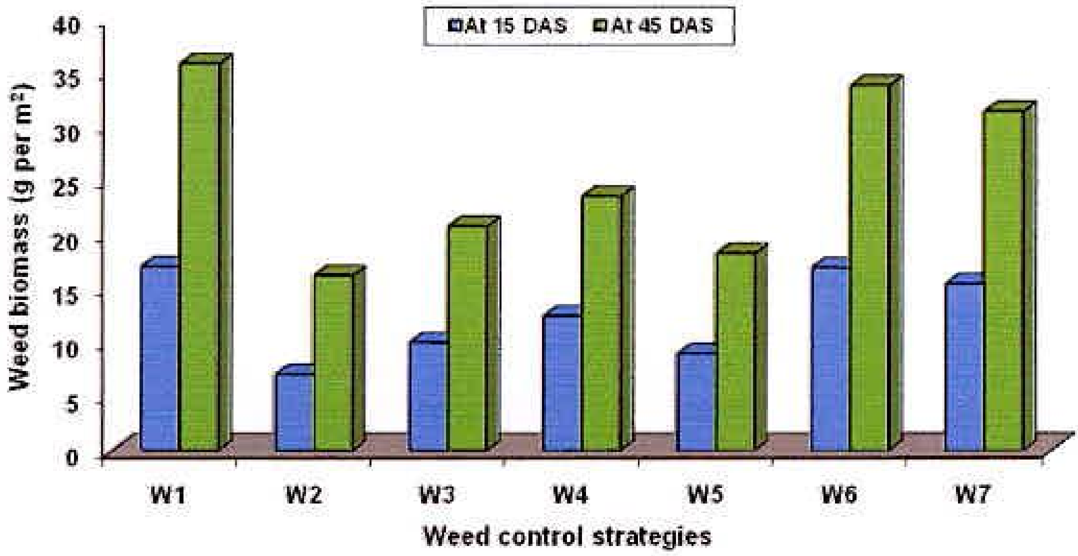

Fig. 4: Effect of weed control strategies on weed biomass at different DAS

Here

W_1 = Control	W_5= Acassia extract
W_2 = Hand weeding	W_6 = Sunflower extract
W_3 = Herbicide	W_7 = Brassica extract
W_4 = Sorghum extract	

4.2.3 Interaction of Variety and Weed Control Strategies

It was observed that mean data regarding dry weed biomass (g m^{-2}) were significantly affected by the combination of variety and various weed management strategies (Appendix iv and Table 2). Minimum weed biomass (g m^{-2}) at 15 DAS was noted in the interaction of BU mung2 and hand weeding (6.60 g m^{-2}) which was followed by interaction of BARI mung6 and hand weeding (7.54 g m^{-2}), BU mung2 and acassia extract (8.60 g m^{-2}) , BU mung2 and herbicide (9.74 g m^{-2}) application. At 15 DAS, BARI mung6 and control combination produced maximum weed biomass (17.72 g m^{-2}). It was noted that weed biomass (g m^{-2}) were decreased accordingly by 62.75% in BU mung2 and hand weeding, 57.44% in BARI mung6 and hand weeding, 51.46% in BU mung2 and acassia extract over BARI mung6 and control combination at 15 DAS.

Table 2: Combined effect of varieties and weed control strategies on weed density per m², weed biomass (g m⁻²) and weed control efficiency (%)

Treatments	Weed density per m²		Weed biomass (g per m²)		Weed control efficiency (%)	
	At 15 DAS	At 45 DAS	At 15 DAS	At 45 DAS	At 15 DAS	At 45 DAS
$V_1 \times W_1$	14.95 a	28.24 a	17.72 a	36.30 a	-	-
$V_1 \times W_2$	7.31 h	14.07 l	7.54 i	16.47 l	56.33 b	53.80 a
$V_1 \times W_3$	7.47 h	18.17 i	10.26 f	20.38 i	41.99 e	43.32 c
$V_1 \times W_4$	12.45 c	20.40 g	12.54 e	23.46 g	28.59 g	34.66 e
$V_1 \times W_5$	8.16 gh	16.19 k	9.34 g	18.94 j	46.01 d	47.16 b
$V_1 \times W_6$	15.10 a	24.66 d	17.02 b	33.38 d	1.96 k	2.22 ij
$V_1 \times W_7$	11.41 d	23.04 e	14.91 d	31.49 e	14.20 i	12.25 g
$V_2 \times W_1$	13.81 b	27.47 b	16.32 c	35.29 b	-	-
$V_2 \times W_2$	9.27 ef	13.57 m	6.60 j	15.93 m	58.04 a	54.21 a
$V_2 \times W_3$	9.99 e	19.69 h	9.74 g	21.07 h	39.72 f	39.83 d
$V_2 \times W_4$	9.57 ef	20.60 g	12.38 e	23.54 g	24.70 h	32.10 f
$V_2 \times W_5$	8.70 fg	17.16 j	8.60 h	17.53 k	47.60 c	53.10 a
$V_2 \times W_6$	12.42 c	25.28 c	16.78 b	34.08 c	1.18 k	3.46 i
$V_2 \times W_7$	10.25 e	22.36 f	15.99 c	31.19 f	3.22 j	8.92 h
SE	0.3367	0.1352	0.1389	0.0537	0.3195	0.8671
CV (%)	5.41	2.13	1.92	1.36	2.13	2.13

Here
V_1 = BARI mung6
V_2 = BU mung2

W_1 = Control
W_2 = Hand weeding
W_3 = Herbicide
W_4 = Sorghum extract
W_5 = Acassia extract
W_6 = Sunflower extract
W_7 = Brassica extract

At 45 DAS, the lowest weed biomass (g m^{-2}) was shown by the interaction of BU mung2 and hand weeding (15.93 g m^{-2}) combination which was significantly lowest than BARI mung6 and hand weeding (16.47 g m^{-2}), BU mung2 and acassia extract (17.53 g m^{-2}), BARI mung6 and acassia extract (18.94 g m^{-2}) combination respectively. BARI mung6 and control combination resulted the highest weed biomass (36.30 g m^{-2}) at 45 DAS. Weed biomass (g m^{-2}) was shown to be decreased by 56.11% in BU mung2 and hand weeding combination, 54.62% in BARI mung6 and hand weeding combination, 51.70% in BU mung2 and acassia extract combination ,47.82% in BARI mung6 and acassia extract combination over the highest weed biomass (g m^{-2}) in BARI mung6 and control combination.

4.3 WEED CONTROL EFFICIENCY (%)

4.3.1 Effect of Variety

Weed control efficiency was significantly affected by the two variety BARImung-6 and BU mung2 at 15 DAS (Appendix iv and Fig. 5). The highest weed control efficiency at 15 DAS was obtained from the BARI mung6 (27.02%) compared to BU mung2 (24.93%).

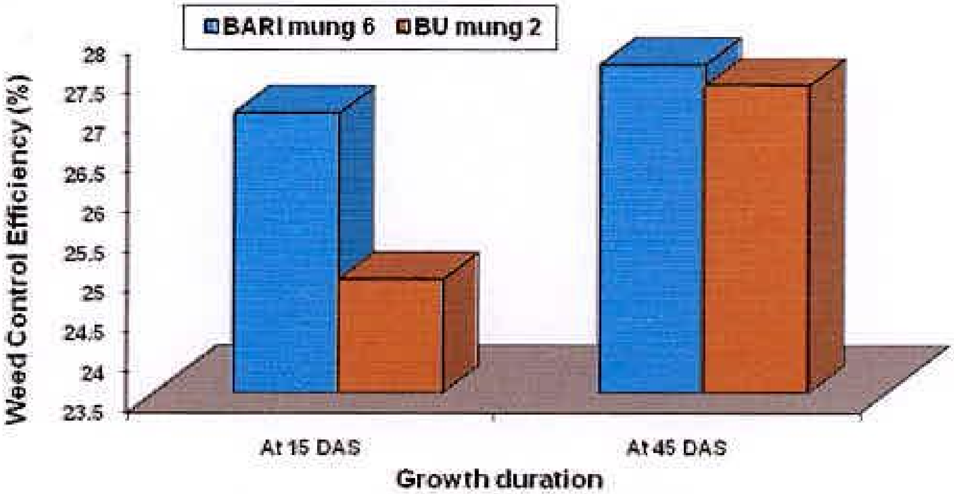

Fig.5: Effect of variety on weed control efficiency (%) at different DAS

The variety BARI mung6 showed 8.38% higher weed control efficiency than BU mung2. But there was no significant difference of weed control efficiency between BARI mung6 (27.63%) and BU mung2 (27.37%) at 45 DAS.

4.3.2 Effect of Weed Control Strategies

Weed control efficiency was significantly affected by the different weed control strategies (Appendix iv and Fig. 6). The best weed control efficiency at 15 DAS (57.18%) was obtained from the plots where crops received hand weeding, which was significantly higher than crops receiving acassia extract (46.80%) followed by receiving herbicide (40.86%) and sorghum extract (26.64%) treatment. Similar trend of weed control efficiency was also found at 45 DAS where the best Weed Control Efficiency (54.00%) was obtained from the plots where crops receiving hand weeding that was significantly higher than crops receiving acassia extract (50.13%) followed by receiving herbicide (41.57%) and sorghum extract (33.38%) treatment.

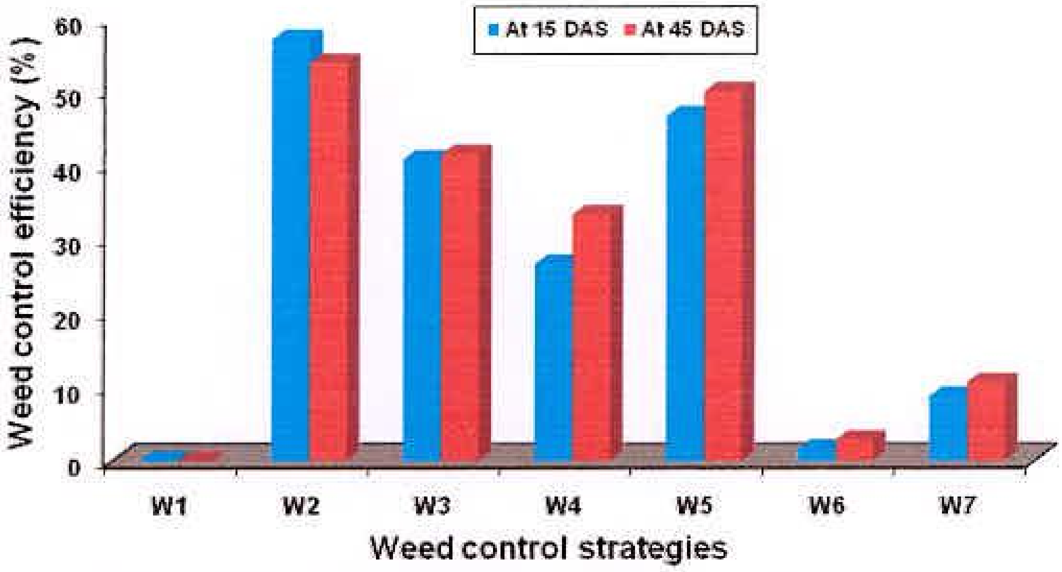

Fig. 6: Effect of weed control strategies on weed control efficiency (%) at different DAS

Here

W_1 = Control
W_2 = Hand weeding
W_3 = Herbicide
W_4 = Sorghum extract
W_5 = Acassia extract
W_6 = Sunflower extract
W_7 = Brassica extract

4.3.3 Interaction of Variety and Weed Control Strategies

It was observed that weed control efficiency was significantly affected by the interaction of variety and weed control strategies (Appendix iv and Table 2) at 15 and at 45 DAS. Weed control efficiency was observed higher in combination with BU mung2 and hand weeding (58.04%) followed by BARI mung6 and hand weeding combination (56.33%), BU mung2 and acassia extract combination (47.60%), BARI mung6 and acassia extract combination (46.01%) and also at BARI mung6 and herbicide combination (41.99%) at 15 DAS. BARI mung6 and control combination and also BU mung2 and control combination resulted no efficiency of controlling weeds at 15 DAS.

At 45 DAS, the best weed control efficiency was found with the combination of BU mung2 and Hand weeding (54.21%) which was statistically similar tothe combination of BARI mung6 and Hand weeding (53.80%), and the combination of BU mung2 and acassia extract (53.10%) which was significantly higher than the combination of BARI mung6 and acassia extract (47.16%), BARI mung6 and herbicide (43.32%), BU mung2 and herbicide (39.83%) interaction. BARI mung6 and control combination and also BU mung2 and control combination resulted no efficiency of controlling weeds at 45 DAS.

4.4 ROOT AND SHOOT LENGTH (cm)

4.4.1 Effect of Variety

It was observed that root length at 15 DAS was significantly influenced by two varieties BARI mung6 and BU mung2 (Appendix iv and Table 3). The root length was obtained higher in BARI mung6 (4.20 cm) compared to BU mung2 (3.91 cm) at 15 DAS. The variety BARI mung6 showed 7.42 % higher root length than BU mung2 at 15 DAS. The shoot length at 15 DAS had no significant effect between two varieties BARI mung6 and BU mung2 where BARI mung6 produced 6.98 cm and BU mung2 produced 6.93 cm shoot length.

4.4.2 Effect of Weed Control Strategies

Plant root and shoot length at 15 DAS was significantly affected by the different weed control strategies (Appendix iv and Table 3). The highest plant root length at 15 DAS (4.42 cm) was obtained from the plots where crops received hand weeding, which was significantly higher than crops receiving acassia extract (4.22 cm) followed by receiving herbicide (4.13 cm) and Brassica extract (4.00 cm) treatment. The shortest root length of plant (3.81 cm) was obtained from no weeding treatment which was statistically similar to sunflower extract (3.83 cm) treatment at 15 DAS. Plant root length was increased by 16% in hand weeding, 10.76% in acassia extract and 8.40% in herbicide treatement over control at 15 DAS.

At 15 DAS, the highest plant shoot length (7.57 cm) was obtained from the treatment sorghum extract, which was significantly higher than hand weeding (7.45 cm) treatment followed by Brassica extract (7.16 cm) and acassia extract (6.84 cm) treatment. The shortest shoot length of plant (6.58 cm) was obtained from no weeding treatment which was statistically similar to herbicide (6.63 cm) treatment at 15 DAS. Plant shoot length was increased by 15.04% in sorghum extract, 13.22% in hand weeding and 8.81% in Brassica extract treatment over control at 15 DAS.

Table 3: Influence of varieties, weed control strategies and their interaction on root and shoot length (cm) at 15 DAS

Treatments		Root length at 15 DAS (cm)	Shoot length at 15 DAS (cm)
Variety (V)			
BARI mung6 (V_1)		4.20 a	6.98
BU mung2 (V_2)		3.91 b	6.93
SE		0.0126	NS
Weed Control Strategies (W)			
Control	(W_1)	3.81 f	6.58 e
Hand weeding	(W_2)	4.42 a	7.45 b
Herbicide	(W_3)	4.13 c	6.63 e
Sorghum extract	(W_4)	3.95 e	7.57 a
Acassia extract	(W_5)	4.22 b	6.84 d
Sunflower extract	(W_6)	3.83 f	6.45 f
Brassica extract	(W_7)	4.00 d	7.16 c
SE		0.0203	0.0347
Interaction of Variety and Weed Control Strategies (V x W)			
V_1 x W_1		3.81 f	6.48 e
V_1 x W_2		4.48 a	7.39 b
V_1 x W_3		4.11 d	6.54 e
V_1 x W_4		4.10 de	7.50 ab
V_1 x W_5		4.40 b	7.36 b
V_1 x W_6		4.23 c	6.44 ef
V_1 x W_7		4.28 c	7.11 c
V_2 x W_1		3.81 f	6.68 d
V_2 x W_2		4.40 b	7.50 ab
V_2 x W_3		4.15 d	6.72 d
V_2 x W_4		3.80 f	7.64 a
V_2 x W_5		4.03 e	6.33 f
V_2 x W_6		3.42 g	6.45 ef
V_2 x W_7		3.74 f	7.20 c
SE		0.0287	0.0491
CV (%)		1.23	1.30

4.4.3 Interaction of Variety and Weed Control Strategies

It was observed that plant root and shoot length was significantly affected by the interaction of weeding and variety (Appendix iv and Table 3) at 15 DAS. At 15 DAS, the tallest plant root was found with the combination of BARI mung6 and hand weeding (4.48 cm) which was significantly higher than the combination of BARI mung6 and acassia extract (4.40 cm), BARI mung6 and Brassica extract (4.28 cm) which was statistically similar to BARI mung6 and sunflower extract (4.23 cm). The shortest plant root at 15 DAS was obtained from the combination of BU mung2 and sunflower extract (3.42 cm). The plant root was increased in the combination by 30.99% in BARI mung6 and hand weeding, 28.65% in BARI mung6 and acassia extract, 25.15% in BARI mung6 and Brassica extract over the shortest plant height obtained from the combination of BU mung2 and sunflower extract.

It was observed that plant shoot length was highest in the interaction of BU mung2 and sorghum extract (7.64 cm) which was statistically similar to the interaction of BARI mung6 and sorghum extract (7.50 cm) and also the interaction of BU mung2 and hand weeding (7.50 cm) that was significantly higher than the interaction of BARI mung6 and acassia extract (7.36 cm), BU mung2 and Brassica extract (7.20 cm). The shortest shoot length at 15 DAS was obtained from the interaction of BU mung2 and acassia extract (6.33 cm). The shoot length was increased by 20.70%, 16.27%, 13.74%, in the interaction of BU mung2 and sorghum extract, BARI mung6 and acassia extract, BU mung2 and Brassica extract respectively over the shortest shoot length at 15 DAS.

4.5 PLANT HEIGH (cm)

4.5.1 Effect of Variety

Plant height is one of the most important growth characters of mungbean. Plant height was significantly affected by the two variety BARImung-6 and BU mung2 (Appendix v and Fig. 7). The tallest plant at 30 DAS was obtained from the BARI mung6 (27.20 cm) compared to BU mung2 (20.59 cm). The variety BARI mung6 showed 32.10% higher plant height than BU mung2. The similar trend of plant height was also observed at 45 DAS and at harvest which was 28.39% and 27% taller than BU mung2. The plant height varies with the variation in variety were also reported by Ahmed *et al.* (2003).

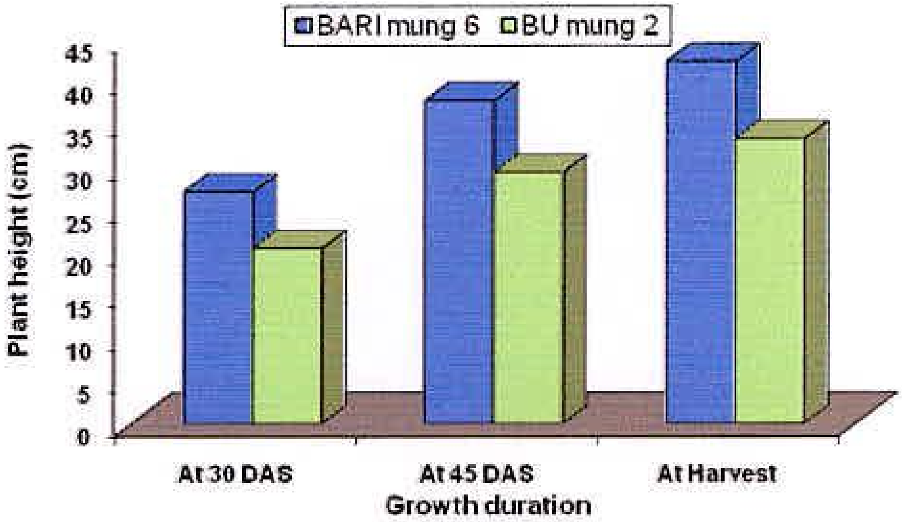

Fig.7 : Effect of variety on plant height at different DAS

4.5.2 Effect of Weed Control Strategies

The plant height was significantly influenced by different types of weed control strategies (Appendix v and Fig. 8). The tallest plant at 30DAS (27.00 cm) was obtained from the plots where crops received acassia extract for weeding, which was significantly higher than crops receiving herbicide (25.90 cm) followed by receiving hand weeding (25.35 cm) and sunflower extract (22.97 cm) treatment. The shortest plant (20.51 cm) was obtained from no weeding treatment. Plant height was increased by 30.61% in acassia extract, 26.28% in herbicide, 23.60% in hand weeding, 12% in sunflower extract and 11.12% in Brassica extract treatments over control at 30 DAS.

At 45 DAS, the tallest plant height (36.26 cm) was obtained from the plots where crops receiving acassia extract, which was statistically similar to hand weeding treatment (35.99cm), significantly higher than crops receiving herbicide (35.62 cm) followed by sorghum extract (32.74 cm), sunflower extract (32.66 cm) and Brassica extract (31.63 cm) treatment. The shortest plant (30.77 cm) was obtained from no weeding treatment. Plant height was increased by 30.61% in acassia extract, 26.28% in hand weeding, 23.60% in herbicide, 12% in sunflower extract and 11.12% in Brassica extract treatments over control at 45DAS.

At harvest, the tallest plant height was obtained from the plots where crops receiving acassia extract (40.62 cm), which was statistically similar to crops receiving hand weeding treatment (40.51cm) and herbicide (40.42cm) treatment, significantly higher than crops receiving sorghum extract (37.25 cm) followed by sunflower extract (36.34 cm) treatment. The shortest plant (34.79) was obtained from no weeding treatment which was statistically similar to Brassica extract treatment (35.16 cm). Plant height was increased by 16.75% in acassia extract, 7.07% in sorghum extract and 4.5% in sunflower extract treatments over control at harvest. Plant height of mungbean reduced due to competition with weeds (Karim and Mamun, 1988). Rahman (1985) and Islam (1987) also recorded reduction in plant height of mungbean due to weed competition by 11.48 and 4.54% in their studies, respectively.

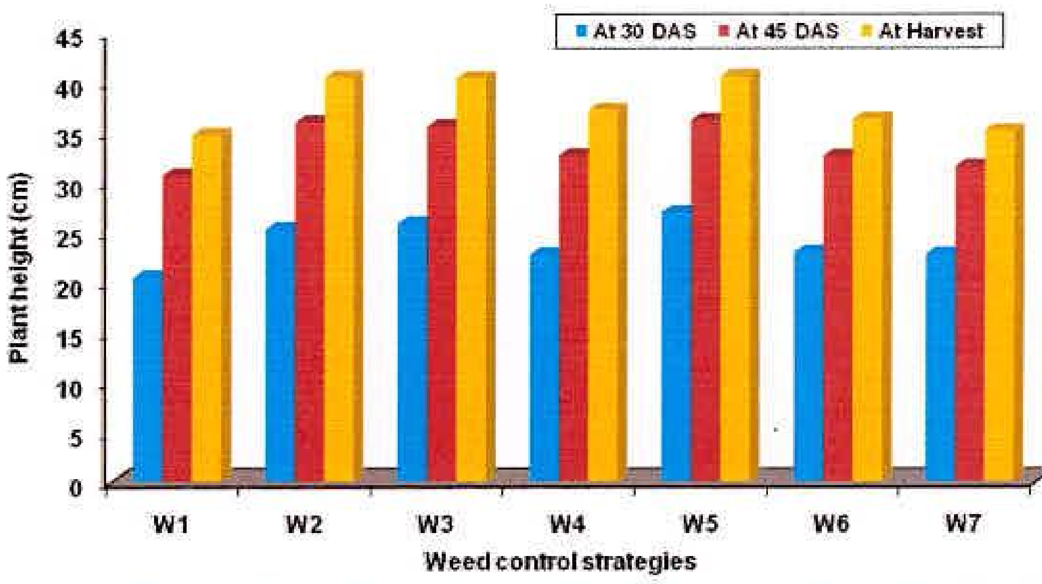

Fig.8 : Effect of weed control strategies on plant height at different DAS

Here

W_1 = Control
W_2 = Hand weeding
W_3 = Herbicide
W_4 = Sorghum extract
W_5 = Acassia extract
W_6 = Sunflower extract
W_7 = Brassica extract

The possible reason could be that plants sprayed with acassia extract, herbicides and hand weeding twice resulted in less competition of plants with weeds for nutrients particularly for NPK and environmental factor like water and light which were usually needed in adequate amounts for proper growth. The lesser competition and greater availability of water, nutrient and light resulted in faster rate of growth and taller plants.

4.5.3 Interaction of Variety and Weed Control Strategies

The combined effect of weeding and variety was found to be significant for plant height (Appendix v and Table 4) at 30, 45 DAS and at harvest. Plant height was observed higher in combination with BARI mung6 and acassia extract (32.74 cm) followed by BARI mung6 and hand weeding combination (31.38 cm), BARI mung6 and herbicide combination (29.31 cm), BARI mung6 and sunflower extract combination (26.17 cm) at 30 DAS. BU mung2 and control combination resulted the shortest plant height (18.82 cm) at 30 DAS. Plant height was increased by 73.96% in BARI mung6 and acassia extract combination, 66.73% in BARI mung6 and hand weeding combination, 55.74% in BARI mung6 and herbicide combination, 12.91% BU mung2 and acassia extract combination, 2.6% BU mung2 and hand weeding combination over the shortest plant height combination of BU mung2 and control at 30 DAS.

At 45 DAS, the tallest plant was found with the combination of BARI mung6 and hand weeding (42.06 cm) which was statistically similar to the combination of BARI mung6 and acassia extract (41.99 cm), significantly higher than the combination of BARI mung6 and herbicide (40.14 cm), BARI mung6 and sorghum extract (37.14 cm), BARI mung6 and Brassica extract (34.12 cm), BARI mung6 and no weeding (32.42 cm), BU mung2 and herbicide (31.11 cm) , BU mung2 and acassia extract (30.53 cm). The shortest plant height at 45 DAS was obtained from the combination of BU mung2 and sorghum extract (28.34 cm), which was statistically similar to the combination of BU mung2 and sunflower extract (28.20 cm). The plant height was increased in the combination by 49.47% in BARI mung6 and hand weeding, 42.64% in BARI mung6 and herbicide, 31.91% in BARI mung6 and sunflower extract, 10.55% in BU mung2 and herbicide over the shortest plant height obtained from the combination of BU mung2 and sorghum extract at 45 DAS.

At harvest, it was observed that plant height was highest in the interaction of BARI mung6 and acassia extract (46.13 cm) which was significantly higher than the interaction of BARI mung6 and hand weeding (45.25 cm), BARI mung6 and herbicide (44.23 cm), BARI mung6 and sorghum extract (42.23 cm) and BARI mung6 and sunflower extract (41.27 cm). The shortest plant height at harvest was obtained from the interaction of BU mung2 and Brassica extract (30.28 cm). The plant height was increased by 52.35% , 49.43% , 46.07% , 39.46% , 18.13% in the interaction of BARI mung6 and acassia extract, BARI mung6 and hand weeding, BARI mung6 and herbicide, BARI mung6 and sorghum extract, BU mung2 and hand weeding respectively over the shortest plant height at harvest.

Table 4: Combined effect of varieties and weed control strategies on plant height (cm) at different days after sowing

Treatments	Plant height (cm)		
	At 30 DAS	At 45 DAS	At Harvest
V_1 x W_1	22.21 h	32.42 e	37.47 g
V_1 x W_2	31.38 b	42.06 a	45.25 b
V_1 x W_3	29.31 c	40.14 b	44.23 c
V_1 x W_4	25.53 e	37.14 c	42.23 d
V_1 x W_5	32.74 a	41.99 a	46.13 a
V_1 x W_6	26.17 d	37.12 c	41.27 e
V_1 x W_7	23.08 f	34.12 d	40.03 f
V_2 x W_1	18.82 l	29.12 i	32.12 j
V_2 x W_2	19.31 k	29.91 h	35.77 i
V_2 x W_3	22.48 g	31.11 f	36.60 h
V_2 x W_4	19.98 j	28.34 j	32.27 j
V_2 x W_5	21.25 i	30.53 g	35.10 i
V_2 x W_6	19.78 j	28.20 j	31.41 k
V_2 x W_7	22.50 g	29.14 i	30.28 l
SE	0.0721	0.1466	0.2421
CV (%)	1.52	1.75	2.11

Here

V_1 = BARI mung6
V_2 = BU mung2

W_1 = Control
W_2 = Hand weeding
W_3 = Herbicide
W_4 = Sorghum extract
W_5 = Acassia extract
W_6 = Sunflower extract
W_7 = Brassica extract

4.6 DRY WEIGHT PER PLANT (g)

4.6.1 Effect of Variety

Dry weight per plant was not significantly affected by the two varieties BARI mung6 and BU mung2 at 15 DAS (Appendix v and Fig. 9). But at 30 and 45 DAS, dry weight per plant was significantly affected by the two variety BARI mung6 and BU mung2.The higher dry weight per plant at 30 and 45 DAS was obtained from the BU mung2 (1.96 g and 3.56 g) compared to BARI mung6 (1.78 g and 3.34 g) respectively. The variety BU mung2 showed 10% and 6.58% higher dry weight per plant than BARI mung6 at 30 and 45 DAS respectively. Variety had no significant effect on dry weight per plant at harvest.

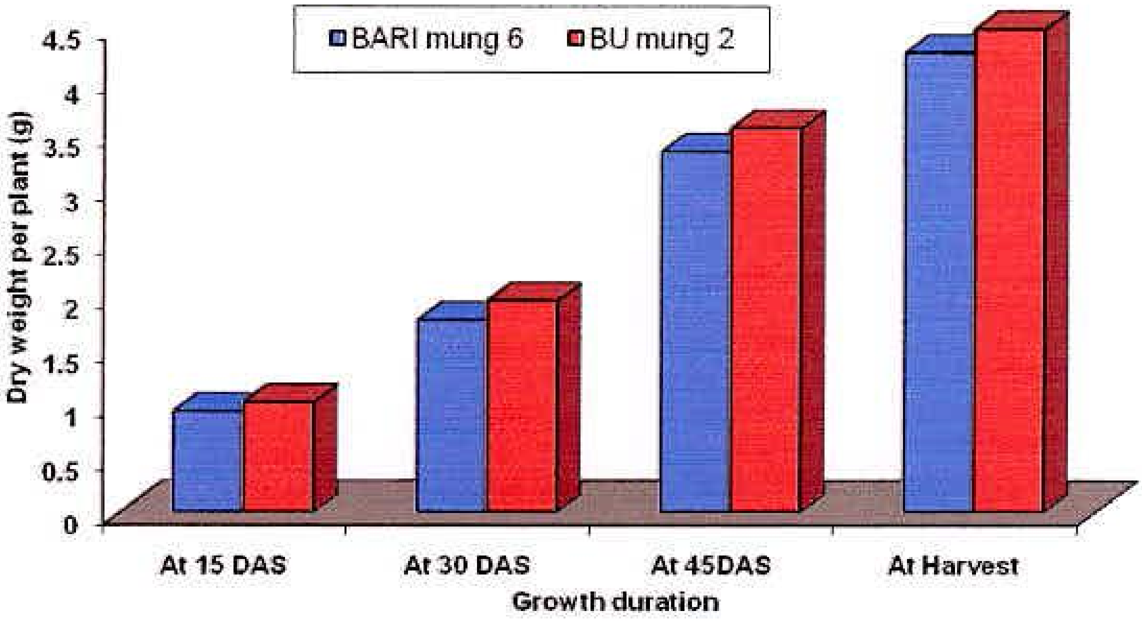

Fig.9 : Effect of variety on dry weight per plant (g) at different DAS

4.6.2 Effect of Weed Control Strategies

Dry weight per plant was significantly affected by the different weed control strategies (Appendix v and Fig. 10). The highest dry weight per plant at 15 DAS (1.61 g) was obtained from the plots where crops received hand weeding, which was significantly higher than crops receiving acassia extract (1.32 g) followed by crop receiving herbicide (1.06 g) which was statistically similar to crop receiving sorghum extract (1.01 g) and also followed by crop receiving Brassica extract (0.77 g) treatment. The lowest dry weight per plant at 15DAS (0.50 g) was obtained from no weeding treatment. Dry weight per plant was increased by 220% in hand weeding, 164% in acassia extract, 112% in herbicide, and 54% in Brassica extract treatements over control at 15 DAS.

The highest dry weight per plant at 30 DAS (3.21 g) was obtained from the plots where crops received hand weeding, which was significantly higher than crops receiving acassia extract (2.63 g) followed by crop receiving herbicide (2.10 g), crop receiving sorghum extract (1.66 g) and crop receiving Brassica extract (1.42 g) treatment. The lowest dry weight per plant at 30 DAS (0.96 g) was obtained from no weeding treatment. Dry weight per plant was increased by 234% in hand weeding, 174% in acassia extract, 118% in herbicide, 73% in sorghum extract and 48% in Brassica extract treatements over control at 30 DAS.

At 45 DAS, the highest dry weight per plant (4.74 g) was obtained from the plots where crops received hand weeding, which was significantly higher than crops receiving acassia extract (4.31 g) followed by crop receiving herbicide (3.76 g) and crop receiving sorghum extract (3.20 g) treatment. The lowest dry weight per plant at 45 DAS (2.37 g) was obtained from no weeding treatment. Dry weight per plant was increased by 100% in hand weeding, 82% in acassia extract, 59% in herbicide and 35% in sorghum extract treatements over control at 45 DAS.

The highest dry weight per plant (5.89 g) was obtained from the plots where crops received hand weeding, which was significantly higher than crops receiving acassia extract (5.40 g) followed by crop receiving herbicide (4.58 g) and crop receiving sorghum extract (4.11 g) treatment at harvest. The lowest dry weight per plant at harvest (3.11 g) was obtained from no weeding treatment. Dry weight per plant was increased by 89% in hand weeding, 73% in acassia extract, 47% in herbicide and 32% in sorghum extract treatments over control at harvest.

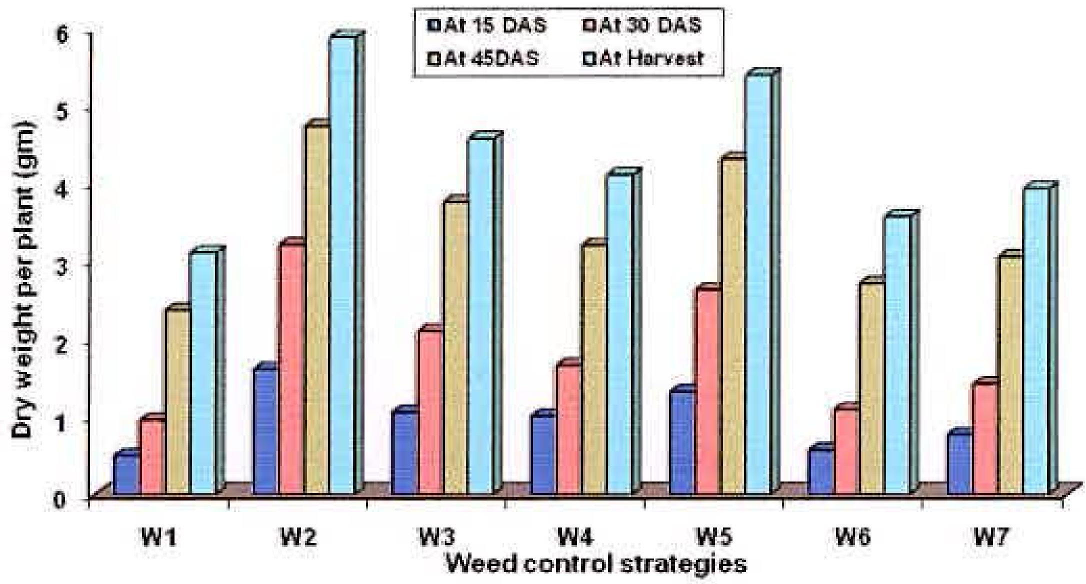

Fig.10 : Effect of weed control strategies on dry weight per plant at different DAS

Here
W_1 = Control
W_2 = Hand weeding
W_3 = Herbicide
W_4 = Sorghum extract
W_5= Acassia extract
W_6 = Sunflower extract
W_7 = Brassica extract

4.6.3 Interaction of Variety and Weed Control Strategies

It was observed that dry weight per plant was significantly affected by the interaction of variety and weed control strategies (Appendix v and Table 5) at 15, 30 and 45 DAS. Dry weight per plant was observed higher in combination with BU mung2 and hand weeding (1.74 g) followed by BARI mung6 and hand weeding combination (1.49 g) which was statistically similar to BU mung2 and acassia extract combination (1.36 g), BARI mung6 and acassia extract combination (1.29 g) was followed by BARI mung6 and herbicide combination (1.05 g) at 15 DAS. BARI mung6 and control combination resulted the lowest dry weight per plant (0.45 g) at 15 DAS. Dry weight per plant was increased by 286% in BU mung2 and hand weeding combination, 231% in BARI mung6 and hand weeding combination, 187% in BARI mung6 and acassia extract combination, 140% BU mung2 and herbicide combination over the lowest dry weight per plant combination of BARI mung6 and control at 15 DAS.

At 30 DAS, dry weight per plant was observed higher in combination with BU mung2 and hand weeding (3.48 g) followed by BARI mung6 and hand weeding combination (2.93 g), BU mung2 and acassia extract combination (2.69 g), BARI mung6 and acassia extract combination (2.56 g) and BU mung2 and herbicide combination (2.15 g) at 30 DAS. BARI mung6 and control combination resulted the lowest dry weight per plant (0.85 g) at 30 DAS. Dry weight per plant was increased by 309% in BU mung2 and hand weeding combination, 245% in BARI mung6 and hand weeding combination, 216% in BU mung2 and acassia extract combination, 201% BARI mung6 and acassia extract combination over the lowest dry weight per plant combination of BARI mung6 and control at 30 DAS.

Table 5: Combined effect of varieties and weed control strategies on dry weight per plant (g) at different days after sowing

Treatments	Dry weight per plant (g)			
	At 15 DAS	At 30 DAS	At 45 DAS	At harvest
$V_1 \times W_1$	0.45 h	0.85 k	2.26 k	4.01
$V_1 \times W_2$	1.49 b	2.93 b	4.55 b	5.20
$V_1 \times W_3$	1.05 d	2.06 f	3.59 f	4.42
$V_1 \times W_4$	1.07 d	1.83 g	3.11 h	4.08
$V_1 \times W_5$	1.29 c	2.56 d	4.23 d	5.32
$V_1 \times W_6$	0.45 h	0.89 k	2.58 j	3.40
$V_1 \times W_7$	0.75 f	1.30 i	3.08 h	3.81
$V_2 \times W_1$	0.54 gh	1.08 j	2.48 j	4.20
$V_2 \times W_2$	1.74 a	3.48 a	4.92 a	5.00
$V_2 \times W_3$	1.08 d	2.15 e	3.93 e	4.74
$V_2 \times W_4$	0.95 de	1.49 h	3.29 g	4.13
$V_2 \times W_5$	1.36 bc	2.69 c	4.39 c	5.47
$V_2 \times W_6$	0.69 fg	1.30 i	2.84 i	3.74
$V_2 \times W_7$	0.80 ef	1.54 h	3.03 h	4.06
SE	0.0012	0.0241	0.0480	NS
CV (%)	9.59	3.24	2.41	2.44

Here

V_1 = BARI mung6
V_2 = BU mung2

W_1 = Control
W_2 = Hand weeding
W_3 = Herbicide
W_4 = Sorghum extract
W_5 = Acassia extract
W_6 = Sunflower extract
W_7 = Brassica extract

At 45 DAS, dry weight per plant was observed higher in combination with BU mung2 and hand weeding (4.92 g) followed by BARI mung6 and hand weeding combination (4.55 g), BU mung2 and acassia extract combination (4.39 g), BARI mung6 and acassia extract combination (4.23 g) and BU mung2 and herbicide combination (3.93 g) at 45 DAS. BARI mung6 and control combination resulted the lowest dry weight per plant (2.26 g) at 45 DAS. Dry weight per plant was increased by 118% in BU mung2 and hand weeding combination, 101% in BARI mung6 and Hand weeding combination, 94% in BU mung2 and acassia extract combination, 87% BARI mung6 and acassia extract combination over the lowest dry weight per plant combination of BARI mung6 and control.

Dry weight per plant was not significantly affected by the interaction of variety and various weed management strategies at harvest where dry weight per plant was observed numerically higher in combination with BU mung2 and hand weeding (6.00 g). BARI mung6 and control combination resulted the minimum dry weight per plant (3.01 g) at harvest.

4.7 NUMBER OF LEAVES PER PLANT

4.7.1 Effect of Variety

Analysis of the data showed that the two varieties BARI mung6 and BU mung2 had significant effect on number of leaves per plant at 30 and 45 DAS (Appendix v and Table 6). The highest number of leaves per plant (6.88) were recorded from BU mung2 compared to that of BARI mung6 (5.68) at 30 DAS. BU mung2 had 21.13% increased number of leaves per plant than that of BARI mung6 at 30 DAS. Similarly at 45 DAS, the higher number of leaves per plant (8.33) was recorded from BU mung2 compared to that of BARI mung6 (7.45). The number of leaves per plant was 11.81% higher in BU mung2 than BARI mung6 at 45 DAS.

4.7.2 Effect of Weed Control Strategies

The analyzed data of number of leaves per plant revealed that different weed control treatments significantly affected the number of leaves per plant (Appendix v and Table 6). The higher number of leaves per plant was recorded from sunflower extract treatment (7.50) followed by acassia extract treatment (6.78), herbicide application treatment (6.35) and Brassica extract treatment (6.25) at 30 DAS. The lowest number of leaves per plant was obtained from control (5.24) at 30 DAS. The number of leaves per plant was increased by 43.13% in sunflower extract treatment, 29.38% in acassia extract treatment, 21.18% in herbicide treatment and 19.27% in Brassica extract treatment over control treatment at 30 DAS.

At 45 DAS, the highest number of leaves per plant was recorded from hand weeding treatment (8.35) which was statistically similar to sunflower extract treatment (8.31) followed by acassia extract treatment (8.19), sorghum extract treatment (7.92) which was statistically similar to Brassica extract treatment (7.82). The lowest number of leaves per plant was obtained from control treatment (7.30) which was statistically similar to herbicide treatment (7.35) at 45 DAS. The number of leaves per plant was increased by 14.38% in hand weeding treatment, 12.19% in acassia extract treatment, and 8.49% sorghum extract treatment over control treatment at 45 DAS.

Application of acassia and sorghum extract increased number of leaves per plant. This might be due to favorable environmental conditions and greater availability of essential nutrients which increased vegetative growth and produced favorable conditions for higher number of leaves.

4.7.3 Interaction of Variety and Weed Control Strategies

It was observed that mean data regarding number of leaves per plant were significantly affected by the combination of variety and various weed management strategies at 30 and 45 DAS (Appendix v and Table 6). The highest number of leaves per plant was recorded from the interaction of BU mung2 and sunflower extract (7.94) which was followed by the interaction of BU mung2 and hand weeding (7.49), BARI mung6 and acassia extract (7.05) which was statistically similar to the interaction of BARI mung6 and sunflower extract (7.05) and BU mung2 and herbicide application (6.91) which was followed by the interaction of BU mung2 and acassia extract (6.52) at 30 DAS. The lowest number of leaves per plant was obtained from the combination of BARI mung6 and controls (4.39) which was statistically similar to the combination of BARI mung6 and hand weeding (4.51) at 30 DAS. The number of leaves per plant was increased by 80.86% in the interaction of BU mung2 and sunflower extract, 70.61% in the interaction of BU mung2 and hand weeding, 60.59% in the interaction of BARI mung6 and acassia extract and 48.51% in the interaction of BU mung2 and acassia extract over the lowest combination of BARI mung6 and control 30 DAS.

At 45 DAS, the highest number of leaves per plant was recorded from the interaction of BU mung2 and sorghum extract (9.31) which was statistically similar to the interaction BU mung2 and hand weeding (9.17) that followed by the interaction of BU mung2 and sunflower extract (8.60) which was statistically similar to the interaction of BARI mung6 and acassia extract (8.56), the interaction of BU mung2 and Brassica extract (8.17) was statistically similar to the interaction of BARI mung6 and sunflower extract (8.01). The lowest number of leaves per plant was obtained from the combination of BARI mung6 and sorghum extract (6.54) at 45 DAS. The number of leaves per plant was increased by 42.35% in the interaction of BU mung2 and sorghum extract, 30.89% in the interaction of BARI mung6 and acassia extract, 22.47% in the interaction of BARI mung6 and sunflower extract and 22.01% in the interaction of BU mung2 and herbicide application over lowest the combination of BARI mung6 and sorghum extracts at 45 DAS.

4.8 NUMBER OF BRANCHES PER PLANT

4.8.1 Effect of Variety

Analysis of the data showed that the two varieties BARI mung6 and BU mung2 had significant effect on number of branches per plant at 30 and 45 DAS (Appendix vi and Table 6). The highest number of branches per plant (0.80) were recorded from BARI mung6 compared to that of BU mung2 (0.50) at 30 DAS. BARI mung6 had 60% increased number of branches per plant than that of BU mung2 at 30 DAS. Similarly at 45 DAS, the highest number of branches per plant (0.91) was recorded from BARI mung6 compared to that of BU mung2 (0.68). The number of branches per plant was 33.82% higher in BARI mung6 than BU mung2 at 45 DAS.

Table 6: Influence of varieties, weed control strategies and their interaction on leaves and branches per plant at different days after sowing

Treatments		Number of leaves per plant		Number of branches per plant	
		At 30 DAS	At 45 DAS	At 30 DAS	At 45 DAS
Variety (V)					
BARI mung6 (V_1)		5.68 b	7.45 b	0.80 a	0.91 a
BU mung2 (V_2)		6.88 a	8.33 a	0.50 b	0.68 b
SE		0.0209	0.0330	0.0087	0.0065
Weed Control Strategies (W)					
Control	(W_1)	5.24 g	7.30 d	0.37 e	0.43 f
Hand weeding	(W_2)	6.00 e	8.35 a	1.00 a	1.18 a
Herbicide	(W_3)	6.35 c	7.35 d	0.61 c	0.93 c
Sorghum extract	(W_4)	5.84 f	7.92 c	0.51 d	0.73 d
Acassia extract	(W_5)	6.78 b	8.19 b	0.93 b	1.05 b
Sunflower extract	(W_6)	7.50 a	8.31 ab	0.52 d	0.61 e
Brassica extract	(W_7)	6.25 d	7.82 c	0.61 c	0.65 de
SE		0.0330	0.0421	0.0203	0.0336
Interaction of Variety and Weed Control Strategies (V x W)					
V_1 x W_1		4.39 i	7.32 gh	0.45 f	0.49
V_1 x W_2		4.51 i	7.52 f	1.26 a	0.77
V_1 x W_3		5.81 g	6.72 i	0.80 cd	0.85
V_1 x W_4		5.44 h	6.54 j	0.65 e	0.84
V_1 x W_5		7.05 c	8.56 b	0.99 b	0.92
V_1 x W_6		7.05 c	8.01 cd	0.63 e	0.77
V_1 x W_7		5.52 h	7.47 fg	0.85 c	0.73
V_2 x W_1		6.08 f	7.27 h	0.30 h	0.36
V_2 x W_2		7.49 b	9.17 a	0.74 d	0.98
V_2 x W_3		6.91 c	7.98 de	0.43 fg	0.82
V_2 x W_4		6.23 e	9.31 a	0.38 fg	0.61
V_2 x W_5		6.52 d	7.82 e	0.87 c	0.97
V_2 x W_6		7.94 a	8.60 b	0.41 fg	0.46
V_2 x W_7		6.98 c	8.17 c	0.36 gh	0.56
SE		0.0467	0.0595	0.0288	NS
CV (%)		1.29	1.31	7.65	10.33

4.8.2 Effect of Weed Control Strategies

The analyzed data of number of branches per plant revealed that different weed control treatments significantly affected the number of branches per plant (Appendix 5 and Table 6). The highest number of branches per plant was recorded from hand weeding treatment (1.00) followed by acassia extract treatment (0.93), herbicide application treatment (0.61) which was statistically similar to Brassica extract treatment (0.61) and was followed by sunflower extract treatment (0.52) at 30 DAS. The lowest number of branches per plant was obtained from control which was (0.37) at 30 DAS. The number of branches per plant was increased by 170% in hand weeding treatment, 151% in acassia extract treatment, 65% herbicide treatment and 41% sunflower extract treatment over control treatment at 30 DAS.

At 45 DAS, the highest number of branches per plant was recorded from hand weeding treatment (1.18) followed by acassia extract treatment (1.05), herbicide application treatment (0.93), sorghum extract treatment (0.73) which was statistically similar to Brassica extract treatment (0.65). The lowest number of branches per plant was obtained from control which was (0.43) at 45 DAS. The number of branches per plant was increased by 174% in hand weeding treatment, 144% in acassia extract treatment, 98% herbicide treatment and 55% sorghum extract treatment over control treatment at 45 DAS.

The probable reason might be that decrease in number of weeds made the nutrients available to the crop that caused initiation of greater number of branches per plant in plots where weeds were suppressed. Less number of branches per plant were observed in control plots which might be due to the competition of weeds with plants for nutrients, space, light etc. Similar results were reported by Cheema *et al.* (2001 a) who reported that with the application of water extracts number of branches were increased.

4.8.3 Interaction of Variety and Weed Control Strategies

It was observed that mean data regarding number of branches per plant were significantly affected by the combination of variety and various weed management strategies at 30 DAS (Appendix vi and Table 6). The highest number of branches per plant was recorded from the interaction of BARI mung6 and hand weeding (1.26) which was followed by the interaction of BARI mung6 and acassia extract (0.99), BU mung2 and acassia extract (0.87) that was statistically similar to the interaction of BARI mung6 and Brassica extract (0.85), BARI mung6 and herbicide (0.80) at 30 DAS. The lowest number of branches per plant was obtained from the combination of BU mung2 and control (0.30) at 30 DAS. The number of branches per plant was increased by 320% in the interaction of BARI mung6 and hand weeding, 230% in the interaction of BARI mung6 and acassia extract, 190% in the interaction of BU mung2 and acassia extract and 147% in the interaction of BU mung2 and hand weeding over lowest the combination of BU mung2 and control at 30 DAS.

At 45 DAS, though the combined effect had no significant effect on number of branches per plant but the numerical maximum number of branches per plant was recorded from the interaction of BARI mung6 and hand weeding (1.38). The minimum number of branches per plant was obtained from the combination of BU mung2 and control (0.36) at 45 DAS.

4.9 NUMBER OF PODS PER PLANT

4.9.1 Effect of Variety

Number of pods per plant is one of the most important yield contributing character of mungbean. Significant variation was observed among the varieties BARI mung6 and BU mung2 in respect of number of pods per plant at 45 DAS and at harvest (Appendix vi and Table 7). The higher number of pods per plant (11.34) was recorded from BARI mung6 compared to that of BU mung2 (9.79) at 45 DAS. BARI mung6 had 15.83% higher number of pods per plant than that of BU mung2. Similarly at harvest, the higher number of pods per plant (14.99) was recorded from BARI mung6 compared to that of BU mung2 (13.23). The number of pods per plant was 13.30% higher in BARI mung6 than that of BU mung2 at harvest. Similar results were reported by Ahmed *et al.* (2003).

4.9.2 Effect of Weed Control Strategies

The analyzed data revealed that the number of pods per plant significantly affected by different weed control treatments (Appendix vi and Table 7). The highest number of pods per plant was recorded from acassia extract treatment (13.57) followed by hand weeding treatment (12.82) which was statistically similar to herbicide application treatment (12.77) and followed by sorghum extract treatment (10.35), Brassica extract treatment (9.91) at 45 DAS. The lowest number of pods per plant was obtained from control (6.36) at 45 DAS. The number of pods per plant was increased by 113% in acassia extract treatment, 101% in hand weeding treatment, 62% in sorghum extract treatment and 55% in Brassica extract treatment over control treatment at 45 DAS.

At harvest, the highest number of pods per plant was recorded from hand weeding treatment (17.08) followed by acassia extract treatment (15.99) which was statistically similar to herbicide application treatment (15.77) and followed by sorghum extract treatment (14.51), Brassica extract treatment (12.94). The lowest number of pods per plant was obtained from control (10.38). The number of pods per plant was increased by 64% in hand weeding treatment, 54% in acassia extract treatment, 40% in sorghum extract treatment and 25% in Brassica extract treatment over control treatment at harvest. Mamun and Salim (1989) and Blackshaw (1993) also reported considerable reduction in number of effective pods per plant in mungbean due to weed competition.

Application of different plant extract like acassia, sorghum extract increased number of pods per plant. This might be due to favorable environmental conditions and greater availability of essential nutrients which increased the growth and led to greater stimulation of vegetative growth and produced favorable conditions for producing more pods. Similar results were obtained by Mukhapadhyay and Gosh (1980), who reported that herbicides controlled weed efficiently and increased pods per plant as compared to mechanical weed control method. Cheema *et al.* (2001 a) also reported the increase in number of pods per plant with application of water extracts.

4.9.3 Interaction of Variety and Weed Control Strategies

The combined effect between variety and various weed management strategies was significant in respect of number of pods plant^{-1} at 45 DAS and at harvest (Appendix vi and Fig. 11). The highest number of pods per plant was recorded from the interaction of BARI mung6 and hand weeding (14.68) that was statistically similar to the interaction of BARI mung6 and acassia extract (14.55) was followed by the interaction of BARI mung6 and herbicide (12.87) which was statistically similar to the interaction of BU mung2 and herbicide (12.67), BU mung2 and acassia extract (12.59) was followed by the interaction of BU mung2 and hand weeding (10.95) at 45 DAS. The lowest number of pods per plant was obtained from the combination of BU mung2 and controls (5.30) at 45 DAS. The number of pods per plant was increased by 177% in the interaction of BARI mung6 and hand weeding, 139% in the interaction of BU mung2 and herbicide, 106% in the interaction of BU mung2 and hand weeding, 95% in the interaction of BARI mung6 and Brassica extract over the lowest combination of BU mung2 and control at 45 DAS.

At harvest, the highest number of pods per plant was recorded from the interaction of BARI mung6 and hand weeding (18.12) which was followed by the interaction of BARI mung6 and acassia extract (17.06), BARI mung6 and herbicide (16.57), BU mung2 and hand weeding (16.05) which was statistically similar to the interaction of BARI mung6 and sorghum extract (15.64) that followed by the interaction of BU mung2 and herbicide (14.97). The lowest number of pods per plant was obtained from the combination of BU mung2 and control (8.95) at harvest. The number of pods per plant was increased by 102% in the interaction of BARI mung6 and hand weeding, 91% in the interaction of BARI mung6 and acassia extract, 85% in the interaction of BARI mung6 and herbicide, 79% in the interaction of BU mung2 and hand weeding over the lowest combination of BU mung2 and control at harvest.

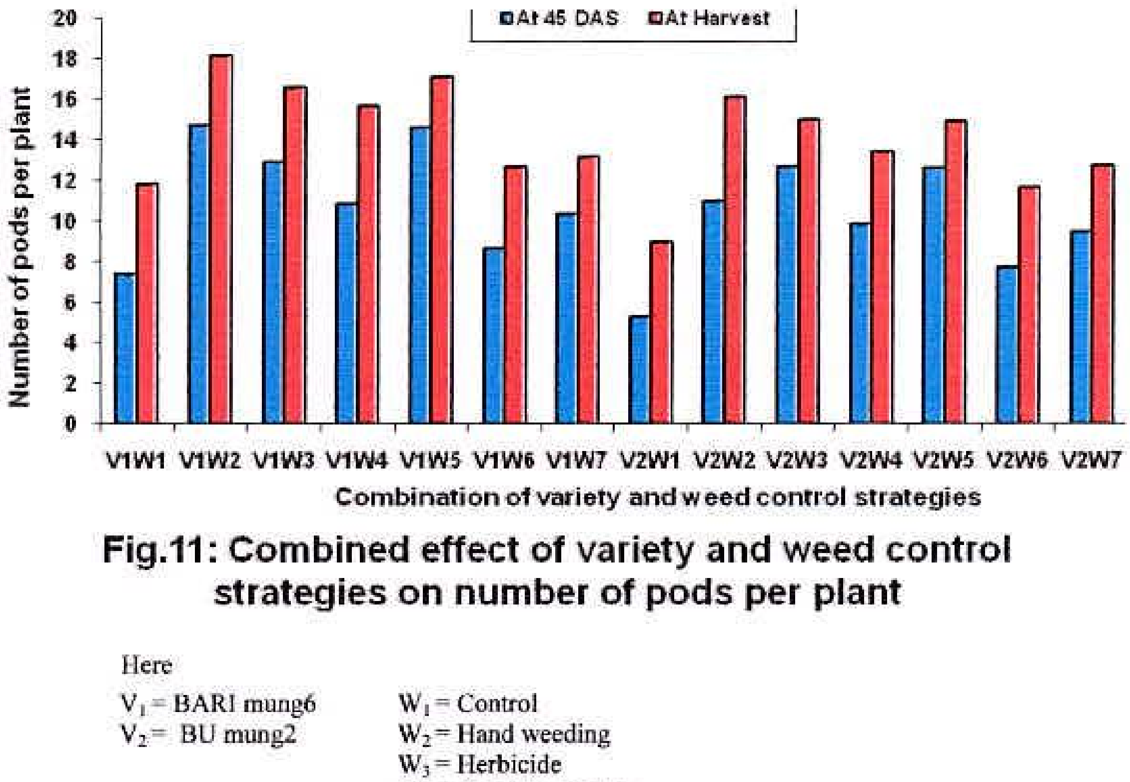

Fig.11: Combined effect of variety and weed control strategies on number of pods per plant

Here

V_1 = BARI mung6
V_2 = BU mung2

W_1 = Control
W_2 = Hand weeding
W_3 = Herbicide
W_4 = Sorghum extract
W_5 = Acassia extract
W_6 = Sunflower extract
W_7 = Brassica extract

4.10 POD LENGTH (cm)

4.10.1 Effect of Variety

It was observed that pod length was significantly influenced by two varieties BARI mung6 and BU mung2 (Appendix vi and Table 7).

The pod length was obtained higher in BARI mung6 (7.75 cm) compared to BU mung2 (7.28 cm). The variety BARI mung6 showed 6.45 % higher pod length than BU mung2.

4.10.2 Effect of Weed Control Strategies

Pod length was significantly affected by the different weed control strategies (Appendix vi and Table 7). The longest pod was obtained from the plots where crops received hand weeding (8.37 cm) which was significantly higher than crops receiving acassia extract (8.02 cm) followed by crops receiving herbicide (7.68 cm), sorghum extract (7.34 cm) treatment and Brassica extract (7.16 cm) treatment. The shortest pod length was obtained from no weeding treatment which was (6.93 cm). Pod length was increased by 20.77% in hand weeding, 15.73% in acassia extract, 10.82% in herbicide and 5.91% in sorghum extract treatement over control. Singh and Singh (1993) also observed a reduction in pod length by 9.76% due to weed competition.

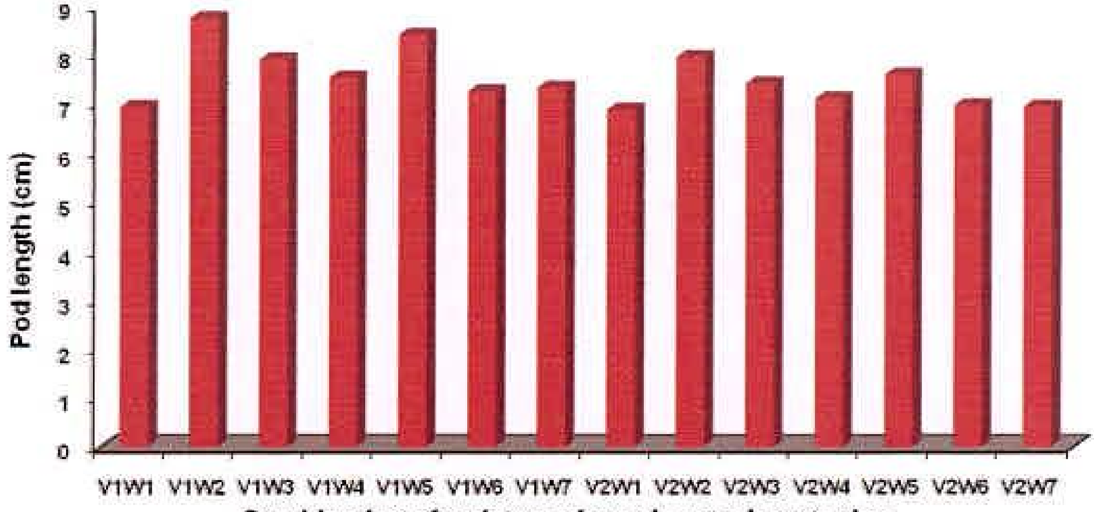

Fig.12 : Combined effect of variety and weed control strategies on pod length (cm)

Here

V_1 = BARI mung6	W_1 = Control
V_2 = BU mung2	W_2 = Hand weeding
	W_3 = Herbicide
	W_4 = Sorghum extract
	W_5 = Acassia extract
	W_6 = Sunflower extract
	W_7 = Brassica extract

4.10.3 Interaction of Variety and Weed Control Strategies

It was observed that pod length was significantly affected by the interaction of variety and weed control strategies (Appendix vi and Fig. 12). The highest pod length was found with the combination of BARI mung6 and hand weeding (8.76 cm) which was significantly higher than the combination of BARI mung6 and acassia extract (8.42 cm), BU mung2 and hand weeding (7.97 cm) which was statistically similar to BARI mung6 and herbicide (7.92 cm) that followed by the combination of BU mung2 and acassia extract (7.62 cm) which was statistically similar to BARI mung6 and sorghum extract (7.55 cm). The shortest pod length was obtained from the combination of BU mung2 and control (6.90 cm) which was statistically similar to BARI mung6 and control (6.95 cm), BU mung2 and Brassica extract (6.96). The pod length was increased in the combination by 26.95% in BARI mung6 and hand weeding, 22.02% in BARI mung6 and acassia extract, 15.50% in BU mung2 and hand weeding, 9.44% in BU mung2 and acassia extract over the shortest pod length obtained from the combination of BU mung2 and control.

4.11 NUMBER OF SEEDS PER POD

4.11.1 Effect of Variety

Two Varieties BARI mung6 and BU mung2 had significant effect in respect of number of seeds pod^{-1} (Appendix vi and Table 7). The number of seeds per pod was obtained higher in BARI mung6 (11.94) compared to BU mung2 (10.00). The variety BARI mung6 showed 19.40 % higher number of seeds per pod than BU mung2.

4.11.2 Effect of Weed Control Strategies

Number of seeds per pod was significantly affected by the different weed control strategies (Appendix vi and Table 7). The highest number of seeds per pod was obtained from the plots where crops received hand weeding (13.46) which was significantly higher than crops receiving acassia extract (12.25) followed by crops receiving herbicide (11.75), sorghum extract (11.29) treatment and Brassica extract (10.38) treatment. The lowest number of seeds per pod was obtained from no weeding treatment (8.16). Number of seeds per pod was increased by 64.95% in hand weeding, 50.12% in acassia extract, 44.10% in herbicide and 38.35% in sorghum extract treatement over control. Singh and Singh (1993) observed a reduction of 40% in number of seeds pod^{-1} due to weed competition.

4.11.3 Interaction of Variety and Weed Control Strategies

It was observed that number of seeds per pod was significantly affected by the interaction of variety and weed control strategies (Appendix vi and Fig. 13). The highest number of seeds per pod was found with the combination of BARI mung6 and hand weeding (14.40) which was significantly higher than the combination of BARI mung6 and herbicide (13.15) but similar to BARI mung6 and acassia extract (13.10) and followed by BARI mung6 and sorghum extract (12.57) that was statistically similar to BU mung2 and hand weeding (12.52). The combination of BU mung2 and acassia extract (11.40) was statistically similar to BARI mung6 and Brassica extract (11.30). The lowest number of seeds per pod was obtained from the combination of BU mung2 and control which was 7.58 seeds per pod. The number of seeds per pod was increased in the combination by 86.02% in BARI mung6 and hand weeding, 72.82% in BARI mung6 and acassia extract, 65.17% in BU mung2 and hand weeding, 50.39% in BU mung2 and acassia extract over the lowest number of seeds per pod obtained from the combination of BU mung2 and control.

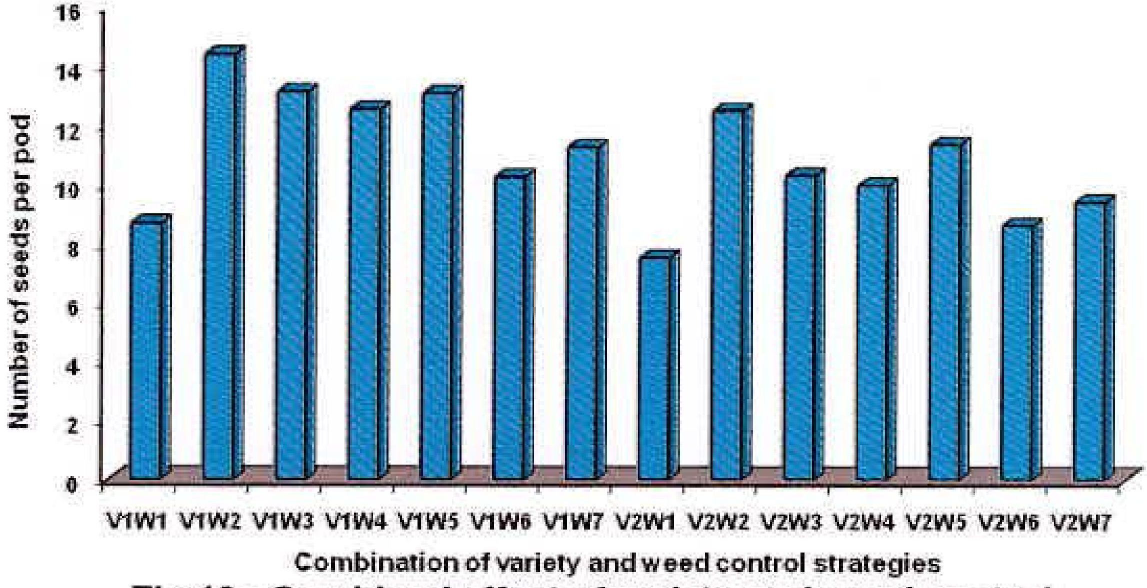

Fig.13 : Combined effect of variety and weed control strategies on number of seeds per pod

Here

V_1 = BARI mung6
V_2 = BU mung2

W_1 = Control
W_2 = Hand weeding
W_3 = Herbicide
W_4 = Sorghum extract
W_5= Acassia extract
W_6 = Sunflower extract
W_7 = Brassica extract

Table 7: Influence of varieties and weed control strategies on yield contributing characteristics of mungbean

Treatments		Number of pods per plant		Number of seeds per pod	Pod length (cm)
		At 45 DAS	At Harvest		
Variety (V)					
BARI mung6 (V_1)		11.34 a	14.99 a	11.94 a	7.75 a
BU mung2 (V_2)		9.79 b	13.23 b	10.00 b	7.28 b
SE		0.0323	0.0626	0.0559	0.0556
Weed Control Strategies (W)					
Control	(W_1)	6.36 f	10.38 f	8.16 g	6.93 f
Hand weeding	(W_2)	12.82 b	17.08 a	13.46 a	8.37 a
Herbicide	(W_3)	12.77 b	15.77 b	11.75 c	7.68 c
Sorghum extract	(W_4)	10.35 c	14.51 c	11.29 d	7.34 d
Acassia extract	(W_5)	13.57 a	15.99 b	12.25 b	8.02 b
Sunflower extract	(W_6)	8.20 e	12.13 e	9.48 f	7.13 e
Brassica extract	(W_7)	9.91 d	12.94 d	10.38 e	7.16 e
SE		0.0333	0.1073	0.1149	0.0474
CV (%)		1.86	1.90	2.57	1.54

Here
V_1 = BARI mung6 W_1 = Control
V_2 = BU mung2 W_2 = Hand weeding
W_3 = Herbicide
W_4 = Sorghum extract
W_5 = Acassia extract
W_6 = Sunflower extract
W_7 = Brassica extract

4.12 THOUSAND SEED WEIGHT (g)

4.12.1 Effect of Variety

Data regarding thousand seed yield (g) was significantly affected by two varieties BARI mung6 and BU mung2 (Appendix vi and Table 8). The thousand seed yield (g) was obtained higher in BARI mung6 (51.05 g) compared to BU mung2 (49.22 g). The variety BARI mung6 showed 3.72 % higher thousand seed yield than that of BU mung2.

4.12.2 Effect of Weed Control Strategies

Different types of weed control strategies showed significant difference in case of 1000-seed weight (g) (Appendix vi and Table 8). The highest thousand seed weight (g) was obtained from the plots where crops received hand weeding (53.16 g) which was significantly higher than crops receiving acassia extract (51.88 g) followed by crops receiving herbicide (51.49 g), sorghum extract (50.90 g) treatment and Brassica extract (48.74 g) treatment. The lowest thousand seed weight (g) was obtained from no weeding treatment (47.22 g) which was statistically similar to sunflower extract treatment (48.56 g).Thousand seed weight was increased by 12.58% in hand weeding, 9.87% in acassia extract, 9.04% in herbicide and 7.79% in sorghum extract treatement over control.

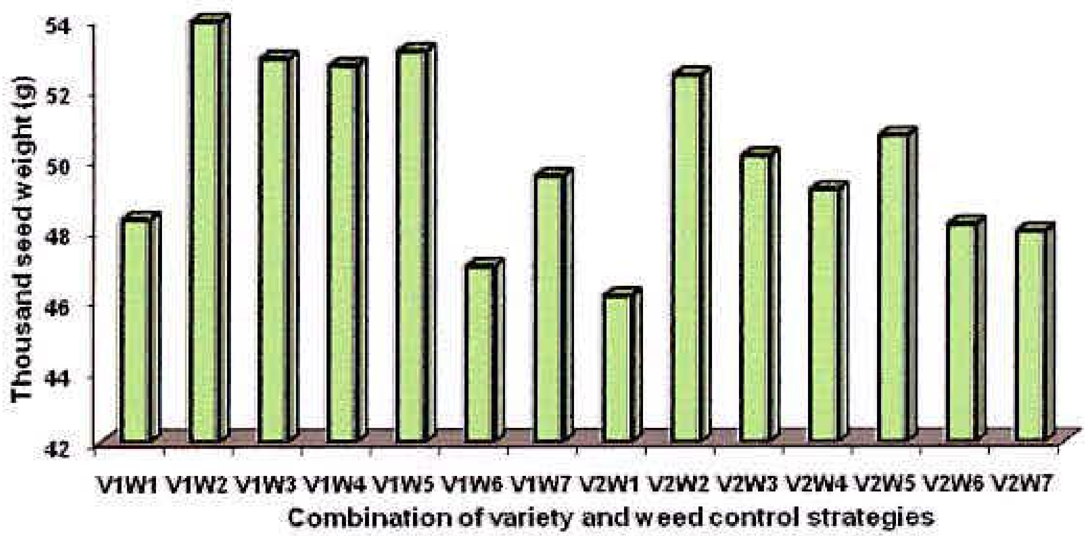

Fig.14 : Combined effect of effect of variety and weed control strategies on thousand seed weight (g)

Here

V_1 = BARI mung6	W_1 = Control
V_2 = BU mung2	W_2 = Hand weeding
	W_3 = Herbicide
	W_4 = Sorghum extract
	W_5 = Acassia extract
	W_6 = Sunflower extract
	W_7 = Brassica extract

4.12.3 Interaction of Variety and Weed Control Strategies

It was observed that thousand seed weight (g) was significantly affected by the interaction of variety and weed control strategies (Appendix vi and Fig. 15). The highest thousand seed weight (g) was found with the combination of BARI mung6 and hand weeding (53.92 g) which was significantly higher than the combination of BARI mung6 and acassia extract (53.08 g) which was statistically similar to BARI mung6 and herbicide (52.87 g), BARI mung6 and sorghum extract (52.67 g) that followed by the combination of BU mung2 and acassia extract (50.68 g) and the combination of BU mung2 and herbicide (40.10 g). The lowest thousand seed weight (g) was obtained from the combination of BU mung2 and control which was 46.12 g. The thousand seed weight (g) was increased in the combination by 16.91% in BARI mung6 and hand weeding, 15.09% in BARI mung6 and acassia extract, 9.88% in BU mung2 and acassia extract, 8.63% in BU mung2 and herbicide over the lowest thousand seed yield (g) obtained from the combination of BU mung2 and control.

Table 8: Influence of varieties and weed control strategies on seed weight and yield of mungbean

Treatments		Thousand seed weight (g)	Seed yield (kg ha^{-1})	Straw yield (kg ha^{-1})
Variety (V)				
BARI mung6 (V_1)		51.05 a	1117.03 a	2572.13 a
BU mung2 (V_2)		49.22 b	851.98 b	2173.12 b
SE		0.1246	0.1941	0.7235
Weed Control Strategies (W)				
Control	(W_1)	47.22 f	634.00 g	1624.00 g
Hand weeding	(W_2)	53.16 a	1326.00 a	3072.00 a
Herbicide	(W_3)	51.49 c	1148.00 c	2646.00 c
Sorghum extract	(W_4)	50.90 d	944.30 d	2335.00 d
Acassia extract	(W_5)	51.88 b	1235.00 b	2849.00 b
Sunflower extract	(W_6)	47.56 f	763.20 f	1948.00 f
Brassica extract	(W_7)	48.74 e	840.70 e	2135.00 e
SE		0.1323	0.3720	2.6968
CV (%)		1.65	2.09	2.28

Here

V_1 = BARI mung6
V_2 = BU mung2

W_1 = Control
W_2 = Hand weeding
W_3 = Herbicide
W_4 = Sorghum extract
W_5 = Acassia extract
W_6 = Sunflower extract
W_7 = Brassica extract

4.13 SEED YIELD (kg ha^{-1})

4.13.1 Effect of Variety

Data regarding seed yield (kg ha^{-1}) was significantly affected by two varieties BARI mung6 and BU mung2 (Appendix vi and Table 8). The seed yield (kg ha^{-1}) was obtained higher in BARI mung6 (1117.03 kg ha^{-1}) compared to BU mung2 (851.98 kg ha^{-1}). The variety BARI mung6 showed 31.11 % higher seed yield than that of BU mung2. The highest seed yield in BARI mung6 might be due to the contribution of more number of pods $plant^{-1}$ and individual seed weight.

4.13.2 Effect of Weed Control Strategies

It was observed that seed yield was significantly influenced by the different weed control strategies (Appendix vi and Table 8). The highest seed yield (kg ha^{-1}) was obtained from the plots where crops received hand weeding (1326.00 kg ha^{-1}) which was significantly higher than crops receiving acassia extract (1235.00 kg ha^{-1}) followed by crops receiving herbicide (1148.00 kg ha^{-1}), sorghum extract (944.30 kg ha^{-1}) treatment and Brassica extract (840.70 kg ha^{-1}) treatment. The lowest seed yield (kg ha^{-1}) was obtained from no weeding treatment (634.00 kg ha^{-1}). Seed yield was increased by 109.14% in hand weeding, 94.80% in acassia extract, 81.07% in herbicide and 48.94% in sorghum extract treatement over control.

4.13.3 Interaction of Variety and Weed Control Strategies

Seed yield was significantly affected by the interaction of weeding and variety (Appendix vi and Fig. 14). The highest seed yield was found with the combination of BARI mung6 and hand weeding (1501.00 kg ha^{-1}) which was significantly higher than the combination of BARI mung6 and acassia extract (1402.00 kg ha^{-1}), BARI mung6 and herbicide (1321.00 kg ha^{-1}), BU mung2 and hand weeding (1151.00 kg ha^{-1}), BARI mung6 and sorghum extract (1102.00 kg ha^{-1}) and the combination of BU mung2 and acassia extract (1068.00 kg ha^{-1}). The lowest seed yield was obtained from the combination of BU mung2 and control which was 583.00 kg ha^{-1}. The seed yield was increased in the combination by 157.46% in BARI mung6 and Hand weeding, 140.48% in BARI mung6 and acassia extract, 126.58% in BARI mung6 and herbicide, 97.42% in BU mung2 and hand weeding over the lowest seed yield obtained from the combination of BU mung2 and control. Ali *et al.* (2004) reported similar results that water extract application increased the grain yield of crops.

The probable reason for higher yield in weed control plots might be that hand weeding, acassia and sorghum extract application reduced the mungbean plants competition with weeds for nutrients, light, moisture and space and thus maximized the utilization of nutrients from the soil which finally developed heavy seeds. Similar results were obtained by Salisbury and Ross (1978), who found that sorghum extract increased grain yield by suppressing the vegetative growth of weeds.

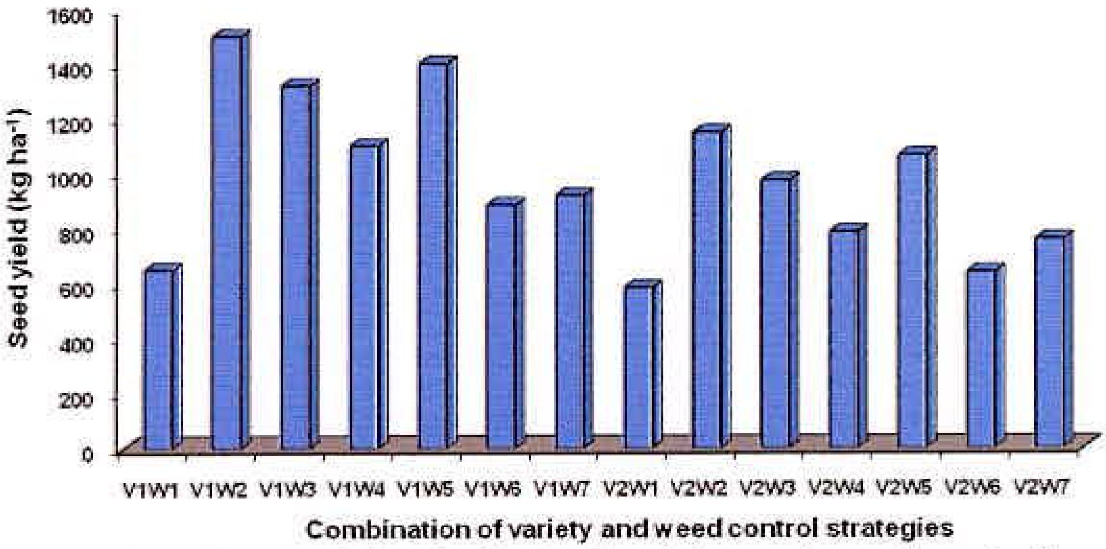

Fig.15 : Combined effect of variety and weed control strategies on seed yield

Here
V_1 = BARI mung6
V_2 = BU mung2

W_1 = Control
W_2 = Hand weeding
W_3 = Herbicide
W_4 = Sorghum extract
W_5 = Acassia extract
W_6 = Sunflower extract
W_7 = Brassica extract

4.14 STRAW YIELD (kg ha^{-1})

4.14.1 Effect of Variety

Data regarding straw yield was significantly affected by two varieties BARI mung6 and BU mung2 (Appendix vi and Table 8). The straw yield was obtained higher in BARI mung6 (2572.13 kg ha^{-1}) compared to BU mung2 (2173.12 kg ha^{-1}). The variety BARI mung6 showed 18.36 % higher straw yield than that of BU mung2.

4.14.2 Effect of Weed Control Strategies

Straw yield was significantly affected by the different weed control strategies (Appendix vi and Table 8). The highest straw yield was obtained from the plots where crops received hand weeding (3072.00 kg ha^{-1}) which was significantly higher than crops receiving acassia extract (2849.00 kg ha^{-1}) followed by crops receiving herbicide (2646.00 kg ha^{-1}), sorghum extract (2335.00 kg ha^{-1}) treatment and Brassica extract (2135.00 kg ha^{-1}) treatment. The lowest straw yield was obtained from no weeding treatment (1624.00 kg ha^{-1}). Straw yield was increased by 89.19% in hand weeding, 75.43% in acassia extract, 50.61% in herbicide and 43.78% in sorghum extract treatement over control.

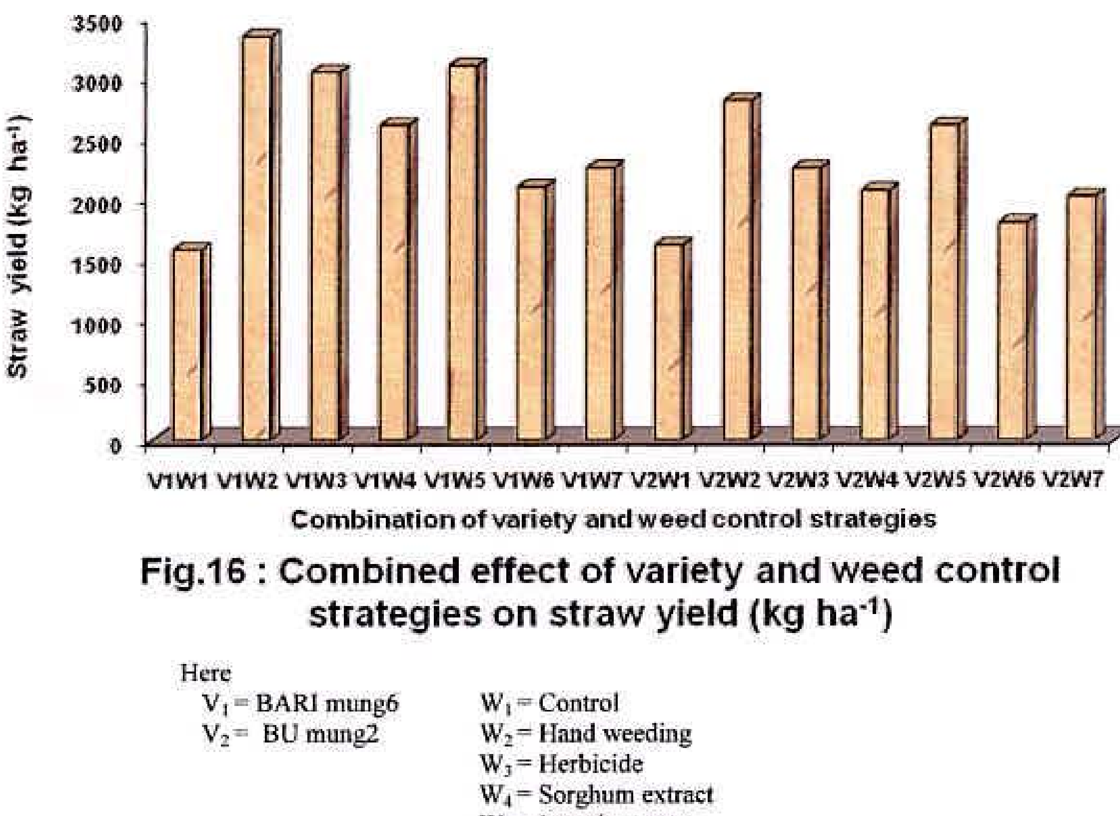

Fig.16 : Combined effect of variety and weed control strategies on straw yield (kg ha^{-1})

Here

V_1 = BARI mung6
V_2 = BU mung2

W_1 = Control
W_2 = Hand weeding
W_3 = Herbicide
W_4 = Sorghum extract
W_5 = Acassia extract
W_6 = Sunflower extract
W_7 = Brassica extract

4.14.3 Effect of Interaction of Variety and Weed Control Strategies

The straw yield was significant with the combined effect of variety and weeding (Appendix vi and Fig. 15). The highest straw yield was found with the combination of BARI mung6 and hand weeding (3338.00 kg ha^{-1}) which was significantly higher than the combination of BARI mung6 and acassia extract (3096.00 kg ha^{-1}), BARI mung6 and herbicide (3043.00 kg ha^{-1}), BU mung2 and hand weeding (2806.00 kg ha^{-1}), BARI mung6 and sorghum extract (2604.00 kg ha^{-1}) which was statistically similar to the combination of BU mung2 and acassia extract (2602.00 kg ha^{-1}). The lowest straw yield (kg ha-1) was obtained from the combination of BARI mung6 and control which was 1579.00 kg ha^{-1}. The straw yield was increased in the combination by 111.39% in BARI mung6 and hand weeding, 96.07% in BARI mung6 and acassia extract, 92.71% in BARI mung6 and herbicide, 77.70% in BU mung2 and hand weeding over the lowest straw yield obtained from the combination of BARI mung6 and control.

CHAPTER 5

SUMMARY AND CONCLUSION

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The field experiment was conducted at the Agronomy Farm of Sher-e-Bangla Agricultural University (SAU), Dhaka to evaluate the performance of different weed control strategies to control weeds of two mungbean varieties during the period from March 2008 to June 2008. The experiment was carried out in split-plot design with three replications having two varieties in main plot and seven weed control strategies in the sub plot. The varieties were BARI mung6 and BU mung2 and weed control strategies were no weeding, hand weeding, herbicide application, acassia extract application, sorghum extract application, Brassica extract application and sunflower extract application.

The data on weed characteristics like weed density m^{-2}, weed biomass and weed control efficiency at different days after sowing, crop growth characters like root and shoot length, plant height, dry weight of plant, number of leaves $plant^{-1}$, number of branches $plant^{-1}$ at different days after sowing and yield as well as yield contributing characters like number of pods $plant^{-1}$, pod length, number of seeds pod^{-1}, thousand seed weight, seed yield and straw yield were recorded and analysed by using MSTAT-C software. The main differences among the treatments were compared by DMRT test at 5% level of significance.

Weed density (m^{-2}) in mungbean field significantly influenced by varieties. The lowest weeds density m^{-2} was obtained from BARI mung6 (10.98 weeds/m^2) at 15 DAS. Weed density m^{-2} were significantly affected by various weed management strategies. The lowest weed density m^{-2} was shown by hand weeding (8.29 weeds/m^2) and control had the highest weed population (14.38 weeds/m^2) at 15 DAS. Hand weeding had the lowest value of 13.82 weed m^{-2} and control had the highest value of 27.86 weeds m^{-2} at 45 DAS. Minimum number of weeds at 15 DAS and at 45 DAS was noted in the interaction of BARI mung6 and hand weeding (7.31weeds/m^2) and in the interaction of BU mung2 and hand weeding (13.57 weeds/m^2).

The lowest dry weights of weeds 12.35 g m^{-2} and 25.52 g m^{-2} were recorded from BU mung2 at 15 and 45 DAS respectively. Weed control treatments significantly reduced the dry weight of weeds where the lowest dry weight of 7.07g m^{-2} and 16.20 g m^{-2} was recorded from hand weeding treatment at 15 and 45 DAS respectively. The interaction of BU mung2 and hand weeding had minimum weed biomass 6.60 g m^{-2} and 15.93 g m^{-2} at 15 and 45 DAS respectively.

Weed control efficiency was significantly affected by the two varieties where the highest weed control efficiency 27.02% was obtained from the BARI mung6 at 15 DAS. Hand weeding had the best weed control efficiency of 57.18% and 54.00% at 15 and 45 DAS respectively. Weed control efficiency was observed higher in combination of BU mung2 and hand weeding which were 58.04% and 54.21% at 15 and 45 DAS respectively.

Plant heights of mungbean were influenced significantly by the variety, weed management strategies and also their interaction at different growth stages. Plant height was always highest in BARI mung6 at all the studied durations. Plant height was significantly higher with the weed management strategies of acassia extract application which were 27.00 cm, 36.26 cm, 40.62 cm and with the interaction of BARI mung6 and acassia extract which were 32.74 cm, 42.06 cm, 46.13 cm at 30, 45 DAS and at harvest respectively.

At 30 and 45 DAS, dry weight $plant^{-1}$ was significantly higher in BARI mung6 which were 1.96 g and 3.56 g respectively. The highest dry weight $plant^{-1}$ (1.61, 3.21, 4.74 and 5.89 g) was obtained from the plots where crops received hand weeding at 15, 30, 45 DAS and at harvest respectively. Dry weight per plant was significantly affected by the interaction of weeding and variety where combination of BU mung2 and hand weeding had the highest dry weight per plant which were 1.74, 3.48, 4.92 g at 15, 30 and 45 DAS respectively.

The highest number of leaves $plant^{-1}$ was recorded from BU mung2 (6.88 and 8.33) at 30 and 45 DAS, from sunflower extract treatment (7.50) at 30 DAS, from hand weeding treatment (8.35) at 45 DAS, from the interaction of BU mung2 and sunflower extract (7.94) at 30 DAS and from the interaction of BU mung2 and sorghum extract (9.31) at 45 DAS.

The highest number of branches $plant^{-1}$ was recorded from BARI mung6 (0.80 and 0.91) at 30 and 45 DAS, from hand weeding treatment (1.00 and 1.18) at 30 and 45 DAS, from the interaction of BARI mung6 and hand weeding (1.26) at 30 DAS.

The yield and yield contributing characteristics of mungbean significantly influenced by variety, different weed control strategies and their interaction. The highest number of pods per plant (11.34, 14.99) was recorded from BARI mung6 at 45 DAS and at harvest respectively. The number of pods per plant significantly affected by different weed control treatments where the highest number of pods per plant was recorded from acassia extract treatment (13.57) at 45 DAS and from hand weeding treatment (17.08) at harvest. The highest number of pods per plant was recorded from the interaction of BARI mung6 and hand weeding (14.68 and 18.12) at 45 DAS and at harvest. The pod length was obtained higher in BARI mung6 (7.75 cm), in hand weeding (8.37 cm) treatment and in the combination of BARI mung6 and hand weeding (8.76 cm). The number of seeds per pod was obtained higher in BARI mung6 (11.94), in the plots where crops received hand weeding (13.46) and in the combination of BARI mung6 and hand weeding (14.40). The thousand seed weight was significantly higher in BARI mung6 (51.05 g), in hand weeding (53.16 g), in the combination of BARI mung6 and hand weeding (53.92 g). Data regarding seed yield (kg ha^{-1}) was significantly affected by two varieties, different weed control strategies and the interaction of variety and weed control strategies. The seed yield was obtained higher in BARI mung6 (1117.03 kg ha^{-1-}), in hand weeding (1326.00 kg ha^{-1}) treatment and in the combination of BARI mung6 and hand weeding (1501.00 kg ha^{-1}).The highest straw yield was found in BARI mung6 (2572.13 kg ha^{-1}), in the plots where crops received hand weeding (3072.00 kg ha^{-1}) and in the combination of BARI mung6 and hand weeding (3338.00 kg ha^{-1}).

Among the two varieties BARI mung6 was the best performer in reducing weed biomass and percent weed control efficiency. Hand weeding, acassia extract and other plant extract application significantly reduced weed density, weed biomass and increase weed control efficiency. BU mung2 and hand weeding, BARI mung6 and acassia extract combination and also combination of variety and other plant extract had the higher weed control eefficiency. From the above results, it might be concluded that the treatments hand weeding, herbicide application, acassia extract application, sorghum extract application and also other plant extract application had significant effect on growth of BARI mung6 and BU mung2. With combined application, the highest grain yield were obtained from BARI mung6 and hand weeding and second highest in BARI mung6 and acassia extract application. Seed yield of mungbean was higher in hand weeding that followed by acassia extract application, herbicide application and sorghum extract application.

It might be concluded that though hand weeding and its combination with BARI mung6 and BU mung2 gave higher pods per plant, seeds per pod, 1000 seed weight and finally seed yield but it is costly and laborious. So use of acassia extract, sorghum extract and Brassica extract application by exploiting allelopathy as an alternative tool for crop production against weeds was more economic, labour saving and environmentally friendly. However, to reach a specific conclusion and recommendation, more research work on allelopathic plant extract application for controlling weed in crop field should be done over different Agro Ecological Zones along with their cost analysis.

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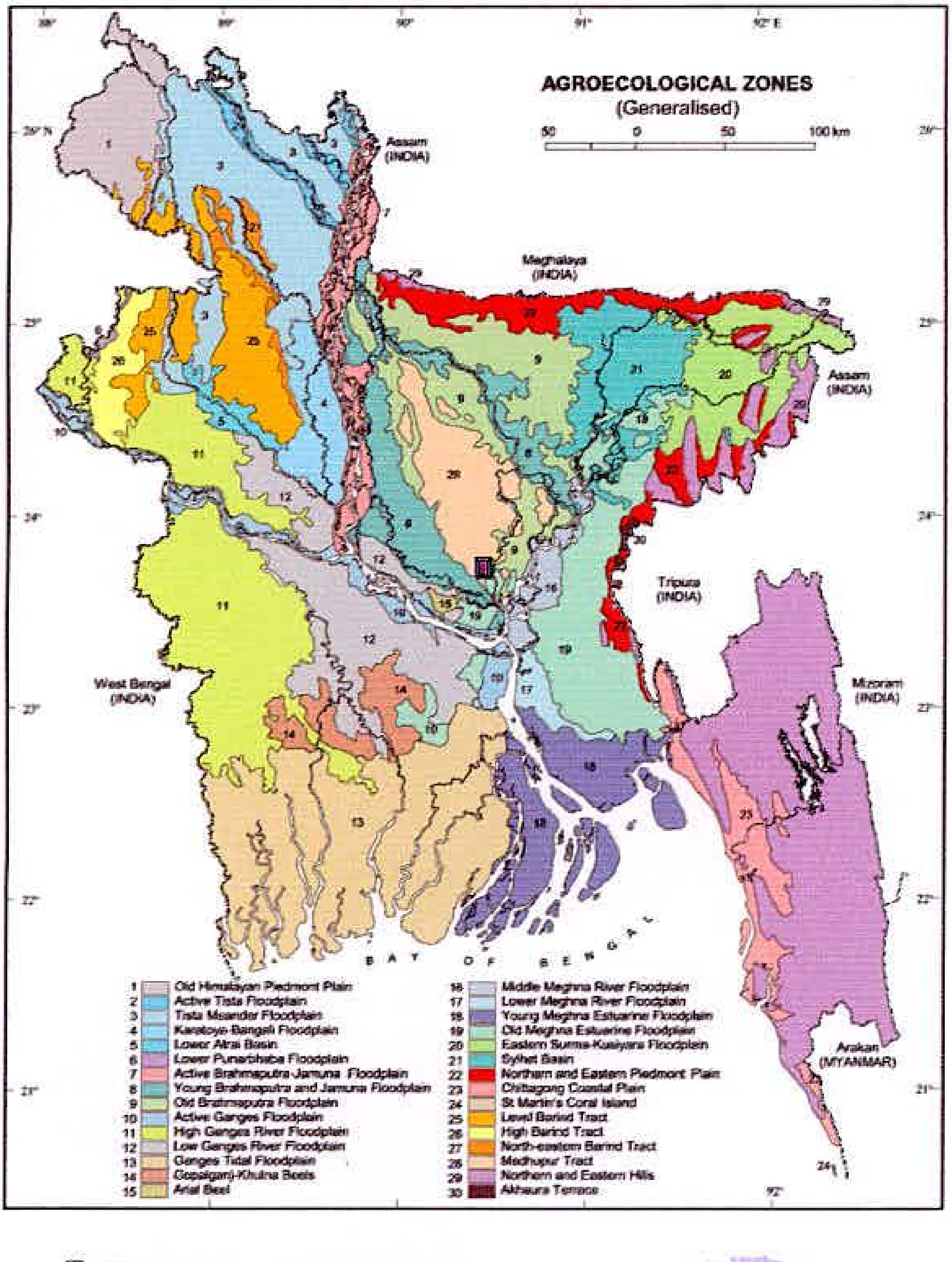
APPENDICES

APPENDICES

Appendix I. Map showing the experimental sites under study



The experimental site under study

Appendix II. Physical characteristics and chemical composition of soil of the experimental plot

Characteristics / composition	Analytical results
Agroecological Zone	Madhupur Tract
P^{H}	5.55
Organic matter (%)	0.83
Total N (%)	0.41
Available phosphorous (ppm)	21
Total S (ppm)	221
Exchangeable K meq / 100 g soil	0.42
Available S (ppm)	15.00
Boron (ppm)	1.72
Copper (µg/g soil)	3.56
Iron (µg/g soil)	262.9
Manganese (µg/g soil)	163.0
Zinc (µg/g soil)	3.31

Source: Soil Resources Development Institute. Farmgate. Dhaka.

Appendix III. Monthly average air temperature, relative humidity, total rainfall and total sunshine hours during the experimental period (March, 2008 to July, 2008)

Month	Year	Monthly average air temperature (^0C)			Average relative humidity (%)	Total rainfall (mm)	Total sunshine (hours)
		Maximum	Minimum	Mean			
March	2008	29.21	23.52	26.37	75.09	Trace	214.38
April	2008	29.25	25.81	27.53	77.05	351	211.50
May	2008	30.18	24.29	27.24	79.90	680	194.00
June	2008	30.32	26.40	28.36	80.78	853	226.50
July	2008	31.32	25.00	28.16	82.13	942	223.30

Source: Bangladesh Meteorological Department (Climate Division), Agargaon, Dhaka – 1212.

Appendix IV. Summary of analysis of variance of weed and growth attributes of mungbean

Source of variation	Degrees of freedom	Mean of square							
		Weed density per m^2 at 15 DAS	Weed density per m^2 at 45 DAS	Weed biomass at 15 DAS ($g\ m^{-2}$)	Weed biomass at 45 DAS ($g\ m^{-2}$)	Weed control efficiency (%) at15 DAS	Weed control efficiency (%) at 45 DAS	Root length at 15 DAS (%)	Shoot length at 15 DAS (%)
Replication	2	0.591	0.249	0.334	0.308	0.633	0.895	0.014	0.044
Variety	1	1.736*	0.402 NS	1.806*	0.692**	45.840*	0.678	0.918**	0.020 NS
Error I	2	0.092	0.120	0.019	0.004	0.736	2.321	0.003	0.008
Weed control strategies	6	37.790**	140.189**	96.595**	373.695**	3198.358**	3097.713**	0.307**	1.177**
Variety x Weed control strategies	6	6.878**	1.183**	0.920**	0.981**	29.107**	16.603**	0.146**	0.290**
Error II	24	0.340	0.055	0.058	0.009	0.306	2.256	0.002	0.007

*Significant at 5% level of probability

** Significant at 1% level of probability

NS not significantly different at $p<0.05$

Appendix V. Summary of analysis of variance of growth attributes of mungbean

Source of variation	Degrees of freedom	Mean of square								
		Plant height at 30 DAS (cm)	Plant at height 45 DAS (cm)	Plant height at harvest (cm)	Dry weight per plant at 15 DAS (g)	Dry weight per plant at 30 DAS (g)	Dry weight per plant at 45DAS (g)	Dry weight per plant at harvest (g)	No. of leaves per plant at 30 DAS	No. of leaves per plant at 45 DAS
Replication	2	0.074	1.372	1.482	0.015	0.010	0.028	0.034	0.049	0.228
Variety	1	459.428**	736.853**	852.571**	0.084NS	0.360**	0.471*	0.497 NS	15.012**	8.175**
Error I	2	0.018	0.132	0.168	0.035	0.0005	0.006	0.051	0.009	0.023
Weed control strategies	6	30.532**	30.332**	40.555**	0.970**	4.088**	4.430**	5.908**	3.099**	1.121**
Variety x Weed control strategies	6	25.422**	15.484**	5.449**	0.024*	0.117**	0.027**	0.016 NS	1.694**	1.974**
Error II	24	0.016	0.064	0.176	0.009	0.002	0.007	0.011	0.007	0.011

*Significant at 5% level of probability

** Significant at 1% level of probability

NS not significantly different at $p<0.05$

Appendix VI. Summary of analysis of variance of yield and other crop characters of mungbean

Source of variation	Degree of freedom	Mean of square								
		No. of branches per plant at 30 DAS	No. of branches per plant at 45 DAS	No. of pods per plant at 45 DAS	No. of pods per plant at harvest	Pod length (cm)	No. of seeds per pod	Thousand seed weight (g)	Seed yield (kg ha^{-1})	Straw yield (kg ha^{-1})
Replication	2	0.001	0.007	0.229	0.276	0.042	0.438	1.129	0.918	30.047
Variety	1	0.979**	0.579**	3.798**	3.149**	2.203*	39.343**	35.182**	737640.724**	1671702.263**
Error I	2	0.002	0.001	0.021	0.082	0.065	0.066	0.326	0.791	10.993
Weed control strategies	6	0.318**	0.426**	42.862**	34.725**	1.665**	19.002**	31.728**	400531.173**	1588397.847**
Variety x Weed control strategies	6	0.037**	0.014 NS	1.958**	0.965**	0.111**	0.475**	3.390**	14680.473 **	119914.834**
Error II	24	0.002	0.007	0.007	0.069	0.013	0.079	0.105	0.830	43.637

*Significant at 5% level of probability

** Significant at 1% level of probability

NS not significantly different at $p<0.05$