# INFLUENCE OF WEED FREE PERIODS ON GROWTH AND YIELD OF MUNGBEAN

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# INFLUENCE OF WEED FREE PERIODS ON GROWTH AND YIELD OF MUNGBEAN

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## *CERTIFICATE*

*This is to certify that the thesis entitled, "**INFLUENCE OF WEED FREE PERIODS ON GROWTH AND YIELD OF MUNGBEAN**" submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE IN AGRONOMY,** embodies the results of a piece of bona-fide research work carried out by **Shanta Rani Das**, Registration No.* **10-03772** *under my supervision and my guidance. No part of the thesis has been submitted for any other degree or diploma.*

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

*Dated:*

*Dhaka, Bangladesh*

***Prof. Dr. Parimal Kanti Biswas***

*Supervisor*

*DEDICATED TO MY BELOVED PARENTS*

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*May God protect them all.*

*The Author*

## INFLUENCE OF WEED FREE PERIODS ON GROWTH AND YIELD OF MUNGBEAN


## ABSTRACT

A field experiment was carried out at the research field of Sher-e-Bangla Agricultural University, Dhaka during the period of March to June 2015 to study the influence of weed free periods on growth and yield of mungbean. The experiment comprised of two factors; Factor A: Variety (2) viz. BARI Mung-4 ($V_1$) and BARI Mung-6 ($V_2$) and Factor B: Weed free periods (6) viz. No weed free period ($W_1$), 15 days weed free period ($W_2$), 25 days weed free period ($W_3$), 35 days weed free period ($W_4$), 45 days weed free period ($W_5$) and total weed free period ($W_6$). The experiment was laid out in factorial arrangements with Randomized Complete Block Design (RCBD) with three replications. Results revealed that plant height (53.10 cm), number of leaflets plant$^{-1}$ (30.39) and dry matter weight (19.42 g) plant$^{-1}$ were significantly higher in BARI Mung-4 ($V_1$) but number of seeds pod$^{-1}$ (12.05), pod length (9.10 cm), weight of 1000-seed (53.68 g), seed yield (1.73 t ha$^{-1}$) and harvest index (42.07 %) were higher in BARI Mung-6 ($V_2$) at harvest. Weed number (225.33) and dry weight (35.65 g) of weeds m$^{-2}$ were found to be higher in BARI Mung-6 ($V_2$) at harvest. Total weed free period ($W_6$) showed better results in case of all growth and yield parameters than no weed free period ($W_1$). Results from interaction effect of variety and weed free periods revealed that the highest plant height (54.67 cm), number of branches plant$^{-1}$ (4.67), number of leaflets plant$^{-1}$ (34.33), number of pod plant$^{-1}$ (38.67), stover yield (6.39 t ha$^{-1}$) and biological yield (8.42 t ha$^{-1}$) were observed in $V_1W_6$ interaction but number of seeds pod$^{-1}$ (12.33), pod length (9.29 cm), weight of 1000-seed (55.49 g), pod yield (3.21 t ha$^{-1}$), seed yield (2.04 t ha$^{-1}$) and harvest index (54.19 %) were higher in the interaction of $V_2W_6$ at harvest. Weed number (368.0) and dry weight (94.82 g) of weeds m$^{-2}$ were found to be higher in $V_2W_1$ interaction at harvest. The overall result showed that BARI Mung-6 ($V_2$) with 35 days to total weed free periods ($W_4$ - $W_6$) produced better yield in mungbean.

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# LIST OF ABBREVIATIONS

| Abbreviations | Full word |
|---|---|
| AEZ | Agro-ecological zone |
| 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. | Cultivar |
| CV | Coefficient of Variation |
| DAS | Days After Sowing |
| *et al.* | And others (*et alibi*) |
| FAO | Food and Agriculture Organization |
| g | Gram |
| ha | Hectare |
| HI | Harvest Index |
| kg | Kilogram |
| LSD | Least Significant Difference |
| $m^2$ | Square Meter |
| MOP | Muriate of Potash |
| No. | Number |
| NS | Non-Significant |
| % | Percent |
| $plant^{-1}$ | per plant |
| Seeds $pod^{-1}$ | Seeds per pod |
| TSP | Triple Super-phosphate |
| t $ha^{-1}$ | Ton (s) per hectare |
| viz. | Namely |

# CHAPTER 1

# INTRODUCTION

Mungbean (*Vigna radiata* L.) is one of the leading pulse crops of Bangladesh. This commonly grown pulse crop belongs to the family Fabaceae. It is considered as the best of all pulses from the nutritional point of view. Its edible grain is characterized by good digestibility, flavour, high protein content and absence of any flatulence effects (Ahmed *et al*., 2008). Per gram seed of mungbean contains 348 kcal energy, 59.9 mg carbohydrate, 24.5 mg protein, 1.2 mg fat, 75 mg calcium, 8.5 mg mineral, 0.72 mg thiamine, 0.15 µg riboflavin and 49 µg beta-carotene (BARI, 2008). It also contains amino acid lysine, which is generally deficit in food grains (Elias *et al*., 1986). The high lysine content makes mungbean a good complementary food for rice-based diets because lysine is usually the first limiting amino acid (Chen *et al*., 1987).

Mungbean (*Vigna radiata*) is the most important source of protein in south and south-east Asia (Prakit *et al.*, 2014). It holds 3$^{rd}$ in protein content and 5$^{th}$ in acreage and production but 1$^{st}$ in market price (BBS, 2008). The total production of mungbean in Bangladesh is about 32000 metric tons from an area of about 39,285 hectares with an average yield of about 0.81 t $ha^{-1}$ during 2013-2014 (BBS, 2016). Among the pulse area, only 8.10% is used for the cultivation of mungbean (Kabir, 2001).

Mungbean plays an important role to increase protein in the cereal-based low-protein diet of the people of Bangladesh. It is one of the least cared crops cultivated with lowest tillage using local varieties with no or lowest fertilizers and pesticides sowing very early or very late not practicing of irrigation and drainage etc. It has many advantages in cropping system because of its rapid growth, early maturation and short duration. The crop has already been transformed from a marginal to major crop for its additional benefits like enhancing soil fertility, improving rural household income, expanding employment opportunities, diversifying diets and increasing nutritional security (Shanmugasundaram *et al*., 2009).

In developing country like Bangladesh, mungbean can enrich the overall nutritional value of cereal-based diet. The green plants can be used as animal feed and its residues have manural value. The crop is potentially useful in improving cropping pattern as it can be grown as a catch crop due to its rapid growth and short duration characteristics. Mungbean, being a leguminous crop, is capable of fixing atmospheric nitrogen in the soil. It can also fix atmospheric nitrogen through the symbiotic relationship between the host mungbean roots and soil bacteria and thus enrich soil fertility and productivity. On an average, it fixes atmospheric nitrogen @300 kg/ha annually (Sharar *et al*., 2001).

The short-growth duration variety of mungbean is well-fitted in rice-based cropping systems of Asia. But Bangladesh is facing an acute shortage of mungbean due to low yield of approximately 654.36 kg/ha (MOA, 2012). The reasons of low yield may be due to lack of high yielding varieties and some are agronomic mismanagement due to labour shortage or lack of knowledge. Among many other crop production constraints, weed control is one of the most important areas which contribute markedly to the lower seed yield of mungbean (Khan *et al*., 2001).

Weed is called one of the destructive integral pests in crop field. It is also called the nutrient absorbing competitive plant, grow spontaneously out of place even under unfavourable condition. So, it is often said, “Crop production is a fight against weeds” (Cardina *et al*., 2002; Mohler *et al*., 2006). The climatic and edaphic condition of Bangladesh favours the growth of weed whose competitive effect decreased mungbean production by about 45.6% (Pandey and Mishra, 2003). Due to uncontrolled weed growth, yield losses in mungbean range from 27% to 100%, explicitly 27% in summer and 95% in rainy season (AVRDC, 1976). So, weed control is essential to increase mungbean productivity.

All crops have a vulnerable stage during their life cycle when they are particularly sensitive to crop competition. In general, it ranges up to first 1/3$^{rd}$ period of life cycle of crops. In Bangladeh, there is a general belief that mungbean does not require any weeding. So, the farmers of this country do not use any weed control measures in mungbean field, so the problem of weeds and their management such as time of weeding and frequency of weeding is problematic. Depending on weed type and crop-weed competition, it reduces crop yield up to 96.5 % (Verma *et al*., 2015), whereas the loss of mungbean yield due to weeds ranges from 65.4 to 79.0 % (Dungarwal *et al*. 2003). The magnitude of losses largely depends upon the composition of weed flora, period of weed-crop competition and its intensity.

Weeds compete with crop for light, space, water and nurients. The more the duration of weed competition, the more the dry weight of weed (Islam *et al*., 1989). Weed-crop competition commences with the germination period and continues till maturity. Weeds above critical population levels reduced crop yield and quality. Moreover, besides low yield of crop, they increased production cost, harbour insect-pest and diseases, decreased quality of farm produce and reduced land value of the different factors known for reduction in crop production, among them weed stand first (Subramainian *et al*., 1993). So, if weed growth is minimized during the period of crop-weed competition, crop yield will be equivalent to that of weed free crop. Seed yield of mungbean was highest (2108 kg/ha) in the weed free treatments (Punia *et al*., 2004) whereas about 69% reduction in seed yield was caused by weeds (Yadav and Singh, 2005). Weed control is vital during the early growth stage of mungbean. One hand weeding is completely essential at 20 DAS and two weeding are efficient for fruitful mungbean production (BARI, 2005). So, the aim of weed management should be to maintain weed population to a level with lowest cost. Timely and economically weed control through direct and indirect approach i.e., Integrated Weed Management (IWM) is essential for high yield of mungbean. Significantly increased seed yield by weed control have been reported in mungbean by many researchers (Kumar and Kairon, 1990; Musa *et al*., 1996).

The weed free periods in mungbean cultivation play an important role in increasing its growth and yield. In Bangladesh, few studies have been conducted on the influence of weed free periods on the growth and yield of mungbean. In the light of above background, the present study was undertaken to examine the influence of weed free periods on the growth and yield of mungbean. Considering the above circumstances, the present study has been undertaken with the following objectives:

- to find out the varietal response of mungbean
- to determine the effective weed free periods of mungbean for better yield and
- to determine the interaction effect of variety and weed free periods on the growth and yield of mungbean.

# CHAPTER 2

# REVIEW OF LITERATURE

Mungbean is one of the important pulse crops having global economic importance. Extensive research work on mungbean has been done in several countries including Bangladesh and South East Asian countries for the improvement of its yield and quality. In Bangladesh, little attention has so far been given for the improvement of production technology of mungbean. More recently Bangladesh Agricultural Research Institute (BARI), Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Bangladesh Institute of Nuclear Agriculture (BINA) and Pulse Research Centre at Iswardi started research on the improvement of mungbean variety and production technology development. Although this idea was not a recent one but research findings in this regard was scanty. Some of the pertinent works on these technologies reviewed below in this chapter.

## 2.1 Effect of variety on plant parameters of mungbean

An experiment was conducted by Hossain *et al.* (2014) to investigate the comparative roles of nitrogen (50 kg $ha^{-1}$) and inoculums *Bradyrhizobium* (1.5 kg $ha^{-1}$) in improving the yield of two mungbean varieties (BARI Mung-5 and BARI Mung-6) at the Sher-e-Bangla Agricultural University (SAU) Farm, Dhaka. BARI Mung-6 performed higher yield than BARI Mung-5.

Agugo *et al*. (2010) conducted an experiment in the Asian Vegetable Research and Development Centre (AVRDC) with four mungbean accessions. Results showed a significant difference in the yield of varieties with VC 6372 (45-8-1) producing the highest seed yield of 0.53 t $ha^{-1}$ followed by NM 92, NM 94 and VC 1163 with 0.48 t $ha^{-1}$, 0.40 t $ha^{-1}$ and 0.37 t $ha^{-1}$, respectively. The variety VC 6372 (45-8-1) also showed good agronomic characters.

A field experiment was conducted using BARI Mung-6 and Sona mung as planting materials and found that seed yield was higher in BARI Mung-6 after harvesting the crop at 35 days after anthesis. Weight of thousand seeds and pod length were higher in BARI Mung-6 with harvesting the crop at 20 and 25 days after anthesis, respectively. Shelling percentage, pods plant$^{-1}$ and primary branches plant$^{-1}$ were highest in Sona mung with harvesting at 15, 20 and 30 days after anthesis, respectively (Ghosh, 2007).

An experiment was carried out in the field of the Department of Crop Botany, Bangladesh Agricultural University (BAU), Mymensingh to evaluate the influence of seed treatment with IAA at a conc. of 50 ppm, 100 ppm and 200 ppm on the growth, yield and yield contributing characters of two modern mungbean (*Vigna radiata* L.) varieties viz. BARI Mung-4 and BARI Mung-5. Between the mungbean varieties, BARI Mung-5 performed better than that of BARI Mung-4 reported by Quaderi *et al.* (2006).

Islam *et al.* (2006) conducted an experiment at the field of the Department of Crop Botany, Bangladesh Agricultural University (BAU), Mymensingh to evaluate the effect of biofertilizer (*Bradyrhizobium*) and plant growth regulators ($GA_3$ and IAA) on growth of 3 cultivars of summer mungbean (*Vigna radiata* L.). Among the mungbean varieties, Binamoog-5 performed better than that of Binamoog-2 and Binamoog-4.

Tickoo *et al.* (2006) evaluated two mungbean cultivars Pusa 105 and Pusa Vishal, sown at 22.5 and 30 cm spacing and supplied with 36-46 and 58-46 kg NP ha$^{-1}$ in a field experiment in Delhi, India during the Kharif season of 2000. Cultivar Pusa Vishal recorded higher biological and seed yield (3.66 and 1.63 t ha$^{-1}$, respectively) compared to cv. Pusa 105.

Aghaalikhani *et al.* (2006) conducted a field experiment at the Seed and Plant Improvement Institute of Karaj, Iran, in the summer of 1998, to evaluate the effects of crop densities (10, 13, 20 and 40 plants m$^{-2}$) on yield and yield components of two cultivars (Partow and Gohar) and a line of mungbean (VC-1973A). The results indicated that VC-1973A had the highest grain yield which was superior to the other cultivars due to its early and uniform seed maturity and easy mechanized harvest.

A field experiment was conducted by Rahman *et al*. (2005) with mungbean (Feb- Jun, 1999) in Jamalpur, Bangladesh, involving planting methods, i.e. line sowing & broadcasting; mungbean cultivars (5), namely Local, BARI Mung-2, BARI Mung-3, Binamoog-2 and Binamoog-5; and sowing dates (5), i.e. 5 February, 20 February, 5 March, 20 March and 5 April. Significantly the highest dry matter production ability was found in 4 high yielding cultivars, but dry matter partitioning was highest in seeds of Binamoog-2 and lowest in local one. But the local cultivar produced the highest dry matter in leaf and stem.

A yield trial was conducted by Chaisri *et al*. (2005) involving 6 recommended cultivars (KPS 1, KPS 2, CN 60, CN 36, CN 72 and PSU 1) and 5 elite lines (C, E, F, G, H) in Lopburi Province, Thailand, during the dry (Feb-May, 2002), early rainy (Jun-Sep, 2002) and late rainy season (Oct 2002-Jan 2003). The Line C, KPS 1, CN 60, CN 36 and CN 72 gave high yields in the early rainy season, while line H, line G, line E, KPS 1 and line C gave high yields in the late rainy season.

Bhati *et al.* (2005) conducted an experiment from 2000 to 2003 to evaluate the effects of cultivars on the productivity of different kharif legumes (mungbean, mothbean and clusterbean) in the arid region of Rajasthan, India. The experiment with mungbean variety K-851 gave better yield than Asha and the local cultivar. In another experiment, mungbean cv. PDM-54 showed 56.9% higher seed yield and 13.7% higher fodder yield than the local cultivar.

Raj and Tripathi (2005) conducted a field experiment in Jodhpur, Rajasthan, India, during the kharif seasons, to evaluate the effect of cultivars (K-851 and RMG-62) as well as nitrogen (0 and 20 kg $ha^{-1}$) and phosphorus levels (0, 20 and 40 kg $ha^{-1}$) on the productivity of mungbean. The cultivars K-851 produced significantly higher values for seed and stover yields as well as yield attributes (plant height, pods plant$^{-1}$, seeds pod$^{-1}$ and 1000-seed weight) compared with RMG-62.

Shamsuzzaman *et al*. (2004) grown two summer mungbean cultivars, i.e., Binamoog-2 and Binamoog-5, during the kharif-1 season (Feb-May, 2001) in Mymensingh, Bangladesh, under no irrigation or with irrigation one at 30 days after sowing (DAS), two at 30 and 50 DAS, and three at 20, 30 and 50 DAS. The two cultivars tested were synchronous in flowering, pod maturity and leaf senescence which were significantly delayed under different irrigated frequencies. Binamoog-2 performed slightly better than Binamoog-5 for most of the growth and yield parameters studied.

Apurv and Tewari (2004) conducted a field experiment during kharif season in Uttaranchal, India, to investigate the effect of *Rhizobium* inoculation and fertilizer on the yield and yield components of three mungbean cultivars (Pusa 105, Pusa 9531 and Pant Mung-2). Pusa 9531 showed highest yield components and grain yield than Pusa 105 and Pant Mung-2.

Sarkar *et al*. (2004) reported that BARI Mung-2 contributed higher seed yield than BARI Mung-5. Binamoog-2 had the highest number of branches plant$^{-1}$. The highest number of pods plant$^{-1}$ was recorded for BARI Mung-3. Pod length was the maximum in BARI Mung-5. BARI Mung-2 produced the highest seed yield and harvest index. The lowest seed yield and harvest index were recorded for BARI Mung-3. The highest 1000-seeds weight was obtained from BARI Mung-5.

Madriz-Isturiz and Luciani-Marcano (2004) conducted a field trial to evaluate the performance of 20 mungbean cultivars in Venezuela, during the rainy season of 1994-95 and dry season of 1995. Among the cultivars, five like VC 1973C, Creole VC 1973A, VC 2768A, VC 1178B and Mililiter 267 were the most promising cultivars for cultivation in the area with the average yield was 1342.58 kg ha$^{-1}$.

Hossain and Solaiman (2004) investigated the effects of *Rhizobium* inoculation on the nodulation, plant growth, yield attributes, seed and stover yield, and seed protein content of six mungbean (*Vigna radiata*) cultivars. It was concluded that BARI Mung-4 in combination with TAL 169 strain of *Rhizobium* performed the best in terms of nodulation, plant growth, seed and stover yield and seed protein content.

Abid *et al*. (2004) conducted an experiment in Peshawar, Pakistan, during the summer season 2002, to study the effect of sowing dates (15 April, 15 May, 15 June, 15 July and 15 August) on the agronomic traits and yield of mungbean cultivars (NM-92 and M-1). Sowing on 15 April took more number of days to emergence but showed highest plant height. The highest emergence $m^{-2}$ was recorded in 15 June-sown plants. Sowing on 15 August gave the highest number of days to 50% flowering and to physiological maturity while 15 April-sown plants gave the highest mean grain yield. NM-92 gave higher mean grain yield than M-1. The highest seed yield was found in 15 April-sown with cultivar M-1 plants.

Riaz *et al*. (2004) investigated the effect of seeding rates (15, 20 and 25 kg seed $ha^{-1}$) on the growth and yield of mungbean cultivars (NM-92, NARC Mung-1 and NM-98) in Faisalabad, Pakistan during 2002-03. The cultivar NM-98 produced the highest pod number (17.30), grain yield (983.75 kg $ha^{-1}$) and harvest index (24.91%) where cultivar NM-92 produced the highest seed protein content (24.64%).

An experiment was carried out by Taj *et al*. (2003) to find out the effects of seeding rates (10, 20, 30 and 40 kg seed $ha^{-1}$) on the performance of 5 mungbean cultivars (NM-92, NM 19-19, NM 121-125, N/41 and a local cultivar) in Ahmadwala, Pakistan, during the summer season, 1998. Among the cultivars, NM 121-125 recorded the highest average pods $plant^{-1}$ (18.18), seeds $pod^{-1}$ (9.79), 1000-seed weight (28.09 g) and seed yield (1446.07 kg $ha^{-1}$).

A pot experiment was conducted by Ahmed *et al.* (2003) on the growth and yield of mungbean cultivars (Kanti, BARI Mung-4, BARI Mung-5, BU mug-1 and Binamoog-5). Kanti, BARI Mung-4 and BARI Mung-5 gave highest seed yield than rest of the cultivars.

Satish *et al*. (2003) conducted an experiment in Haryana, India to examine the response of mungbean cultivars (Asha, MH 97-2, MH 85-111 and K 851) to different P levels. MH 97-2 and Asha produced significantly more number of pods and branches plant$^{-1}$ compared to MH 85-111 and K 851.

Infante *et al.* (2003) conducted an experiment to evaluate the development phases and seed yield in mungbean cultivars i.e., ML 267, Acriollado and VC 1973C under the agro-ecological conditions of Maracay, Venezuela, during May-July, 1997. The earliest cultivar was ML 267 with 34.87 days to flowering and 61.83 to maturity. There were significant differences for total pod clusters plant$^{-1}$ and pods plant$^{-1}$ where ML 267 and Acriollado had the highest values. The total seeds pod$^{-1}$ of VC 1973C and Acriollado was significantly greater than ML 267. Acriollado showed the highest yield with 1438.33 kg ha$^{-1}$.

Navgire *et al.* (2001) conducted a field experiment in Maharashtra, India during the kharif season including seeds of mungbean cultivars (BM-4, S-8 and BM-86) were inoculated with *Rhizobium* strains (M-11-85, M-6-84, GR-4 and M-6-65) before sowing. S-8, BM-4 and BM-86 recorded the highest mean nodulation (16.66), plant biomass (8.29 q ha$^{-1}$) and grain yield (4.79 q ha$^{-1}$) during the experimental years.

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

A field experiment was conducted by Mitra and Bhattacharya (1999) in India during the kharif (rainy) season of 1996 and 1997 to study the effect of cultivars on the growth and yield of mungbean. They observed that mungbean cv. GM-9002 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.

Hamed (1998) carried out two field experiments during 1995 and 1996 in Shalakan, Egypt, to evaluate mungbean cultivars (Giza 1 and Kawny 1) under 3 irrigation intervals after flowering (15, 22 and 30 days) and 4 fertilizer treatments: inoculation with *Rhizobium* (R) + *Azotobacter* (A) + 5 ($N_1$) or 10 kg N feddan$^{-1}$ ($N_2$) and inoculation with R only +5 ($N_3$) or 10 kg N feddan$^{-1}$ ($N_4$). Kawny 1 exceeded Giza 1 in pod number plant$^{-1}$ (24.3) and seed yield (0.970 t feddan$^{-1}$) while Giza 1 was superior in 1000-seed weight (7.02 g), biological and straw yields (5.53 and 4.61 t feddan$^{-1}$, respectively). The seed yield of both cultivars was positively and highly significantly correlated with all involved characters, except for 1000-seed weight of Giza 1 and branch number plant$^{-1}$ of Kawny 1.

BINA (1998) reported that Binamoog-5 produced higher seed yield over Binamoog-2. Field duration of Binamoog-5 was about 78 days to mature while 82 days for Binamoog-2.

An experiment was conducted by Katial and Shah (1998) with 19 cultivars of *Vigna radiata* and found that 1000 seed weight was the highest in Gajaral-2 (39 g) and the lowest in ML 131 (24 g). Seed yield was the highest in PIMS-1 (0.89 t ha$^{-1}$) and the lowest in 11/99 (0.52 t ha$^{-1}$).

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 the highest number of seeds pod$^{-1}$ (10.43) was found by Mohanty *et al*. (1998).

Farrag (1995) reported that all varieties have not equal potentiality to perform better under similar condition obtained from a field trial with 23 mungbean accessions. Some cultivars like VC 2711 A, KPSI and UTT showed better performance under late sown condition.

Farghali and Hossain (1995) conducted an experiment with 32 accessions of mungbean with three sowing dates, concluded that V6017 had the highest seed yield. They also recorded that accessions V6017 and UTI had significantly higher plant height, number of seeds pod$^{-1}$, pod length and number of pods plant$^{-1}$ than that of other accessions.

ICRISAT (1991) reported that cultivars played a key role in increasing yield. The yield of mungbean cultivars Mubarik, Kanti and Binamoog-1 were ranged from 0.8 to 1.0, 1.0 to 1.2 and 0.8 to 1.0 t ha$^{-1}$, respectively.

Jain *et al*. (1988) conducted an experiment with four mungbean varieties observed that 'ML 131' produced the highest seed yield compared to other varieties. Masood and Meena (1986) reported that mungbean variety 'PDM 11' gave significantly highest seed yield than the other varieties.

Islam (1983) conducted an experiment with four varieties of mungbean, found that the highest number of branches plant$^{-1}$ was produced from the variety Faridpur-1 followed by Mubarik, BM-7715 and BM-7704. The highest number of pods plant$^{-1}$ was produced by Mubarik followed by BM-7704, BM-7715 and Faridpur-1.

The highest seed yield from the variety Mubarik was recorded by Pahlwan and Hossain (1983) which was attributed to the highest number of pods plant$^{-1}$ and seeds pod$^{-1}$.

After conducting a field experiment with five cultivars of mungbean viz. CES 87, CES 14, Pagasa, Hong-1 and local Thai variety with 32 plants m$^{-2}$ Pookpakdi *et al.* (1980) reported that the highest yield of CES 14 was due to the highest number of seeds pod$^{-1}$ and the lowest yield of local variety resulted from the lowest number of pods plant$^{-1}$. Among the varieties, Pagasa produced the lowest amount of total dry weight because the variety gave the lowest shoot dry weight.

The highest seed yield produced by ‘PS 7’ followed by ‘PS 16’ and ‘PS 10’was found by Rajat *et al*. (1978). The highest yield was due to the results of highest number of pods plants$^{-1}$ and 1000-seed weight.

## 2.2 Effect of weed free periods on plant parameters of mungbean

An experiment was conducted with four row spacing ($S_1$=15 cm, $S_2$=20 cm, $S_3$=25 cm and $S_4$=30 cm) and four weeding treatments ($W_0$=No weeding, $W_1$=Weeding at 15 days after sowing (DAS), $W_2$ =Weeding at 15 and 30 days after sowing (DAS) and $W_3$ =Weeding at 15, 30 and 45 days after sowing (DAS) and Zaher *et al.* (2014) observed that the highest number of pods plant$^{-1}$ (43.29), pod length (6.69 cm), number of seeds pod$^{-1}$ (9.43), 1000-seed weight (30.49 g), seed yield (1591 kg ha$^{-1}$), biological yield (3964 kg ha$^{-1}$) and harvest index (44.26%) were produced from 30 cm row spacing with three times of weeding.

Ahmadi (2014) conducted a field experiment to evaluate the effect of mungbean density on competitiveness of mungbean weeds during 2014 in Khorramabad. Treatments were crop density at 4 levels (25, 50, 75 and 100 kg ha$^{-1}$) and weed treatments at 2 levels (weeding and no weeding). The highest yield (2011 kg ha$^{-1}$) was achieved for weed control treatment with crop density of 25 kg ha$^{-1}$, while the lowest yield (672.7 kg ha$^{-1}$) was related to weed plot with crop density of 100 kg ha$^{-1}$, highlighting the importance of weed interference in reducing mungbean yield and necessity of weed control to achieve higher yields.

An experiment was conducted by Akter *et al*. (2013) at the Agronomy field of Bangladesh Agricultural University (BAU), Mymensingh to assess the effect of weeding on growth, yield and yield contributing characters of mungbean cv.

Binamoog-4 during (Oct 2011-Feb 2012). Three-stage weeding (Emergence-Flowering, Flowering-Pod setting and Pod setting- Maturity) ensured the highest plant height (58.62 cm), branches (4.45) and leaflets (10.34) plant$^{-1}$, dry weight plant$^{-1}$ (12.38 g), number of pods (22.03) plant$^{-1}$, pod length (5.95 cm), number of seeds (17.07) pod$^{-1}$, seed yield (1.38 t ha$^{-1}$), biological yield (4.70 t ha$^{-1}$) and harvest index (37.15%).

Mirjha *et al*. (2013) reported that yield attributes and yield of mungbean were significantly increased in weed control treatment over weedy check while a field trial was carried out in India with weed management.

Khot *et al*. (2012) reported that dry matter production plant$^{-1}$ at harvest (18.95 g) and dry weight plant$^{-1}$ (12.38 g) was highest from two hand-weeding (at 20 DAS & 40 DAS) and the lowest from no weeding treatment while conducting an experiment on mungbean with weed management.

The cultivars played an important role in crop-weed competition because of their diverse morphological traits, canopy structures and relative growth rate. A quick growing and early canopy cover enables a cultivar to compete better against weeds was reported by Prasad and Yadav (2011). Kundu *et al*. (2009) recorded the lowest number of pods plant$^{-1}$, seeds pod$^{-1}$ as well as seed yield in weedy check treatment.

Rehman and Ullah (2009) reported that pulses have been grown with poor management practices for long time resulting in poor yields. Proper seed bed, land preparation and weeding are important for adequate germination of seed, crop establishment and good yields, because weed infestation is one of the major factors lowering yield in pulses in Pakistan. Khan *et al*. (2008) reported that increase in plant height and number of pods plant$^{-1}$ is inversely proportional to weed dry weight.

Sultana *et al.* (2007) conducted an experiment at the field of the Department of Agronomy, Sher-e-Bangla Agricultural University (SAU), Dhaka to evaluate the effect of nitrogen and weed managements on mungbean (*Vigna radiata* L.) during the period from March 2007 to June 2007. Different managements of nitrogen (0, 20 kg N $ha^{-1}$ at vegetative, 20 kg N $ha^{-1}$ at vegetative & flowering) and weeding (No weeding, one weeding at vegetative, two weeding at vegetative & flowering stage) were integrated. Results showed that application of 20 kg N $ha^{-1}$ as basal + 20 kg N $ha^{-1}$ with one weeding at vegetative stage showed significantly higher values of all growth and yield contributing parameters.

A study was conducted by Kumar *et al*. (2005) to evaluate the benefits of the resource conservation technologies in mungbean during the kharif season, 2004 in Haryana, India. Among the weed control treatments, the highest reduction in dry weight of weeds was recorded in treatment with hand weeding at 20 and 40 DAS. The weedy conditions in the unweeded control treatment reduced pod yield by 30 to 36 percent as compared to integrated weed control method (Jhala *et al*., 2005).

BARI (2005) reported that all crops have a vulnerable stage during their life cycle when they are particularly sensitive to weed competition. In general, it ranges up to first 25 to 50% of the life time of crops. Weed control is essential during the early growth stage of mungbean. One hand weeding is absolutely essential 20 days after planting and two weeding are economical for successful mungbean production.

Higher grain yield with twice hand weeding was obtained by Khajanji *et al*. (2002). Similar result was found by Saikia and Jitendra (1999) and Elliot and Moody (1990).
Bueren *et al*. (2002) reported that weeds compete with main crop for space, nutrients, water and light. It is also recognized that a low weed population can be beneficial to the crop as it provides food and habitat for a range of beneficial organisms.

The lowest number of pods was recorded in weedy check and the highest number of pods was recorded in the plots where weeds were lowest (Cheema *et al*., 2000). Raklia (1999) reported that more weed suppression provides better crop growth for more seed formation. Tessema and Taneer (1997) reported that number of grains was affected due to weed infestation.

An experiment was conducted by Mahla *et al.* (1999) on weeding effect at 20, 30, 40 DAS and no weeding. Plant height, number of branches plant$^{-1}$, dry matter production plant$^{-1}$ and yield was increased with increasing weeding. Three times of weeding had the best effect on plant height, number of branches plant$^{-1}$, dry matter production plant$^{-1}$ and yield of mungbean.

Aebischer (1997) identified weed as one of the most significant agronomic problems associated with organic arable crop production. It was recognized that a low weed population could be beneficial to the crop as it provided food and habitat for a range of beneficial organisms.

A field experiment was conducted 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. Mungbean should be kept weed free during the first 43 days of sowing was reported by Jha *et al.* (1997).

A field experiment was carried out on green gram cultivar K851 to determine the crop-weed competition in summer season 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 (Singh *et al*., 1996).

Das and Yaduraju (1996) observed that the weed growth rate (WGR) increased up to 40 DAS in mungbean which was assumed to be the most critical period of weed competition in this crop while working with different crops and different levels of weeding (at 20, 40 and 60 DAS under no weeding, one weeding at three weeks after sowing and weed free conditions).

A field experiment was conducted by Bayan and Saharia (1996) to study the effect of weed management and phosphorus on greengram (*Vigna radiata*) during the kharif season of 1994-95 in Biswanath Chariali, Assam, India. The results indicated that effective weed management could be achieved with one hand weeding at 20 DAS. Weed-free and hand weeding at 20 DAS resulted in a significant increase in plant dry matter compared with no weeding. Branches plant$^{-1}$, pods plant$^{-1}$ and seed yield were significantly influenced by weed management practices in both years.

The adverse effect of weeds was greatest on vegetative growth was found by Sangakkara *et al*. (1995). The influence on yield components decreased with time. It indicated that vegetative phase is the critical competitive period for crop.

The times of weeding (2 or 3 times) on mungbean resulted in the greatest seed yield and harvest index which were reported to be associated with a greater number of pods plant$^{-1}$ and seeds pod$^{-1}$ was observed by Kalita *et al.* (1995).

The highest seed yield (1762 kg ha$^{-1}$) of mungbean was obtained in plots of 33 plants m$^{-2}$ that was weeded at emergence and the lowest yield (1137 kg ha$^{-1}$) in plots of 50 plants m$^{-2}$ that remained unweeded was observed by Talukder *et al*. (1993). The critical period of weed control appeared to be between 7 and 14 DAE. Unrestricted growth of weeds reduced mungbean seed yield by 30% to 33%.

Bai and Sinha (1993) observed that weed DM yield was decreased by 3 weeding compared with 1 weeding in the first but not in the second year and weed control increased greengram seed yield in both years, with no significant difference between 1 and 3 weeding.

Weeding at different dates after sowing affected some yield contributing characters and yield of mungbean was observed by Sarker and Mondal (1993). Seed yield was reduced by 49 to 55% when weeds were not removed at all. Variable number of weedings in mungbean have been suggested viz., one weeding at 2 weeks after emergence, two weedings during early growth stage (Madrid and Vega, 1984), and three weedings during the first 3 weeks after sowing (Enyi, 1984) for optimum yield.

One hand weeding at 10 or 20 days after emergence (DAE) produced higher yield than unweeded plots in mungbean during early kharif season was observed by Ahmed *et al*. (1992). They also obtained the highest seed yield of mungbean when weeded at 10 DAE.

Critical period of weed competition is the lowest weed free period essential during life cycle of a crop to prevent yield loss; the critical period of weed control in interference study is the period up to which the weeds would be allowed without significant yield losses of crops (Bryson, 1990).

Islam *et al*. (1989) concluded that every crop has a stage during its life cycle when it is particularly sensitive to weed competition. Kumar and Kairon (1988) observed that weed biomass increased and mungbean yield decreased with delay in weeding. But delay in weeding did not affect the number of seeds pod$^{-1}$.

Higher yield of mungbean was observed in the early-weeded plots compared to late or unweeded plots was observed by Singh and Singh, (1988). Pascua (1988) determined the critical period of weed control and competition on mungbean yield. The treatments that gave lower fresh weight of weed had higher number of seeds pod$^{-1}$.

Higher percent of seed yield reduction was recorded when the mungbean plants were exposed to longer weed competition. Highest dry matter content was recorded under weed free condition followed by weed removal at 30 and 40 days after sowing (Kumar and Kairon, 1988).

Ahmed *et al*. (1987) recorded the highest reduction in weed infestation at their removal at 15 & 30, 30 & 45, and 15, 30 & 45 DAS. Weed removal at 15 & 30, 30 & 45 or 15, 30 & 45 facilitated the production of higher dry matter plant$^{-1}$.

Weed control during first 30 DAS gave greater weed control efficiency and higher seed yield and net return was described by Raghvani *et al*. (1985) while conducting an experiment with three weeding treatments such as (a) weeding once at 15, 30 or 45 DAS, (b) weeding twice at 15 and 30 DAS and (c) weeding thrice at 15, 30 and 45 DAS.

Agarcio (1985) stated that two timely weeding during the period of critical competition resulted in optimum yield 663.8.kg ha$^{-1}$, as against 782 kg ha$^{-1}$ for weed free controls.

Enyi (1984) reported that weeding up to 8 weeks after sowing is essential for optimum yield of mungbean. He also reported that weed competition causes reduction in the number of pods plant$^{-1}$.

Two times weeding significantly increased the 1000-seed weight of mungbean compared to control treatment was found by Patel *et al*. (1984) while studying the effect of weeding on the growth and yield of mungbean during the summer season. Removal of weeds at 10, 20 or 30 DAS produced higher yield of mungbean than weedy check was observed by Yadav *et al*. (1983).

Naseem (1982) reported that the highest plant height, highest number of pods plant$^{-1}$ and the highest grain yield were obtained from weed free treatment and the lowest from no weeding control.

An experiment was conducted on weed competition in summer mungbean and black gram at BARI substation at Rajbari. Two weeding treatment gave highest net benefit of mungbean was reported by Musa *et al.* (1982).

Shahota and Govinda Krisnan (1982) reported that the harmful effect of weed infestation does not begin just after emergence of seedling rather the competition between the weeds and crop is the most severe at a particular stage of crop growth which is known as critical period of crop-weed competition.

Panwar and Singh (1980) reported that weeding of mungbean at 20 DAE could effectively produce yields twice than that of unweeded plots. The knowledge of critical period of weed competition is pre-requisite for a good harvest. Mungbean is not very competitive against weeds and therefore, weed control is essential for mungbean production (Moody, 1978).

Madrid and Manimtim (1977) reported that yield losses due to uncontrolled weed growth in mungbean ranged from 27 to 100%. Vats and Sidhu (1977) concluded that weeding in greengram two weeks after sowing was significantly superior to weeding four or eight weeks after sowing.

Madrid and Vega (1977) reported that the yield loss of mungbean was 95% during the dry season in the Philippines. They also reported that mungbean needs to be weeded for the first 5 weeks during the wet season and only for 3 weeks in the dry season.

Weed is one of the major constraints for higher production of mungbean during the kharif season. From the above review, it could be concluded that the constraints of mungbean cultivation could be overcome with yield improvement through use of high yielding mungbean varieties coupled with optimum weed free periods in its growth duration.

# CHAPTER 3
# MATERIALS AND METHODS

The experiment was conducted at the Agronomy field, Sher-e-Bangla Agricultural University (SAU), Dhaka-1207 during the Khrif-1 season from March to June, 2015 to study the influence of weed free periods on growth and yield of mungbean. Detailed of the experimental materials and methods followed in the study are presented in this chapter.

## 3.1 Description of the experimental site

### 3.1.1 Geographical location

The experimental area was situated at $23^{0}77$’N latitude and $90^{0}33$’E longitude at an altitude of 8.6 meter above the sea level (Anon., 2004).

### 3.1.2 Agro-ecological region

The experimental field belongs to the Agro-ecological zone of “The Modhupur Tract”, AEZ-28 (Anon., 1988a). This was a region of multifarious relief and soils developed over the Modhupur clay where flood plain sediments buried the dissected edges of the Modhupur Tract leaving small hillocks of red soils as ‘islands’ surrounded by floodplain (Anon., 1988b). The experimental site was shown in the map of AEZ of Bangladesh in Appendix I.

### 3.1.3 Climate

The area has sub-tropical climate, characterized by high temperature, high relative humidity and heavy rainfall with occasional gusty winds in Kharif season (April-September) and scanty rainfall associated with moderately low temperature during the Rabi season (October-March).

### 3.1.4 Soil

The soil of the experimental site belongs to the general soil type, Shallow Red Brown Terrace Soils under Tejgaon Series. Top soils were clay loam in texture, olive-gray with common fine to medium distinct dark yellowish brown mottles. Soil pH ranged from 5.6 - 6.5 and had organic matter 1.10 - 1.99%. The experimental area was flat having available irrigation and drainage system and above flood level.

## 3.2 Details of the experiment

### 3.2.1 Treatments

Two sets of treatment included in the experiment; the first set comprised of two varieties of mungbean namely BARI Mung-4 and BARI Mung-6, the second set consisted of six levels of weed free periods. Two sets of treatment were as follows.

Factor A: Variety (2)

1. BARI Mung-4 ($V_1$)
2. BARI Mung-6 ($V_2$)

Factor B: Weed free periods (6)

1. No weed free period ($W_1$)
2. 15 days weed free periods ($W_2$)
3. 25 days weed free periods ($W_3$)
4. 35 days weed free periods ($W_4$)
5. 45 days weed free periods ($W_5$) and
6. Total weed free periods ($W_6$)

### 3.2.2 Experimental design and layout

The experiment was laid out in Randomized Complete Block Design (RCBD) in a factorial arrangement with three replications. There were 12 treatment combinations. The total number of unit plot was 36. The size of unit plot was 3.5 m by 2.4 m. The distances between plot to plot and replication to replication were 0.50 m and 1.0 m, respectively. The layout of the experiment has been shown in Appendix II.

## 3.3 Crop/Planting material

BARI Mung-4 and BARI Mung-6 were used as planting material.

### 3.3.1 Description of crop: Variety (BARI Mung-4)

The seed of BARI Mung-4, a mungbean variety was used as one of the experimental materials. BARI Mung-4 was developed by Bangladesh Agricultural Research Institute (BARI). This variety grows erect to a height of 52 - 57 cm. It takes 34 - 36 days after emergence to flower and reaches physiological maturity within 60 - 65 days after emergence. Leaves of the variety are trifoliate, alternate, and green. Leaf pubescence is present. Petiole length is short and greenish purple. The corolla is yellowish green. Seeds are drum-shaped and light green. One thousand seeds weigh 29 g only. The variety produced an average seed yield of 1 - 1.3 t $ha^{-1}$.

### 3.3.2 Description of crop: Variety (BARI Mung-6)

The seed of BARI Mung-6, a modern mungbean variety was used as one of the experimental materials. BARI Mung-6 was developed by Bangladesh Agricultural Research Institute (BARI). The plants of this variety are of 40 - 45 cm in height, life cycle lasts for 55 - 58 days and synchronous type. The plants are erect, stiff and less branched. Each plant contains 15 - 20 pods. Each pod is around 10 cm long and contains 8 - 10 seeds. Seeds are large and green in colour and drum shaped. The seed yield of BARI Mung-6 ranged from 1.6 - 2.0 t $ha^{-1}$.

## 3.4 Land preparation

A pre-sowing irrigation was given on 27 March, 2015. The land was opened with the help of a tractor drawn disc harrow on 28 March, 2015 and then ploughed with rotary plough twice followed by laddering to achieve a medium tilth that required for the crop under consideration. All weeds and other plant residues of previous crop were removed from the field. Immediately after final land preparation, the field layout was made on March 30, 2015 according to experimental design. Individual plots were cleaned and finally prepared the plot.

## 3.5 Manuring

During final land preparation, each unit plot was manured with 44, 88 and 34 kg $ha^{-1}$ of Urea, TSP and MOP, respectively.

## 3.6 Crop management

### 3.6.1 Seed collection

Seeds of BARI Mung-4 and BARI Mung-6 were collected from Pulse Seed Section, BARI, Joydebpur, Gazipur, Bangladesh.

### 3.6.2 Seed sowing

The seeds (BARI Mung-4 and BARI Mung-6 having more than 80% germination) were sown by hand in 30 cm apart from lines with continuous spacing at about 3 cm depth at the rate of 47 g $plot^{-1}$ (BARI Mung-4) and 55 g $plot^{-1}$ (BARI Mung-6) on 30 March, 2015.

## 3.7 Intercultural operations

### 3.7.1 Thinning

The plots were thinned out on 15 days after sowing (DAS) to maintain a uniform plant stand.

### 3.7.2 Weed control

Weed control was done as per experimental treatments.

### 3.7.3 Application of irrigation water

Irrigation water was added to each plot, first irrigation was done as pre sowing and others were given as per requirement.

### 3.7.4 Drainage

There was a heavy rainfall during the experimental period. Drainage channels were properly prepared to easy and quick drained out of excess water.

### 3.7.5 Plant protection measures

The crop was infested by insects and diseases; those were effectively and timely controlled by applying recommended insecticides and fungicides.

### 3.7.6 Harvesting and post-harvest operation

Maturity of crop was determined when 80-90% of the pods become blackish in colour. Two harvesting was done while the first harvesting of BARI Mung-6 and BARI Mung-4 was done on 28 May and 5 June, 2015 respectively and the final harvesting was done on 18 and 29 June, 2015 respectively. The harvesting was done by picking pods from central 3.15 $m^2$ area for avoiding the boarder effects. The collected pods were sun dried, threshed and weighed to a control moisture level. Straw was also sun dried properly. Finally seed and straw yield $m^{-2}$ was determined and converted to ton $ha^{-1}$.

## 3.8 Recording of data

Experimental data were determined from 15 days of growth duration and continued until harvest. Dry weight of plants were collected by harvesting respective number of plants at different specific dates from the inner rows leaving border rows and harvest area for seed. The following data were recorded during the experimentation.

**A. Crop growth characters**

i. Plant height (cm) at 15 days interval up to harvest

ii. Number of leaflets plant$^{-1}$ at 15 days interval up to harvest

iii. Dry matter weight (g) plant$^{-1}$ at 15 days interval up to harvest

iv. Number of nodules plant$^{-1}$ at 30, 45 & 60 DAS

v. Dry weight (g) of nodules at 30, 45 & 60 DAS

**B. Yield and other crop characters**

i. Number of branches plant$^{-1}$ at 30, 45 & 60 DAS

ii. Number of pods plant$^{-1}$

iii. Length of pod (cm)

iv. Number of seeds pod$^{-1}$

v. Weight of 1000-seed (g)

vi. Pod yield (t ha$^{-1}$)

vii. Seed yield (t ha$^{-1}$)

viii. Stover yield (t ha$^{-1}$)

ix. Biological yield (t ha$^{-1}$)

x. Harvest index (%)

**C. Weed characters**

i. Number of weeds m$^{-2}$

ii. Dry matter weight (g) of weeds m$^{-2}$

## 3.9 Detailed procedures of recording data

A brief outline of the data recording procedure followed during the study given below.

### A. Crop growth characters

### 3.9.1 Plant height (cm)

The plant height of five randomly selected plants from each plot was measured at 15, 30 & 45 days after sowing (DAS) and at harvest. The height of the plant was determined by measuring the distance from the soil surface to the tip of the leaf of main shoot.

### 3.9.2 Number of leaflets plant$^{-1}$

The number of leaflets of five randomly selected plants from each plot was recorded at 15, 30 & 45 days after sowing (DAS) and at harvest and the means were determined.

### 3.9.3 Dry matter weight (g) plant$^{-1}$

The five plants randomly selected plot$^{-1}$ was uprooted, sun dried and then oven dried until a constant level, from which the weights of dry matter were recorded at 15 days intervals and at harvest.

### 3.9.4 Number of nodules plant$^{-1}$

The five plants plot$^{-1}$ from second line were uprooted, washed in water and total number of nodules from five plants was counted at 30, 45 & 60 DAS and the mean value was determined.

### 3.9.5 Dry weight (g) of nodules

The five plants plot$^{-1}$ from second line were uprooted and total number of nodules from five plants was collected, oven dried until a constant level and weight was recorded at electrical balance at 30, 45 & 60 DAS and the mean value was determined.

**B. Yield and other crop characters**

### 3.9.6 Number of branches plant$^{-1}$

The branches number was counted from five randomly selected plants plot$^{-1}$ at 30, 45 and 60 DAS and the mean value was determined.

### 3.9.7 Number of pods plant$^{-1}$

The total number of pods of five randomly selected plants plot$^{-1}$ at harvest was counted and the average value was recorded.

### 3.9.8 Pod length (cm)

The length of pods was measured from ten randomly selected pods, collected from five randomly selected plants plot$^{-1}$ at harvest and then the average value was recorded.

### 3.9.9 Number of seeds pod$^{-1}$

The pods from each of five plants plot$^{-1}$ were separated from which ten pods were selected randomly. The number of seeds pod$^{-1}$ was counted and average number of seeds pod$^{-1}$ was determined.

### 3.9.10 Weight of 1000-seed (g)

One thousand cleaned, dried seeds were counted randomly from each sample and weighed by using a digital electric balance at the stage when the grain retained 8% moisture and the mean weight were expressed in gram.

### 3.9.11 Pod yield (t ha$^{-1}$)

The pods were collected from the central 3.15 m$^2$ area of each plot, sun dried and then oven dried until a constant level was reached. Then the oven dried pods were weighed by using a digital electrical balance and expressed as t ha$^{-1}$.

### 3.9.12 Seed yield (t ha$^{-1}$)

The seed yield was determined from the central 3.15 m$^2$ area of each plot and expressed as t ha$^{-1}$ and adjusted with 8% moisture basis. Moisture content was measured by using a digital moisture tester.

### 3.9.13 Stover yield (t ha$^{-1}$)

The stover yield was determined from the central 3.15 m$^2$ area of each plot. After separation of seeds, the sub-samples were oven dried to a constant weight and finally converted to t ha$^{-1}$.

### 3.9.14 Biological yield (t ha$^{-1}$)

The seed yield and straw yield were all together regarded as biological yield. Biological yield was calculated with the following formula.

Biological yield (t ha$^{-1}$) = Seed yield (t ha$^{-1}$) + Stover yield (t ha$^{-1}$)

### 3.9.15 Harvest index (%)

The harvest index denotes the ratio of economic yield (seed yield) to biological yield and was calculated with the following formula (Donald, 1963; Gardner *et al.*, 1985).

$$\text{Harvest index (\%)} = \frac{\text{Seed yield (t ha}^{-1}\text{)}}{\text{Biological yield (t ha}^{-1}\text{)}} \times 100$$

### C. Weed characters

#### 3.9.16 Number of weeds $m^{-2}$

A square shaped spot was randomly selected in each plot using quadrate of $1m^2$ to collect weeds at 10 days intervals up to harvest and counted it and the mean values were determined.

#### 3.9.17 Dry weight (g) of weeds

The fresh weeds from each plot were collected at each time of weeding and washed with tap water. Weeds were oven dried for 72 hours at 70°C temperature and then weighed by using a digital electrical balance at 10 days intervals up to harvest and the mean values were determined.

## 3.10 Statistical analysis

The collected data on different parameters were compiled and analysed statistically following the analysis of variance (ANOVA) technique with the help of the computer package programme STATISTIX 10 software. Mean difference among the treatments were tested with Least Significant Difference Test (LSD) at 5% level of significance.

# CHAPTER 4

# RESULTS AND DISCUSSION

Results obtained from the present study regarding the influence of weed free periods on growth and yield of mungbean have been presented, discussed and compared in this chapter. The analytical results have been presented in Table 1 through Table 10, Figure 1 through Figure 25 and Appendix III through Appendix XI. A general view of the experimental plots and treatments has been shown in Plate 1 through Plate 4.

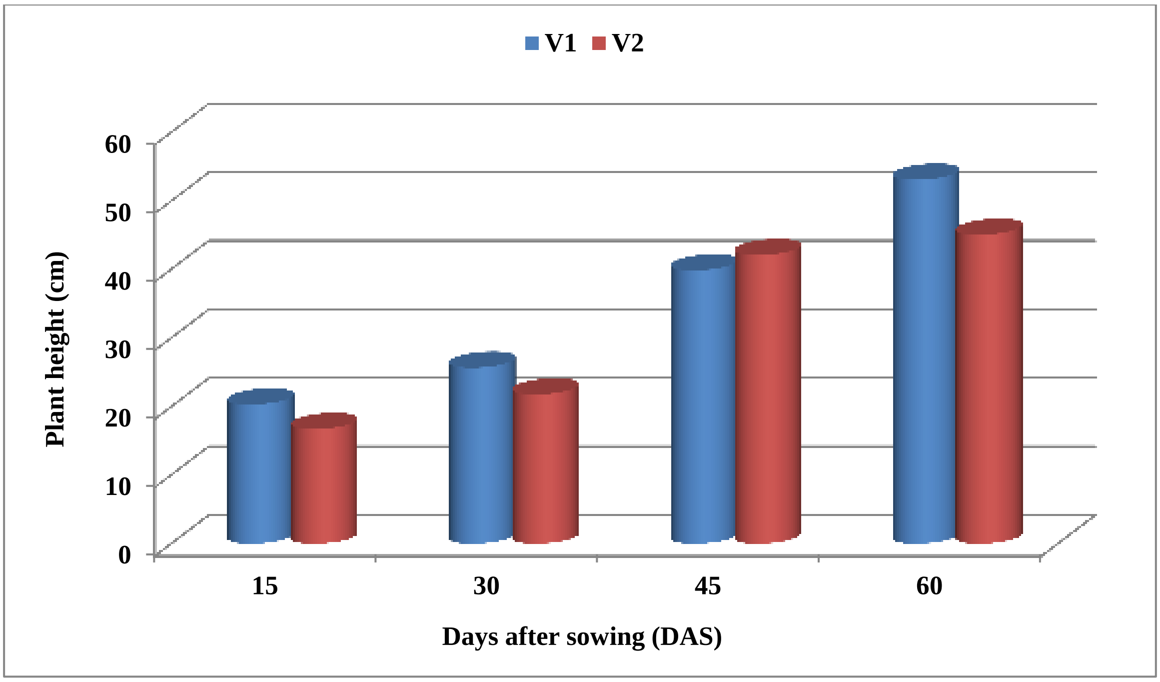
## 4.1 Crop growth characters

### 4.1.1 Plant height at different days after sowing

#### 4.1.1.1 Effect of variety

The plant height of mungbean was significantly influenced by varieties at 15, 30, 45 and 60 days after sowing (Appendix III and Figure 1).

The result revealed that at 15 DAS, the taller plant (20.33 cm) was obtained from BARI Mung-4 ($V_1$) and the shorter plant (16.75 cm) was at BARI Mung-6 ($V_2$). The taller plant (25.68 cm) was recorded at 30 DAS from BARI Mung-4 ($V_1$) followed by BARI Mung-6 ($V_2$) (21.79 cm). Similar trend of plant height was observed at 60 DAS at BARI Mung-4 (53.10 cm) & BARI Mung-6 (45.02 cm). But at 45 DAS, the higher plant height (42.06 cm) was obtained from BARI Mung-6 ($V_2$) and the lower plant height (39.85 cm) was from BARI Mung-4 ($V_1$). These results were agreement with the findings of Ghosh (2004) and Thakuria and Saharia (1990) who reported that varieties differ significantly in respect of plant height of mungbean.



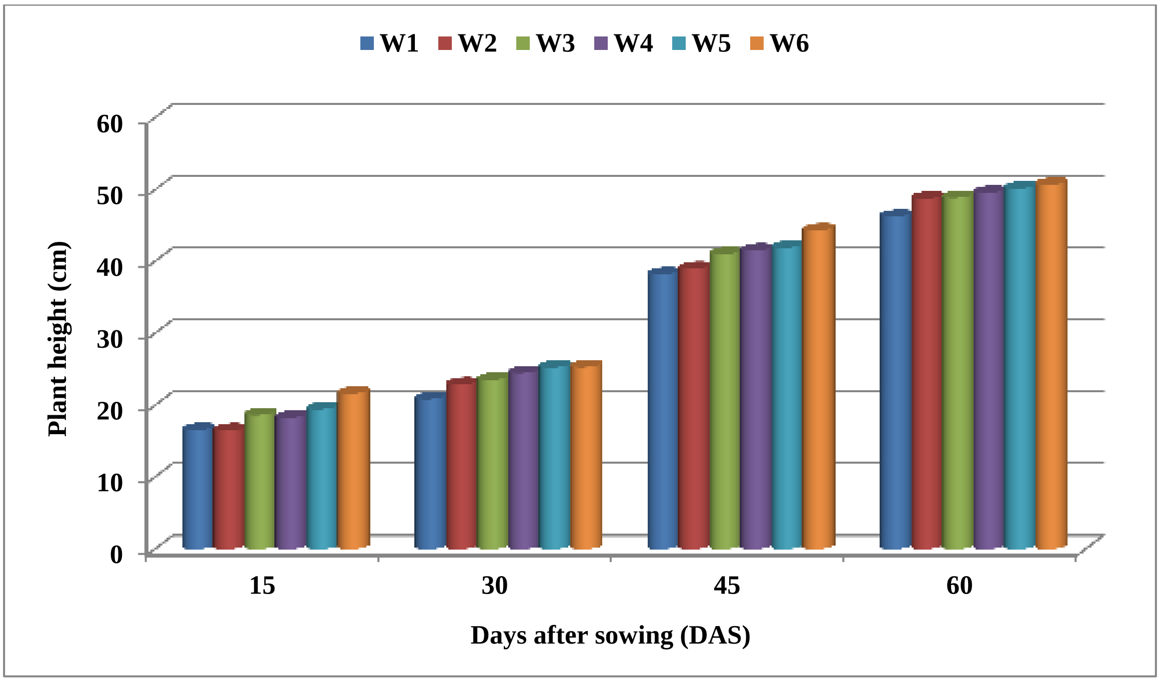

$V_1$ = BARI Mung-4 and $V_2$ = BARI Mung-6

**Figure 1. Effect of variety on plant height of mungbean at different days after sowing (LSD $_{(0.05)}$ = 1.36, 0.97, 1.33 and 0.69 at 15, 30, 45 and 60 DAS, respectively).**

### 4.1.1.2 Effect of weed free periods

There were significant differences observed among the treatments of weed free periods at 15, 30, 45 and 60 DAS for plant height of mungbean (Appendix III and Figure 2).

At 15 DAS, the highest plant height (21.65 cm) was observed with $W_6$ which was statistically similar to $W_5$ and the smallest plant height (16.50 cm) was found with $W_2$ which shown similarity to $W_1$, $W_3$ & $W_4$. At 30 DAS, the tallest plant (25.33 cm) was found with $W_6$ which was statistically similar to $W_4$ & $W_5$ and the smallest (20.88 cm) was observed at $W_1$. At 45 DAS, the tallest plant (44.26 cm) was observed with $W_6$ and the shortest (38.17 cm) was found at $W_1$ that was statistically similar to $W_2$. There were significant differences observed among the treatments at 60 DAS, where the highest plant height (50.70 cm) was observed with $W_6$ which was statistically similar to $W_4$ & $W_5$ and the lowest plant height (46.23 cm) was found at $W_1$. These results indicated that plant height increased with the increase of weed free periods. Shorter plant height in no weeding condition might be due to inhibition by weeds which adversely affected on plant growth and development. This is similar to the report of Khan *et al.* (2008) who reported that the increase in plant height was inversely proportional to weeds density and dry weight.




$W_1$ = No weeding; $W_4$ = 35 days weed free period;
$W_2$ = 15 days weed free period; $W_5$ = 45 days weed free period and
$W_3$ = 25 days weed free period; $W_6$ = Total weed free period

**Figure 2. Effect of different weed free periods on plant height of mungbean at different days after sowing ($LSD_{(0.05)}$ = 2.35, 1.69, 2.31 and 1.20 at 15, 30, 45 and 60 DAS, respectively).**

### 4.1.1.3 Interaction effect of variety and weed free periods

There was significant variation in plant height observed due to interaction between variety and weed free periods at 15, 30, 45 and 60 DAS (Appendix III and Table 1).

At 15 DAS, the longest plant (21.83 cm) was obtained from the interaction of $V_1W_6$ followed by $V_2W_6$, $V_1W_4$, $V_1W_5$, $V_1W_2$, $V_1W_3$ & $V_1W_1$ treatment combinations which were statistically similar, while the lowest plant height (13.17 cm) was recorded in the treatment combination of $V_2W_2$ which was statistically similar with the interactions of $V_2W_1$ & $V_2W_4$. Similar trend of plant height was observed at 30 & 60 DAS. At 30 DAS, the tallest plant (27.48 cm) was recorded in $V_1W_6$ interaction that was followed by the interactions of $V_1W_4$, $V_1W_5$ and $V_1W_3$ and the shortest plant (18.72 cm) was obtained from the treatment combination of $V_2W_1$.

**Table 1. Interaction effect of variety and weed free periods on plant height of mungbean**

| Treatment combinations | Plant height (cm) at | | | |
|---|---|---|---|---|
| | 15 DAS | 30 DAS | 45 DAS | 60 DAS |
| $V_1W_1$ | 19.22 a-c | 23.04 cd | 38.58 d-f | 50.12 c |
| $V_1W_2$ | 19.83 a-c | 24.43 bc | 38.15 ef | 52.73 b |
| $V_1W_3$ | 19.23 a-c | 25.57 ab | 39.03 d-f | 54.39 ab |
| $V_1W_4$ | 21.07 a-c | 27.41 a | 41.12 b-e | 53.24 ab |
| $V_1W_5$ | 20.78 a-c | 26.16 ab | 40.51 b-f | 53.44 ab |
| $V_1W_6$ | 21.83 a | 27.48 a | 41.71 b-d | 54.67 a |
| $V_2W_1$ | 13.93 e | 18.72 e | 37.75 f | 42.33 g |
| $V_2W_2$ | 13.17 e | 21.32 d | 39.77 c-f | 44.80 ef |
| $V_2W_3$ | 18.13 cd | 21.55 d | 42.93 bc | 43.42 fg |
| $V_2W_4$ | 15.59 de | 21.58 d | 41.81 b-d | 45.89 de |
| $V_2W_5$ | 18.21 b-d | 24.41 bc | 43.26 b | 46.93 d |
| $V_2W_6$ | 21.46 ab | 23.17 cd | 46.81 a | 46.72 d |
| **LSD $_{(0.05)}$** | **3.33** | **2.38** | **3.27** | **1.69** |
| **CV (%)** | **10.60** | **5.93** | **4.72** | **2.04** |

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

$V_1$ = BARI Mung-4 and $V_2$ = BARI Mung-6

$W_1$ = No weeding; $W_4$ = 35 days weed free period;
$W_2$ = 15 days weed free period; $W_5$ = 45 days weed free period and
$W_3$ = 25 days weed free period; $W_6$ = Total weed free period

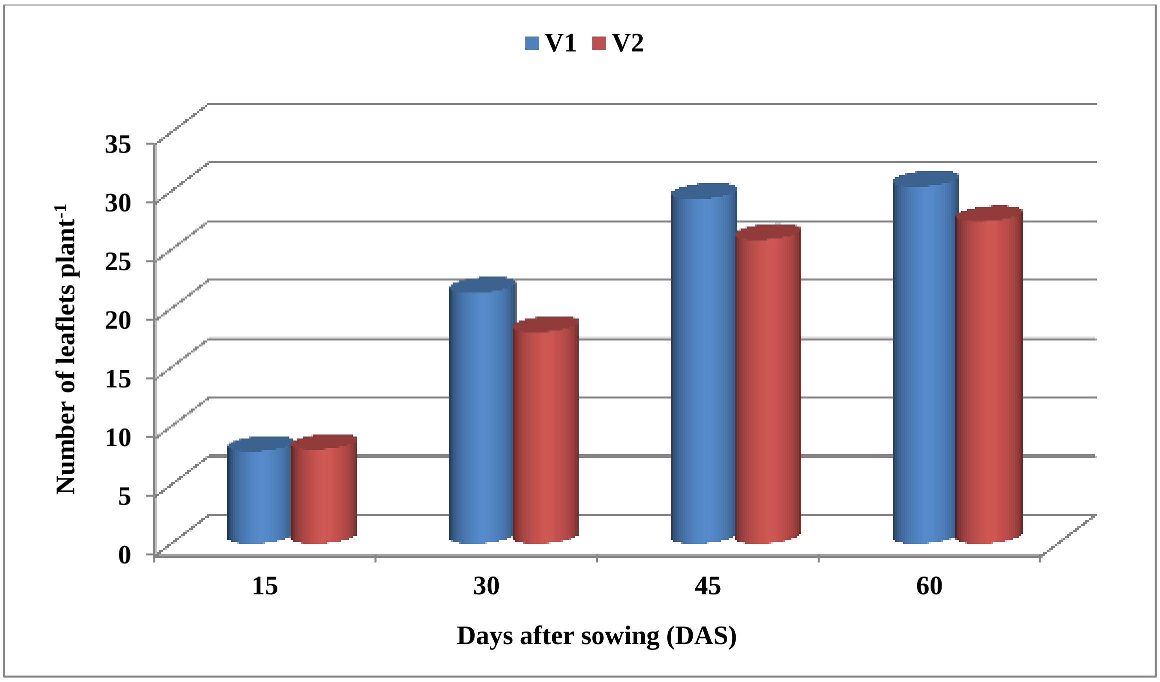
At 60 DAS, the longest plant (54.67 cm) was recorded from the $V_1W_6$ interaction which shown similarity to $V_1W_3$, $V_1W_5$ & $V_1W_4$ combinations and the shortest plant (42.33 cm) was obtained from $V_2W_1$ which was statistically similar to $V_2W_3$ interaction. But At 45 DAS, the highest plant height (46.81cm) was recorded in the treatment combination of $V_2W_1$ and the lowest plant height (37.75 cm) was recorded from the $V_2W_1$ interaction followed by the treatment combinations of $V_1W_2$, $V_1W_1$, $V_1W_3$, $V_2W_2$ and $V_1W_5$. From the findings of experimental result, it was appeared that BARI Mung-4 ($V_1$) showed significantly higher plant height than BARI Mung-6 ($V_2$) in total weed free condition ($W_6$).

### 4.1.2 Number of leaflets plant$^{-1}$ at different days after sowing

#### 4.1.2.1 Effect of variety

The number of leaflets plant$^{-1}$ of mungbean was significantly influenced by varieties at 30, 45 & 60 DAS but at 15 DAS, varieties had no significant effect and as such the number of leaflets plant$^{-1}$ of BARI Mung-4 & BARI Mung-6 were statistically similar at 15 DAS (Appendix IV and Figure 3).

The result revealed that at 30 DAS, the number of leaflets plant$^{-1}$ was higher (21.33) in BARI Mung-4 ($V_1$) compared to BARI Mung-6 ($V_2$). Similar trend of number of leaflets plant$^{-1}$ in BARI Mung-4 (29.33 & 30.39) and BARI Mung-6 (25.83 & 27.39) was observed at 45 and 60 DAS. Ansary (2007) reported that varieties differ significantly in respect of number of leaflets plant$^{-1}$. He also observed two varieties of mungbean BARI Mung-6 and BU mug-2 had significant effect on number of leaflets plant$^{-1}$ at 30 and 45 DAS.



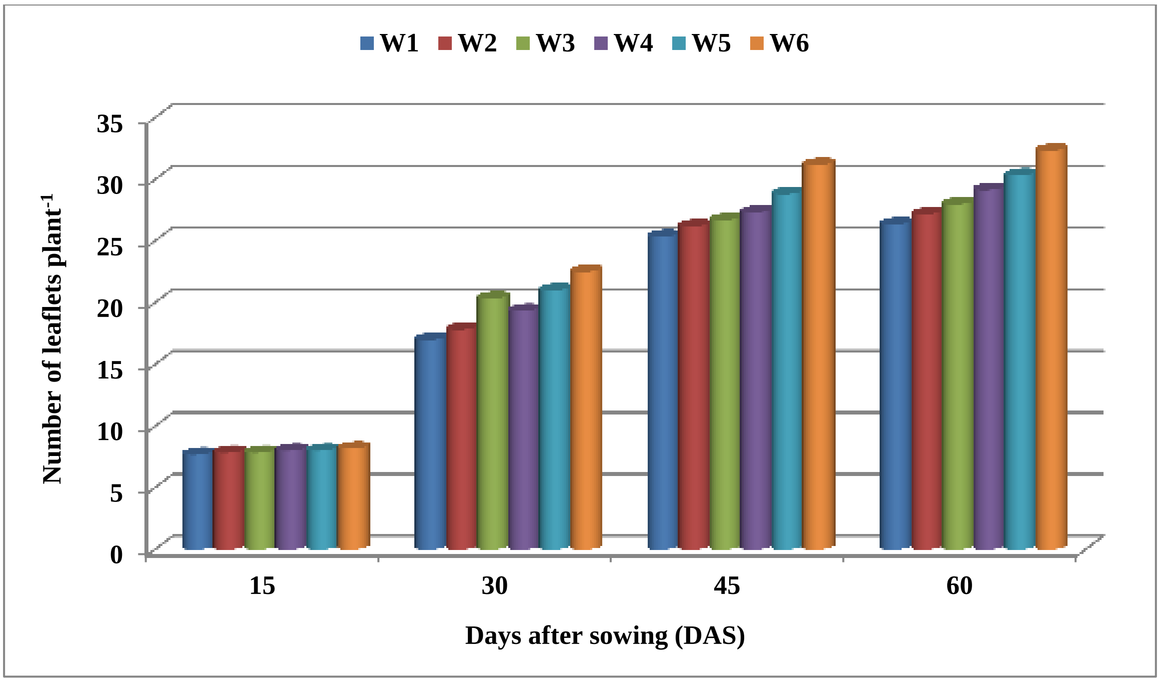

$V_1$ = BARI Mung-4 and $V_2$ = BARI Mung-6

**Figure 3. Effect of variety on the number of leaflets plant$^{-1}$ of mungbean at different days after sowing (LSD $_{(0.05)}$ = 0.93, 1.32 and 1.11 at 30, 45 and 60 DAS, respectively).**

### 4.1.2.2 Effect of weed free periods

The number of leaflets plant$^{-1}$ of mungbean had significantly influenced by different weed free periods at 30, 45 and 60 DAS but insignificant at 15 DAS (Appendix IV and Figure 4).

At 30, 45 and 60 DAS, the highest number of leaflets plant$^{-1}$ (22.50, 31.17 and 32.33) was found in $W_6$ treatment and the lowest number of leaflets plant$^{-1}$ (17.0, 25.33 and 26.33) was recorded from $W_1$ treatment. But at 15 DAS, there was no significant variation observed on the number of leaflets plant$^{-1}$ among the different weed free periods. These results indicated that number of leaflets plant$^{-1}$ increased with the increase of weed free periods upto 45 DAS.




$W_1$ = No weeding; $W_4$ = 35 days weed free period;

$W_2$ = 15 days weed free period; $W_5$ = 45 days weed free period and

$W_3$ = 25 days weed free period; $W_6$ = Total weed free period

**Figure 4. Effect of different weed free periods on the number of leaflets plant$^{-1}$ of mungbean at different days after sowing ($LSD_{(0.05)}$ = 1.61, 2.28 and 1.92 at 30, 45 and 60 DAS, respectively).**

### 4.1.2.3 Interaction effect of variety and weed free periods

Interaction effect of variety and weed free periods had significant influence on the number of leaflets plant$^{-1}$ at 30, 45 and 60 DAS but there was no significant variation observed on the number of leaflets plant$^{-1}$ at 15 DAS (Appendix IV and Table 2). At 30 DAS, the interaction $V_1W_6$ produced the highest number of leaflets plant$^{-1}$ (24.0) which was statistically similar with $V_1W_5$ and the lowest number of leaflets plant$^{-1}$ (15.0) produced by $V_2W_1$ interaction which shown similarity with $V_2W_2$. At 45 DAS, the $V_1W_6$ interaction produced the highest number of leaflets plant$^{-1}$ (33.67) which was statistically similar with $V_1W_5$ combination, while the lowest number of leaflets plant$^{-1}$ (23.67) produced by $V_2W_1$ interaction which was statistically similar with the combinations of $V_2W_2$, $V_2W_3$, $V_2W_4$ and $V_2W_5$. At 60 DAS, the $V_1W_6$ produced the highest number of leaflets plant$^{-1}$ (34.33) which was statistically similar with $V_1W_5$

interaction and the lowest number of leaflets plant$^{-1}$ (24.67) produced by $V_2W_1$ interaction which was statistically similar with $V_2W_2$, $V_2W_3$, and $V_2W_4$ combinations. These might be due to higher number of branches plant$^{-1}$ of BARI Mung-4 ($V_1$) compared to BARI Mung-6 ($V_2$) in total weed free condition ($W_6$).

**Table 2. Interaction effect of variety and weed free periods on the number of leaflets plant$^{-1}$ of mungbean**

| Treatment combinations | Number of leaflets plant$^{-1}$ at | | | |
|---|---|---|---|---|
| | 15 DAS | 30 DAS | 45 DAS | 60 DAS |
| $V_1W_1$ | 7.67 b | 19.0 de | 27.0 cd | 28.0 d-f |
| $V_1W_2$ | 7.67 b | 19.67 c-e | 27.0 cd | 28.33 c-f |
| $V_1W_3$ | 7.67 b | 21.67 bc | 28.0 b-d | 29.0 b-e |
| $V_1W_4$ | 8.0 ab | 20.67 cd | 29.33 bc | 31.0 bc |
| $V_1W_5$ | 8.0 ab | 23.0 ab | 31.0 ab | 31.67 ab |
| $V_1W_6$ | 8.0 ab | 24.0 a | 33.67 a | 34.33 a |
| $V_2W_1$ | 7.67 b | 15.0 g | 23.67 e | 24.67 g |
| $V_2W_2$ | 8.0 ab | 16.0 fg | 25.33 de | 26.0 fg |
| $V_2W_3$ | 8.0 ab | 19.0 de | 25.33 de | 27.0 e-g |
| $V_2W_4$ | 8.0 ab | 18.0 ef | 25.33 de | 27.33 e-g |
| $V_2W_5$ | 8.0 ab | 19.0 de | 26.67 c-e | 29.0 b-e |
| $V_2W_6$ | 8.33 a | 21.0 b-d | 28.67 bc | 30.33 b-d |
| **LSD $_{(0.05)}$** | **0.66** | **2.28** | **3.23** | **2.71** |
| **CV (%)** | **4.92** | **6.84** | **6.91** | **5.54** |

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

$V_1$ = BARI Mung-4 and $V_2$ = BARI Mung-6

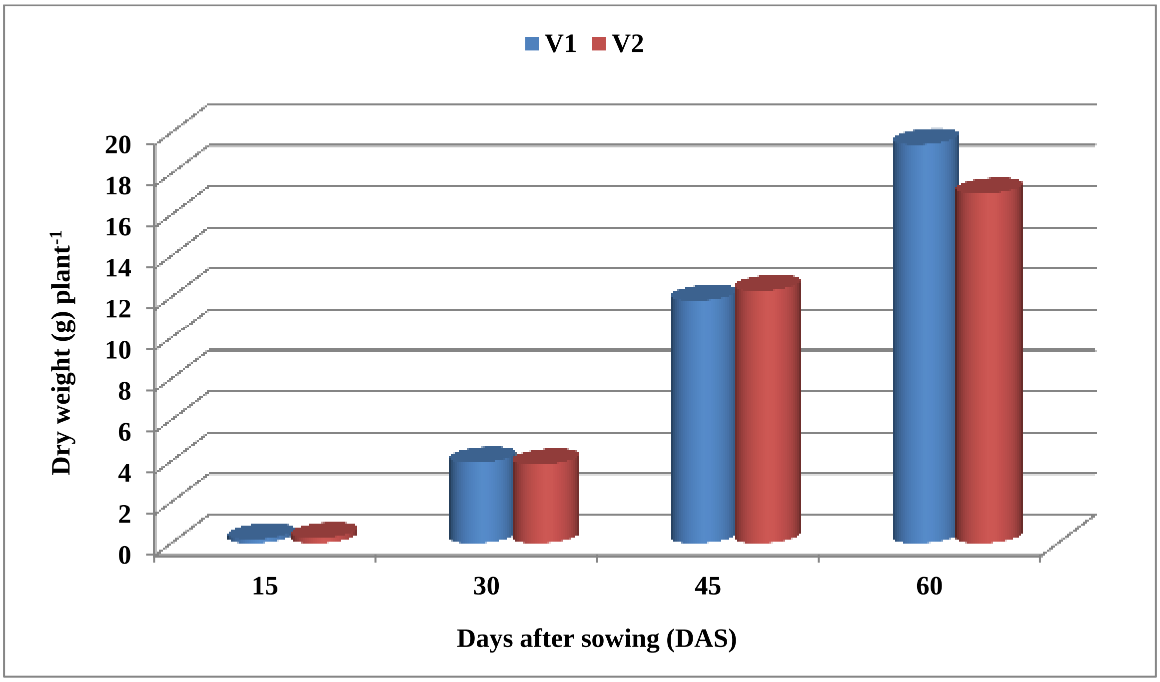
$W_1$ = No weeding; $W_4$ = 35 days weed free period;
$W_2$ = 15 days weed free period; $W_5$ = 45 days weed free period and
$W_3$ = 25 days weed free period; $W_6$ = Total weed free period

### 4.1.3 Dry matter weight plant$^{-1}$ at different days after sowing

#### 4.1.3.1 Effect of variety

The total dry matter weight of plant was significantly influenced by varieties at 15 and 60 DAS but insignificant at 30 and 45 DAS (Appendix V and Figure 5).

At 15 DAS, the higher dry matter weight plant$^{-1}$(0.24 g) was recorded in BARI Mung-6 ($V_2$) and the lower dry matter weight plant$^{-1}$(0.19 g) was recorded in BARI Mung-4 ($V_1$). At 60 DAS, the higher dry matter weight plant$^{-1}$ was produced by $V_1$ (19.42 g) compared to the $V_2$ (17.02 g). But at 30 and 45 DAS, varieties had no significant effect though the higher dry matter weight plant$^{-1}$ observed in BARI Mung-4 ($V_1$) compared to that of BARI Mung-6 ($V_2$). These findings agreed with Pookpakdi *et al*. (1980) who stated that total dry weight and dry matter production varied according to variety.

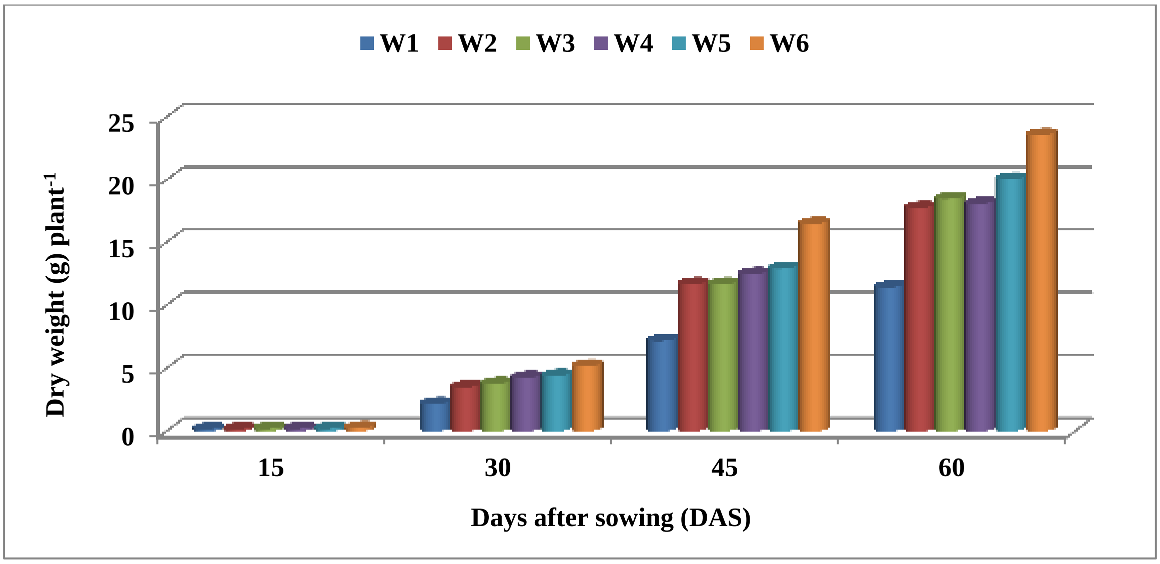



$V_1$ = BARI Mung-4 and $V_2$ = BARI Mung-6

**Figure 5. Effect of variety on the dry matter weight of mungbean at different days after sowing ($LSD_{(0.05)}$ = 0.01 and 2.08 at 15 and 60 DAS, respectively).**

### 4.1.3.2 Effect of weed free periods

The total dry matter weight of plant was significantly influenced by different weed free periods at 15, 30, 45 and 60 DAS (Appendix V and Figure 6). At 15 DAS, the highest dry matter weight plant$^{-1}$ (0.27 g) was recorded in $W_6$ treatment and the lowest (0.18 g) was recorded in $W_1$ treatment which was statistically similar with $W_2$. Similar trend of total dry matter production plant$^{-1}$ was obtained at 30, 45 and 60 DAS. At 30 DAS, the highest dry matter weight plant$^{-1}$ (5.17 g) was recorded in $W_6$ treatment, while the lowest (2.17 g) was recorded in $W_1$ treatment. At 45 DAS, the treatment $W_6$ produced the highest dry matter weight plant$^{-1}$ (16.47 g) and the lowest (7.20 g) was obtained from the $W_1$ treatment. At 60 DAS, the highest dry matter weight plant$^{-1}$ (23.57 g) was obtained from the $W_6$ treatment which shown similarity to $W_5$ and the lowest dry matter weight plant$^{-1}$ (11.43 g) was obtained from the $W_1$ treatment. These results indicated that the total dry matter weight was increased with the increase of weed free periods.




$W_1$ = No weeding; $W_4$ = 35 days weed free period;

$W_2$ = 15 days weed free period; $W_5$ = 45 days weed free period and

$W_3$ = 25 days weed free period; $W_6$ = Total weed free period

**Figure 6. Effect of different weed free periods on the dry matter weight of mungbean at different days after sowing (LSD$_{(0.05)}$ = 0.018, 0.74, 2.23 and 3.60 at 15, 30, 45 and 60 DAS, respectively).**

#### 4.1.3.3 Interaction effect of variety and weed free periods

Interaction effect of variety and weed free periods influenced the total dry matter weight plant$^{-1}$ of mungbean at 15, 30, 45 and 60 DAS (Appendix V and Table 3).

At 15 DAS, the highest dry matter weight plant$^{-1}$ (0.30 g) was observed in the $V_2W_6$ interaction and the lowest dry matter weight plant$^{-1}$ (0.15 g) was observed in the $V_1$ with the interaction of $W_1$ which was statistically similar with $V_1W_2$ interaction. At 30 DAS, the highest dry matter weight plant$^{-1}$ (5.47 g) was obtained from the $V_2W_6$ interaction which was statistically similar to the interactions of $V_1W_6$, $V_1W_4$ & $V_1W_5$ while the lowest (2.07 g) was observed in the $V_1W_1$ interaction which shown similarity to the combinations of $V_2W_1$ & $V_2W_2$. Again at 45 DAS, the highest dry matter weight plant$^{-1}$ (17.07 g) was produced by the $V_2W_6$ which was statistically similar to $V_1W_6$ and the lowest dry matter weight plant$^{-1}$ (6.27 g) was observed in the $V_2W_1$ interaction which shown similarity with $V_1W_1$. At 60 DAS, the $V_2$ with the interaction of $W_6$ produced the highest dry matter weight plant$^{-1}$ (25.60 g) which was statistically similar to $V_1W_6$, $V_1W_5$ & $V_1W_3$ interactions, whereas the lowest dry matter weight plant$^{-1}$ was produced by the $V_2$ with the interaction of $W_1$ (9.20 g) which shown similarity with $V_1W_1$ treatment combination.

**Table 3. Interaction effect of variety and weed free periods on the dry matter weight of mungbean**

| Treatment combinations | Dry matter weight (g plant$^{-1}$) at 15 DAS | 30 DAS | 45 DAS | 60 DAS |
|---|---|---|---|---|
| $V_1W_1$ | 0.15 f | 2.07 e | 8.13 de | 13.67 de |
| $V_1W_2$ | 0.17 ef | 3.93 b-d | 10.97 cd | 19.60 bc |
| $V_1W_3$ | 0.18 de | 3.53 cd | 10.67 cd | 21.20 ab |
| $V_1W_4$ | 0.20 cd | 4.57 a-c | 12.43 c | 19.27 bc |
| $V_1W_5$ | 0.19 c-e | 4.53 a-c | 12.93 bc | 21.27 ab |
| $V_1W_6$ | 0.23 b | 4.87 ab | 15.87 ab | 21.53 ab |
| $V_2W_1$ | 0.20 c | 2.27 e | 6.27 e | 9.20 e |
| $V_2W_2$ | 0.20 cd | 3.07 de | 12.40 c | 15.87 cd |
| $V_2W_3$ | 0.25 b | 4.0 b-d | 12.67 c | 15.73 cd |
| $V_2W_4$ | 0.25 b | 3.93 b-d | 12.53 c | 16.87 b-d |
| $V_2W_5$ | 0.25 b | 4.27 bc | 12.93 bc | 18.87 bc |
| $V_2W_6$ | 0.30 a | 5.47 a | 17.07 a | 25.60 a |
| **LSD $_{(0.05)}$** | **0.025** | **1.05** | **3.16** | **5.09** |
| **CV (%)** | **6.96** | **16.0** | **15.45** | **16.49** |

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

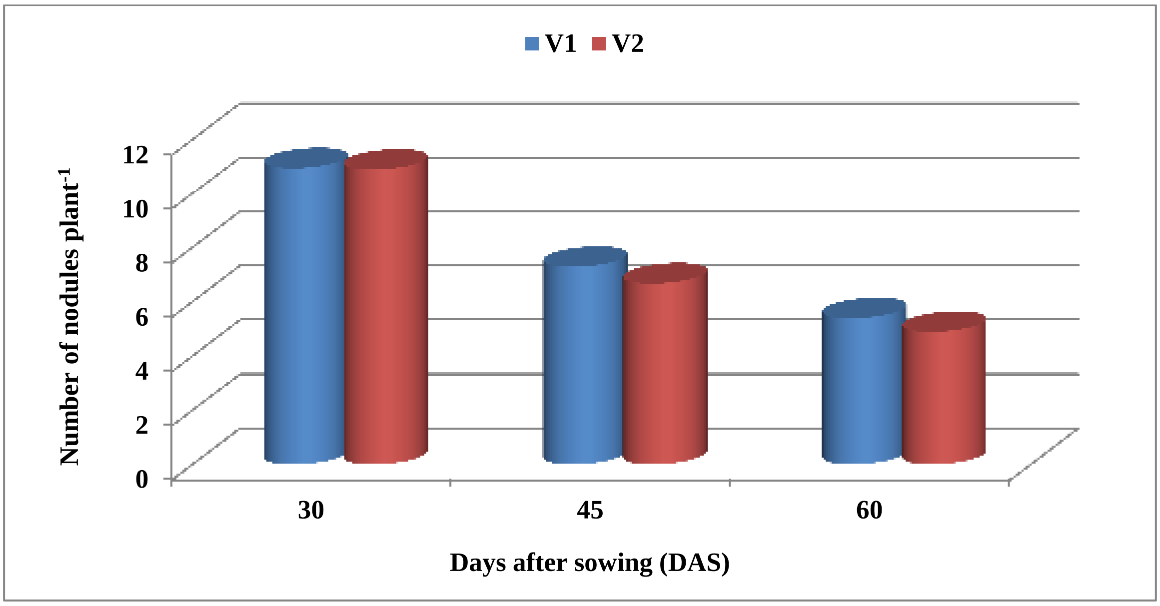
$V_1$ = BARI Mung-4 and $V_2$ = BARI Mung-6

$W_1$ = No weeding; $W_4$ = 35 days weed free period;
$W_2$ = 15 days weed free period; $W_5$ = 45 days weed free period and
$W_3$ = 25 days weed free period; $W_6$ = Total weed free period

### 4.1.4 Number of nodules plant$^{-1}$ at different days after sowing

#### 4.1.4.1 Effect of variety

The total number of nodules plant$^{-1}$ was not significantly influenced by varieties of mungbean throughout the growing season (Appendix VI and Figure 7). The BARI Mung-6 ($V_2$) produced the numerically higher total number of nodules plant$^{-1}$ (10.94, 7.28 and 5.39 at 30, 45 and 60 DAS, respectively) and the BARI Mung-4 ($V_1$) gave the lower total number of nodules plant$^{-1}$ (10.89, 6.67 and 4.89 at 30, 45 and 60 DAS, respectively). The number of nodules plant$^{-1}$ declined with the advancement of growth after 30 DAS. It appeared that the peak nodulation in mungbean occurred between pre-flowering and pod filling stage. Patel and Patel (1994) reported significantly higher number of nodules plant$^{-1}$ in mungbean at 30 DAS followed by 45 DAS.



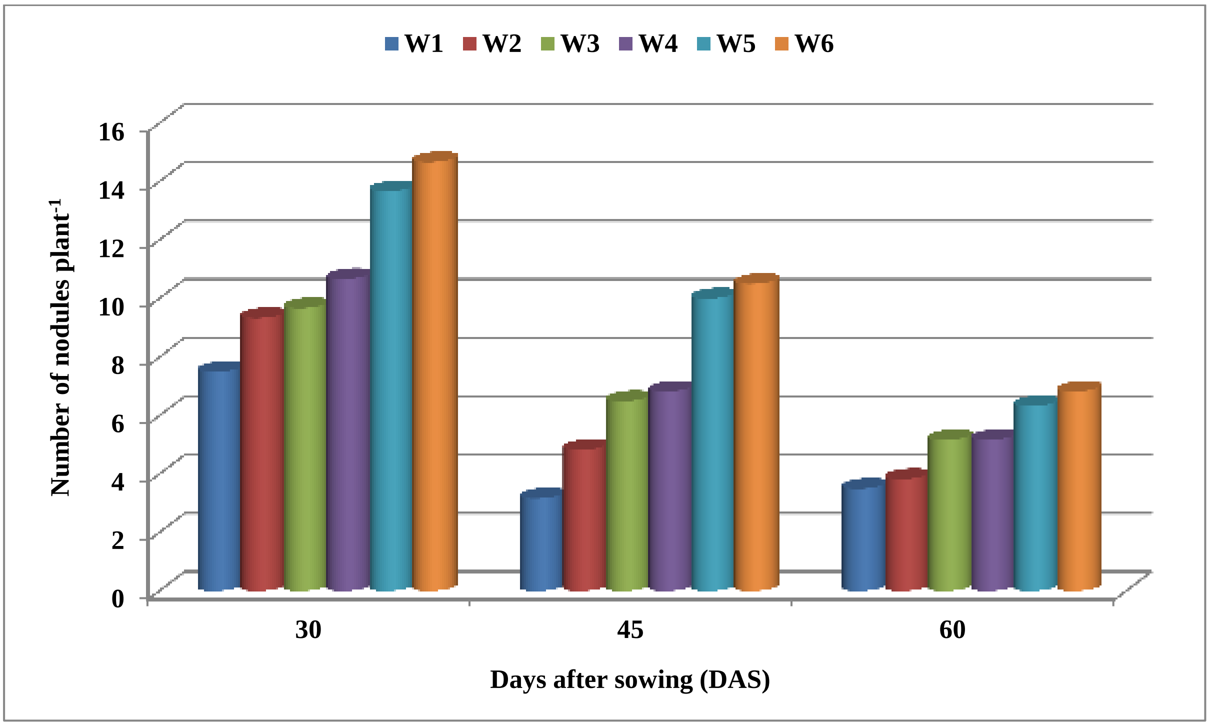

$V_1$ = BARI Mung-4 and $V_2$ = BARI Mung-6

**Figure 7. Effect of variety on the number of nodules plant$^{-1}$ of mungbean at different days after sowing.**

### 4.1.4.2 Effect of weed free periods

The different weed free periods had significant effect in the formation of total number of nodules plant$^{-1}$ recorded at 30, 45 and 60 DAS (Appendix VI and Figure 8).

At 30 DAS, the highest number of nodules plant$^{-1}$ (14.67) was produced by the $W_6$ treatment which was statistically similar to $W_5$ and the lowest number of nodules plant$^{-1}$ (7.50) was produced by $W_1$ which was statistically similar to the $W_2$ & $W_3$ treatments. At 45 DAS, the highest number of nodules plant$^{-1}$ (10.50) was produced by $W_6$ shown similarity with $W_5$ treatment and the lowest number of nodules plant$^{-1}$ (3.17) was produced by $W_1$ treatment. At 60 DAS, the highest total number of nodules plant$^{-1}$ (6.83) was produced by the $W_6$ treatment which was statistically similar to $W_5$ and the lowest number of nodules plant$^{-1}$ (3.50) was produced by $W_1$ which was statistically similar to the treatments of $W_2$. These results indicated that the total number of nodules plant$^{-1}$ was increased with the increase of weed free periods.




$W_1$ = No weeding; $W_4$ = 35 days weed free period;
$W_2$ = 15 days weed free period; $W_5$ = 45 days weed free period and
$W_3$ = 25 days weed free period; $W_6$ = Total weed free period

**Figure 8. Effect of different weed free periods on the number of nodules plant$^{-1}$ of mungbean at different days after sowing ($LSD_{(0.05)}$ = 2.42, 1.42 and 1.15 at 30, 45 and 60 DAS, respectively).**

### 4.1.4.3 Interaction effect of variety and weed free periods

Significant interaction effect between the variety and weed free periods was observed at 30, 45 and 60 DAS on the total number of nodules produced plant$^{-1}$ (Appendix VI and Table 4). At 30 DAS, the highest number of nodules plant$^{-1}$ (15.33) was produced from the $V_1W_6$ which was statistically similar with the interactions of $V_1W_5$, $V_2W_6$ & $V_2W_5$ and the lowest number of nodules plant$^{-1}$ (7.00) was produced in interaction of $V_1W_1$ which was statistically similar with the interactions of $V_2W_1$, $V_1W_3$, $V_1W_2$, $V_2W_2$ & $V_2W_4$.

**Table 4. Interaction effect of variety and weed free periods on the number of nodules plant$^{-1}$ of mungbean**

| Treatment combinations | Number of nodules plant$^{-1}$ at | | |
|---|---|---|---|
| | 30 DAS | 45 DAS | 60 DAS |
| $V_1W_1$ | 7.00 e | 3.33 g | 3.00 f |
| $V_1W_2$ | 9.00 c-e | 5.67 ef | 3.67 ef |
| $V_1W_3$ | 8.33 de | 6.00 d-f | 5.33 b-d |
| $V_1W_4$ | 11.00 b-d | 5.67 ef | 4.67 c-e |
| $V_1W_5$ | 15.00 a | 13.00 a | 5.67 a-c |
| $V_1W_6$ | 15.33 a | 10.00 bc | 7.00 a |
| $V_2W_1$ | 8.00 de | 3.0 g | 4.00 d-f |
| $V_2W_2$ | 9.67 c-e | 4.00 fg | 4.00 d-f |
| $V_2W_3$ | 11.00 b-d | 7.00 de | 5.00 c-e |
| $V_2W_4$ | 10.33 c-e | 8.00 cd | 5.67 a-c |
| $V_2W_5$ | 12.33 a-c | 7.00 de | 7.00 a |
| $V_2W_6$ | 14.00 ab | 11.00 ab | 6.67 ab |
| **LSD $_{(0.05)}$** | **3.43** | **2.01** | **1.63** |
| **CV (%)** | **18.54** | **17.06** | **18.68** |

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

$V_1$ = BARI Mung-4 and $V_2$ = BARI Mung-6

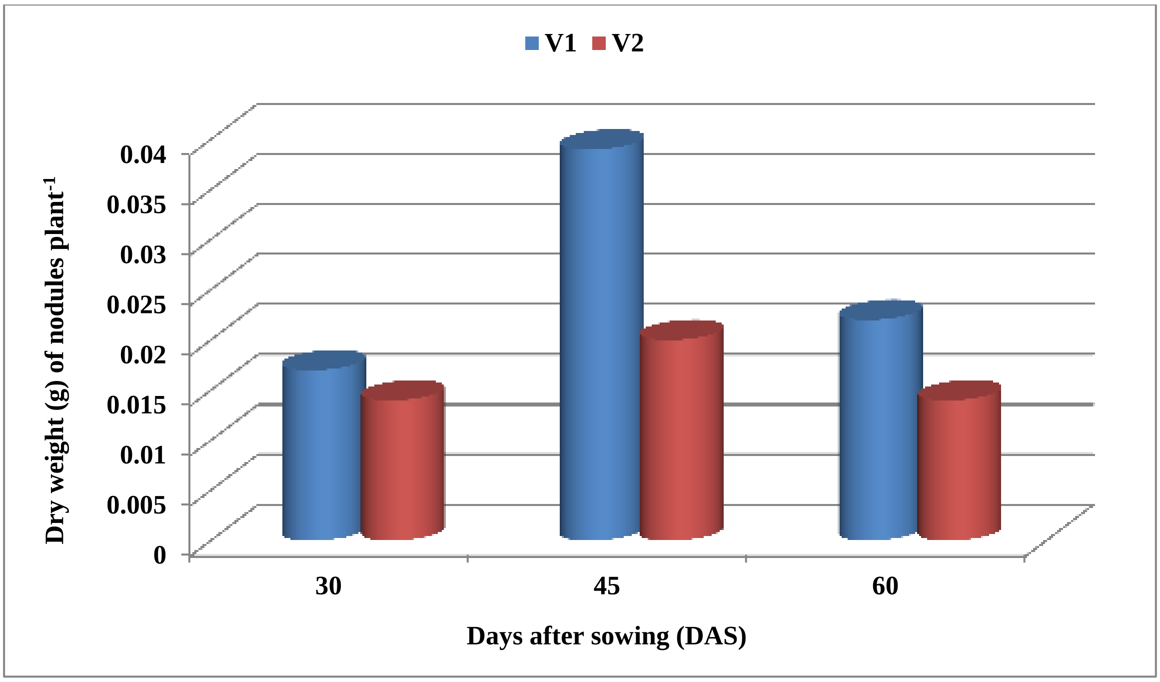
$W_1$ = No weeding; $W_4$ = 35 days weed free period;
$W_2$ = 15 days weed free period; $W_5$ = 45 days weed free period and
$W_3$ = 25 days weed free period; $W_6$ = Total weed free period

At 45 DAS, the highest number of nodules plant$^{-1}$ (13.00) was recorded at the $V_1W_5$ interaction which was statistically similar with the interaction of $V_2W_6$ and the lowest number of nodules plant$^{-1}$ (3.00) was produced from the $V_2$ with $W_1$ combination which shown similarity with the interactions of $V_1W_1$ & $V_2W_2$. At 60 DAS, the highest number of nodules plant$^{-1}$ (7.00) was obtained from the $V_1W_6$ interaction which was statistically similar with the interactions of $V_2W_5$, $V_2W_6$, $V_2W_4$ & $V_1W_5$ while the lowest number of nodules plant$^{-1}$ (3.00) was produced in $V_1W_1$ combination which was statistically similar with the interactions of $V_1W_2$, $V_2W_1$ & $V_2W_2$.

### 4.1.5 Dry weight of nodules plant$^{-1}$ at different days after sowing

#### 4.1.5.1 Effect of variety

The dry weight of nodules plant$^{-1}$ had significant effect for varieties at 30, 45 and 60 DAS (Appendix VI and Figure 9). At 30 DAS, the dry weight of nodules plant$^{-1}$ was higher (0.017 g) in BARI Mung-4 ($V_1$) and lower (0.014 g) in BARI Mung-6 ($V_2$). At 45 DAS, the $V_1$ produced higher dry weight of nodules plant$^{-1}$ (0.039 g) and the $V_2$ gave lower dry weight of nodules plant$^{-1}$ (0.020 g). At 60 DAS, the dry weight of nodules plant$^{-1}$ was higher in BARI Mung-4 (0.022 g) than BARI Mung-6 (0.014 g). Ratna (2007) in her experiment found that dry weight of nodules plant$^{-1}$ varies with varieties of mungbean. Nodule dry weight increased almost exponentially with progress of crop growth up to 40 or 45 DAS and later decreased as number of nodules plant$^{-1}$ disappears after peak nodulation.

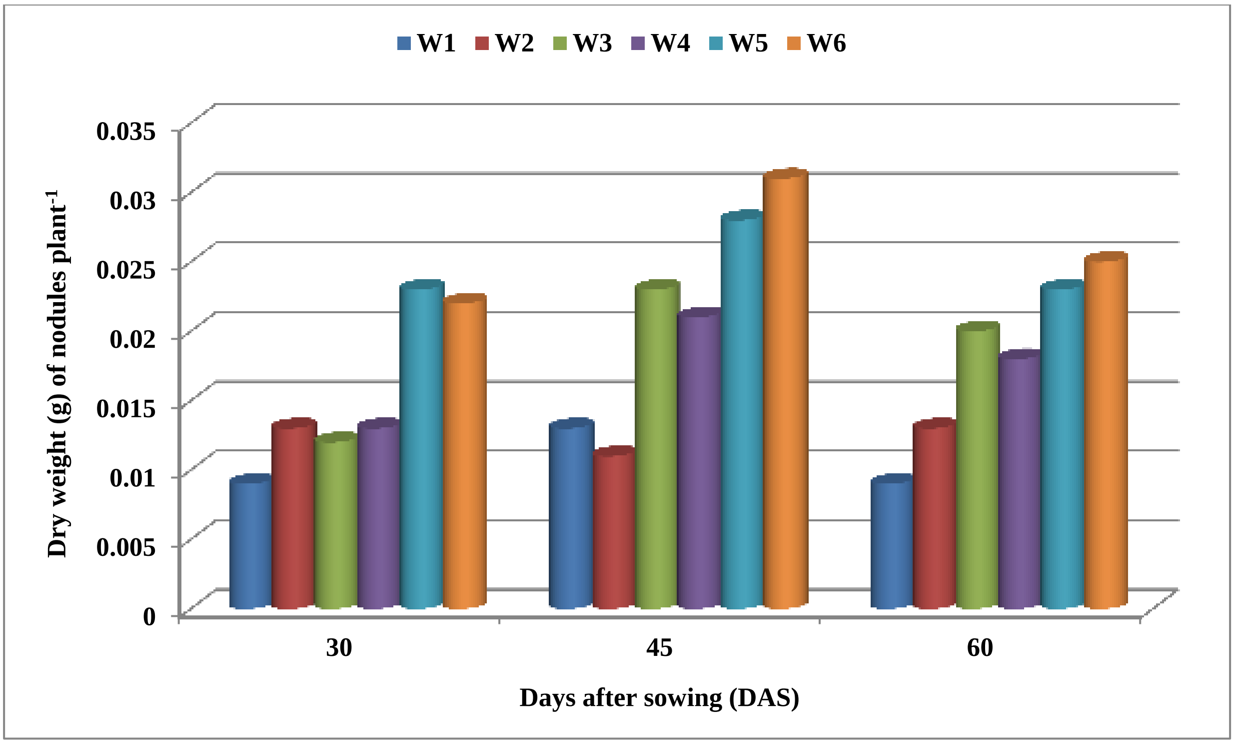



$V_1$ = BARI Mung-4 and $V_2$ = BARI Mung-6

**Figure 9. Effect of variety on the dry weight of nodules plant$^{-1}$ of mungbean at different days after sowing (LSD $_{(0.05)}$ = 0.0015, 0.0017 and 0.0013 at 30, 45 and 60 DAS, respectively).**

### 4.1.5.2 Effect of weed free periods

Weed free periods had significant effect on the dry weight of nodules plant$^{-1}$ recorded at 30, 45 and 60 DAS (Appendix VI and Figure 10). At 30 DAS, the highest dry weight of nodules plant$^{-1}$ (0.023 g) was produced by $W_5$ treatment which shown similarity with $W_6$ and the lowest (0.009 g) was produced by the $W_1$ treatment. At 45 DAS, the highest dry weight of nodules plant$^{-1}$ (0.081 g) was produced by $W_6$ while the lowest dry weight of nodules plant$^{-1}$ (0.011 g) was produced by $W_2$ treatment which was significantly similar to $W_1$. At 60 DAS, the highest dry weight of nodules plant$^{-1}$ (0.025 g) was produced by $W_6$ treatment which shown similarity with the treatment of $W_5$ and the lowest dry weight of nodules plant$^{-1}$ (0.009 g) was produced by $W_1$ treatment. These results indicated that the total dry weight of nodules plant$^{-1}$ was increased with the increase of weed free periods.




$W_1$ = No weeding; $W_4$ = 35 days weed free period;
$W_2$ = 15 days weed free period; $W_5$ = 45 days weed free period and
$W_3$ = 25 days weed free period; $W_6$ = Total weed free period

**Figure 10. Effect of different weed free periods on the dry weight of nodules plant$^{-1}$ of mungbean at different days after sowing ($LSD_{(0.05)}$ = 0.0025, 0.003 and 0.0023 at 30, 45 and 60 DAS, respectively).**

### 4.1.5.3 Interaction effect of variety and weed free periods

Significant interaction effect between the variety and weed free periods was observed at 30, 45 and 60 DAS on the dry weight of nodules produced plant$^{-1}$ (Appendix VI and Table 5). At 30 DAS, the highest dry weight of nodules plant$^{-1}$ (0.029 g) was obtained from the $V_1W_6$ interaction which shown similarity with the interaction of $V_1W_5$ and the lowest dry weight of nodules plant$^{-1}$ was produced in $V_1W_1$ (0.008 g) which was statistically similar with the interactions of $V_2W_1$, $V_2W_3$ & $V_1W_4$. At 45 DAS, the highest dry weight of nodules plant$^{-1}$ (0.141 g) was recorded at $V_1W_6$ whereas, statistically the lowest dry weight of nodules plant$^{-1}$ (0.005 g) was produced in $V_2W_2$ interaction which was statistically similar with the interaction of $V_2W_1$.

**Table 5. Interaction effect of variety and weed free periods on the dry weight of nodules plant$^{-1}$ of mungbean**

| Treatment combinations | Dry weight of nodules (g plant$^{-1}$) at | | |
|---|---|---|---|
| | 30 DAS | 45 DAS | 60 DAS |
| $V_1W_1$ | 0.008 f | 0.02 d | 0.008 g |
| $V_1W_2$ | 0.012 de | 0.018 de | 0.015 de |
| $V_1W_3$ | 0.015 cd | 0.02 d | 0.026 b |
| $V_1W_4$ | 0.01 ef | 0.015 e | 0.021 c |
| $V_1W_5$ | 0.028 a | 0.021 d | 0.027 b |
| $V_1W_6$ | 0.029 a | 0.041 a | 0.033 a |
| $V_2W_1$ | 0.01 ef | 0.007 f | 0.01 fg |
| $V_2W_2$ | 0.014 cd | 0.005 f | 0.011 fg |
| $V_2W_3$ | 0.01 ef | 0.026 c | 0.013 ef |
| $V_2W_4$ | 0.016 bc | 0.028 c | 0.015 de |
| $V_2W_5$ | 0.019 b | 0.034 b | 0.019 c |
| $V_2W_6$ | 0.015 cd | 0.021 d | 0.018 cd |
| **LSD $_{(0.05)}$** | **0.0036** | **0.0042** | **0.0033** |
| **CV (%)** | **13.68** | **8.16** | **10.80** |

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

$V_1$ = BARI Mung-4 and $V_2$ = BARI Mung-6

$W_1$ = No weeding; $W_4$ = 35 days weed free period;
$W_2$ = 15 days weed free period; $W_5$ = 45 days weed free period and
$W_3$ = 25 days weed free period; $W_6$ = Total weed free period

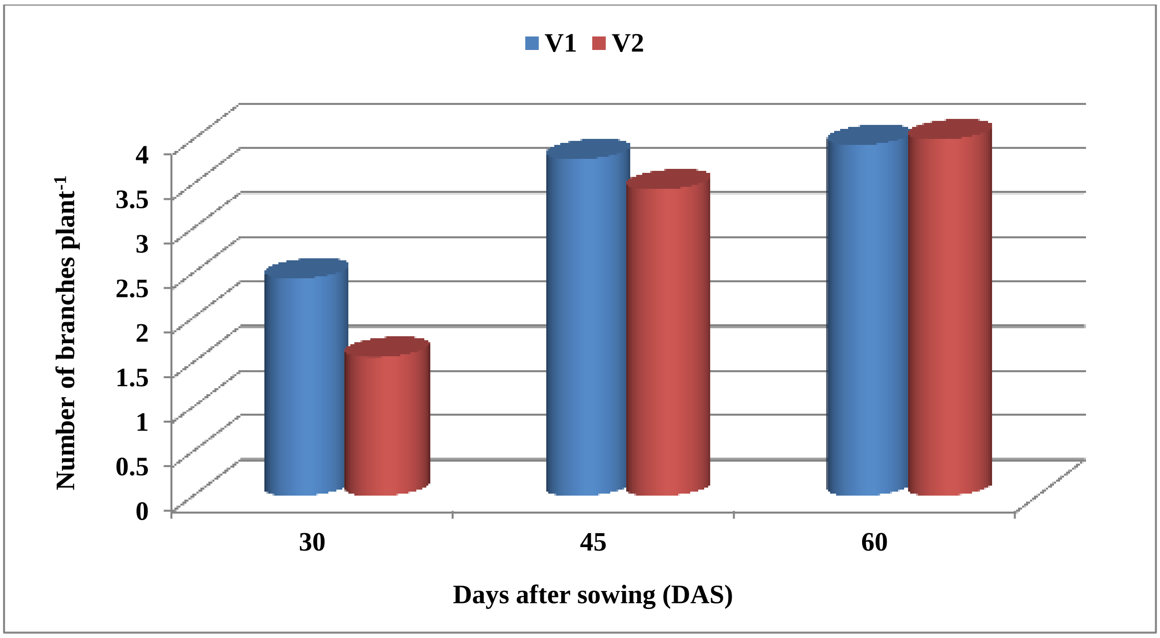
At 60 DAS, the highest dry weight of nodules plant$^{-1}$ (0.033 g) was obtained from the $V_1W_6$ interaction and the lowest (0.008 g) was produced in $V_1W_1$ which was statistically similar with the interactions of $V_2W_1$ & $V_2W_2$. From the findings of the experimental result, it was appeared that BARI Mung-4 ($V_1$) showed significantly higher dry weight of nodules plant$^{-1}$ than BARI Mung-6 ($V_2$) in total weed free condition ($W_6$).

## 4.2 Yield and other crop characters

### 4.2.1 Number of branches plant$^{-1}$ at different days after sowing

#### 4.2.1.1 Effect of variety

The number of branches plant$^{-1}$ was not significantly influenced by the variety at 45 and 60 DAS but at 30 DAS, the number of branches plant$^{-1}$ varied significantly for the two varieties (Appendix VII and Figure 11). At 30 DAS, the higher number of branches plant$^{-1}$ was observed in BARI Mung-4 (2.44) and the lower number of branches plant$^{-1}$ (1.56) was observed in BARI Mung-6. The variation in the production of branches plant$^{-1}$ might be due to genetic constituents of the crop.




$V_1$ = BARI Mung-4 and $V_2$ = BARI Mung-6

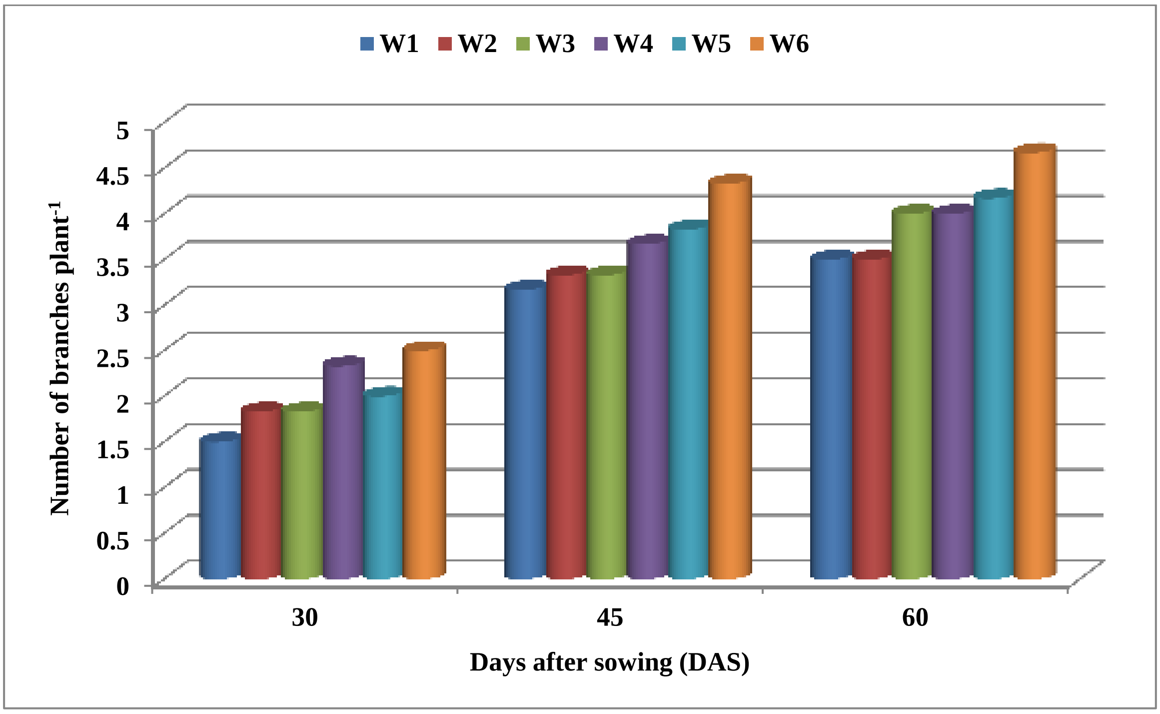
**Figure 11. Effect of variety on the number of branches plant$^{-1}$ of mungbean at different days after sowing (LSD $_{(0.05)}$ = 0.32 at 30 DAS).**

The result agreed with Islam (1983) who observed significant variation in branches number plant$^{-1}$ in different studied varieties of mungbean and the highest number of branches plant$^{-1}$ was in the variety Faridpur-1 followed by Mubarik, BM-7715 and

BM-7704. The result also agreed with the findings of Ghosh (2007) who observed varieties differ significantly in respect of number of branches plant$^{-1}$. He found the higher number of branches plant$^{-1}$ in Sona mung and the lower in BARI Mung-6.

### 4.2.1.2 Effect of weed free periods

Different weed free periods significantly influenced the number of branches plant$^{-1}$ at 30, 45 and 60 DAS (Appendix VII and Figure 12). The highest number of branches plant$^{-1}$ (2.50, 4.33 and 4.67 at 30, 45 and 60 DAS, respectively) were obtained from the $W_6$ treatment which was statistically similar with $W_5$ treatment.




$W_1$ = No weeding; $W_4$ = 35 days weed free period;

$W_2$ = 15 days weed free period; $W_5$ = 45 days weed free period and

$W_3$ = 25 days weed free period; $W_6$ = Total weed free period

**Figure 12. Effect of different weed free periods on the number of branches plant$^{-1}$ of mungbean at different days after sowing (LSD$_{(0.05)}$ = 0.56, 0.59 and 0.60 at 30, 45 and 60 DAS, respectively).**

On the other hand, the lowest number of branches plant$^{-1}$ (1.50, 3.17 and 3.50 at 30, 45 and 60 DAS, respectively) were obtained from $W_1$ which was statistically similar with the treatments of $W_2$ & $W_3$ at 30 DAS; $W_2$, $W_3$ & $W_4$ at 45 and 60 DAS, respectively. These results indicated that the number of branches plant$^{-1}$ was increased with the increase of weed free periods.

### 4.2.1.3 Interaction effect of variety and weed free periods

The number of branches plant$^{-1}$ was significantly influenced by the interaction effect of variety and weed free periods at 30, 45 and 60 DAS (Appendix VII and Table 6).

The highest number of branches plant$^{-1}$ (3.00) was obtained from the $V_1$ with the interaction of $W_6$ which was similar to the interactions of $V_1W_4$, $V_1W_5$, $V_1W_2$ & $V_1W_3$ at 30 DAS while the lowest number of branches plant$^{-1}$ (1.33) was obtained from $V_2W_1$ interaction which was statistically similar with the combinations of $V_2W_2$, $V_2W_3$, $V_1W_1$, $V_2W_4$, $V_2W_5$ and $V_2W_6$. At 45 DAS, the highest number of branches plant$^{-1}$ (4.67) was obtained from the $V_1W_6$ which was similar to the interactions of $V_2W_6$ & $V_1W_5$ and the lowest (3.00) was recorded from the combination of $V_2W_1$ which shown similarity with $V_2W_3$, $V_2W_2$, $V_1W_1$, $V_2W_2$, $V_1W_3$, $V_1W_4$, $V_2W_4$ & $V_2W_5$ interactions. Again at 60 DAS, the highest number of branches plant$^{-1}$ (4.67) was obtained from the $V_1W_6$ which was similar to the interactions of $V_2W_6$, $V_2W_5$, $V_2W_4$, $V_2W_3$, $V_1W_3$ & $V_1W_5$ and the lowest number of branches plant$^{-1}$ (3.33) was recorded from the combination of $V_2W_1$ which was statistically similar with $V_2W_2$, $V_1W_1$, $V_1W_2$, $V_1W_4$, $V_1W_3$ & $V_2W_3$. From the findings of the experimental result, it was appeared that BARI Mung-4 ($V_1$) showed significantly higher number of branches plant$^{-1}$ than BARI Mung-6 ($V_2$) in total weed free condition ($W_6$).

**Table 6. Interaction effect of variety and weed free periods on the number of branches plant$^{-1}$ of mungbean**

| Treatment combinations | Branches plant$^{-1}$ (No.) at | | |
|---|---|---|---|
| | **30 DAS** | **45 DAS** | **60 DAS** |
| **$V_1W_1$** | 1.67 bc | 3.33 bc | 3.67 bc |
| **$V_1W_2$** | 2.33 ab | 3.33 bc | 3.67 bc |
| **$V_1W_3$** | 2.33 ab | 3.67 bc | 4.00 a-c |
| **$V_1W_4$** | 3.00 a | 3.67 bc | 3.67 bc |
| **$V_1W_5$** | 2.33 ab | 4.00 ab | 4.00 a-c |
| **$V_1W_6$** | 3.00 a | 4.67 a | 4.67 a |
| **$V_2W_1$** | 1.33 c | 3.00 c | 3.33 c |
| **$V_2W_2$** | 1.33 c | 3.33 bc | 3.33 c |
| **$V_2W_3$** | 1.33 c | 3.00 c | 4.00 a-c |
| **$V_2W_4$** | 1.67 bc | 3.67 bc | 4.33 ab |
| **$V_2W_5$** | 1.67 bc | 3.67 bc | 4.33 ab |
| **$V_2W_6$** | 2.00 bc | 4.00 ab | 4.67 a |
| **LSD $_{(0.05)}$** | **0.79** | **0.83** | **0.86** |
| **CV (%)** | **23.44** | **13.56** | **12.71** |

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

$V_1$ = BARI Mung-4 and $V_2$ = BARI Mung-6

$W_1$ = No weeding; $W_4$ = 35 days weed free period;
$W_2$ = 15 days weed free period; $W_5$ = 45 days weed free period and
$W_3$ = 25 days weed free period; $W_6$ = Total weed free period

### 4.2.2 Number of pods plant$^{-1}$

#### 4.2.2.1 Effect of variety

The number of pods plant$^{-1}$ was significantly influenced by varietal variation (Appendix VIII and Table 7). Results showed that, the $V_1$ produced the higher number of pods plant$^{-1}$ (28.44) and the lower (14.44) was obtained from $V_2$.

**Table 7. Effect of variety and different weed free periods on the yield and other crop characters of mungbean at harvest**

| Treatments | No. of pods plant$^{-1}$ | Pod length (cm) | No. of seeds pod$^{-1}$ | Weight of 1000 seed (g) |
|---|---|---|---|---|
| **Variety** | | | | |
| **$V_1$** | 28.44 a | 6.64 b | 11.00 b | 34.62 b |
| **$V_2$** | 14.44 b | 9.10 a | 12.05 a | 53.68 a |
| **$LSD_{(0.05)}$** | **1.69** | **0.05** | **0.46** | **0.71** |
| **Weed free periods** | | | | |
| **$W_1$** | 14.17 c | 7.71 e | 11.00 b | 42.63 c |
| **$W_2$** | 18.83 b | 7.76 de | 11.50 ab | 42.71 c |
| **$W_3$** | 20.50b | 7.82 cd | 11.33 ab | 44.22 b |
| **$W_4$** | 21.00 b | 7.91 b | 11.67 ab | 44.03 b |
| **$W_5$** | 26.00 a | 7.88 bc | 11.67 ab | 45.11 ab |
| **$W_6$** | 28.17 a | 8.17 a | 12.00 a | 46.21 a |
| **$LSD_{(0.05)}$** | **2.92** | **0.09** | **NS** | **1.23** |
| **CV (%)** | **11.39** | **0.92** | **5.73** | **2.32** |

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

$V_1$ = BARI Mung-4 and $V_2$ = BARI Mung-6

$W_1$ = No weeding; $W_4$ = 35 days weed free period;
$W_2$ = 15 days weed free period; $W_5$ = 45 days weed free period and
$W_3$ = 25 days weed free period; $W_6$ = Total weed free period

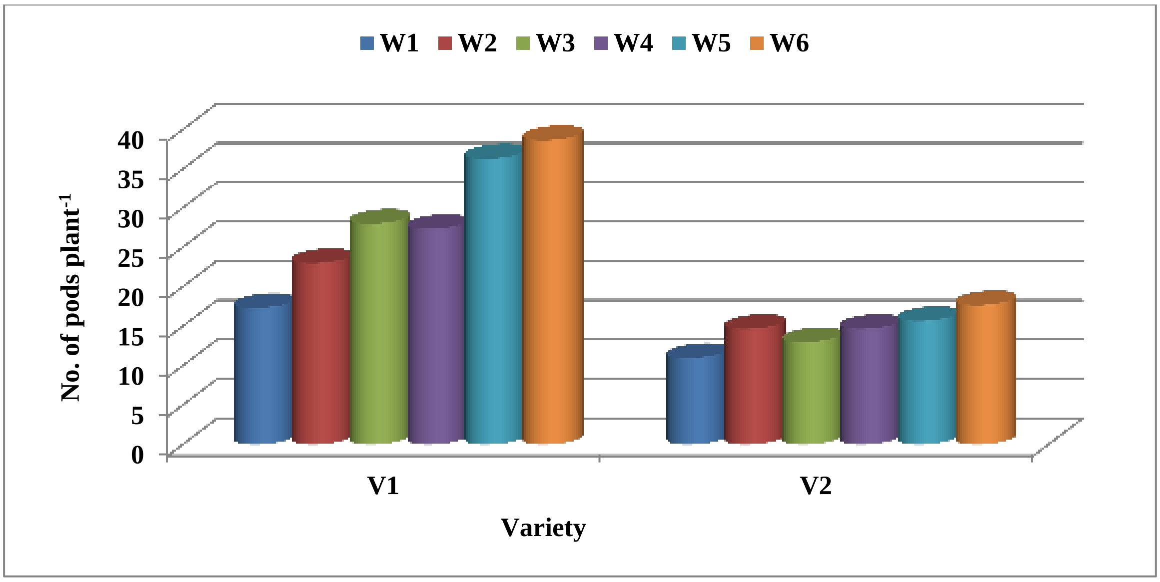
Different varieties responded differently due to genetical characters and the prevailing environment during the growing season. Raj and Tripathi (2005) reported that cultivar K-851 gave significantly higher values for pods plant$^{-1}$ compared with RMG-62. Masood and Meena (1986) reported that number of pods plant$^{-1}$ varied significantly with genotypes. Islam (1983), Haque *et al*. (2002) also opined that pods plant$^{-1}$ is a useful agronomic character contributing to higher yield of mungbean and there was a significant positive correlation between the number of pods plant$^{-1}$ and yield plant$^{-1}$.

### 4.2.2.2 Effect of weed free periods

The number of pods plant$^{-1}$ varied significantly for different weed free periods (Appendix VIII and Table 7). The highest number of pods plant$^{-1}$ (28.17) was found from the $W_6$ treatment which was statistically similar with $W_{5,}$ while the lowest number of pods plant$^{-1}$ (14.17) was obtained from the $W_1$ treatment.

### 4.2.2.3 Interaction effect of variety and weed free periods

The number of pods plant$^{-1}$ was significantly influenced by the interaction effect of variety and weed free periods (Appendix VIII and Figure 13). The highest number of pods plant$^{-1}$ (38.67) was obtained from the $V_1W_6$ interaction which shown similarity with the interaction of $V_1W_5$ whereas, the lowest number of pods plant$^{-1}$ (11.0) was obtained from $V_2W_1$ which was statistically similar to the interactions of $V_2W_3$, $V_2W_2$ and $V_2W_4$.




$V_1$ = BARI Mung-4 and $V_2$ = BARI Mung-6

$W_1$ = No weeding; $W_4$ = 35 days weed free period;
$W_2$ = 15 days weed free period; $W_5$ = 45 days weed free period and
$W_3$ = 25 days weed free period; $W_6$ = Total weed free period

**Figure 13. Interaction effect of variety and weed free periods on the number of pods plant$^{-1}$ of mungbean.**

### 4.2.3 Pod length

#### 4.2.3.1 Effect of variety

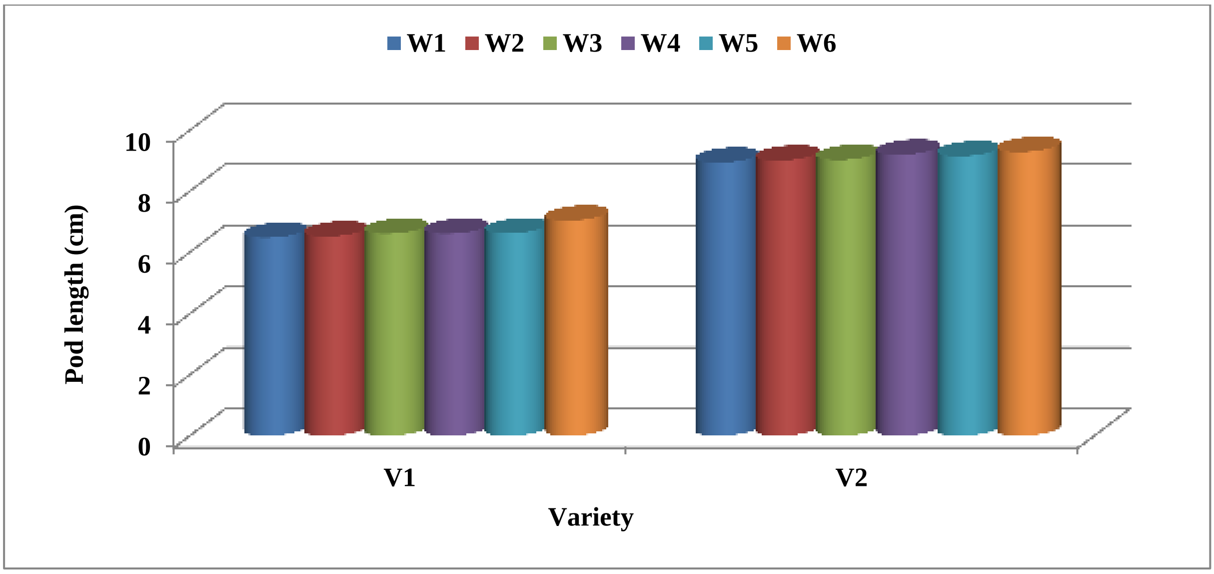
The pod length was significantly influenced by the variety (Appendix VIII and Table 7). The higher (9.10 cm) and lower (6.64 cm) pod length was obtained from the $V_2$ (BARI Mung-6) and $V_1$ (BARI Mung-4), respectively. The result agreed with the findings of Farghali and Hossain (1995) who observed that varieties differ significantly in respect of pod length.

#### 4.2.3.2 Effect of weed free periods

There was significant difference observed in pod length due to different weed free periods (Appendix VIII and Table 7). The highest pod length (8.17 cm) was observed in the $W_6$ treatment and the lowest pod length (7.71 cm) was observed in $W_1$ treatment which was statistically similar to $W_2$.

### 4.2.3.3 Interaction effect of variety and weed free periods

Interaction effect of variety and weed free periods showed significant differences on pod length (Appendix VIII and Figure 14). The longest pod (9.29 cm) was attained from the $V_2W_6$ interaction which was statistically similar with $V_2W_4$, while the shortest pod (6.48 cm) was obtained from the $V_1W_1$ interaction which shown similarity with the $V_1W_2$ interaction.




$V_1$ = BARI Mung-4 and $V_2$ = BARI Mung-6

$W_1$ = No weeding; $W_4$ = 35 days weed free period;

$W_2$ = 15 days weed free period; $W_5$ = 45 days weed free period and

$W_3$ = 25 days weed free period; $W_6$ = Total weed free period

**Figure 14. Interaction effect of variety and weed free periods on pod length of mungbean.**

### 4.2.4 Number of seeds pod$^{-1}$

### 4.2.4.1 Effect of variety

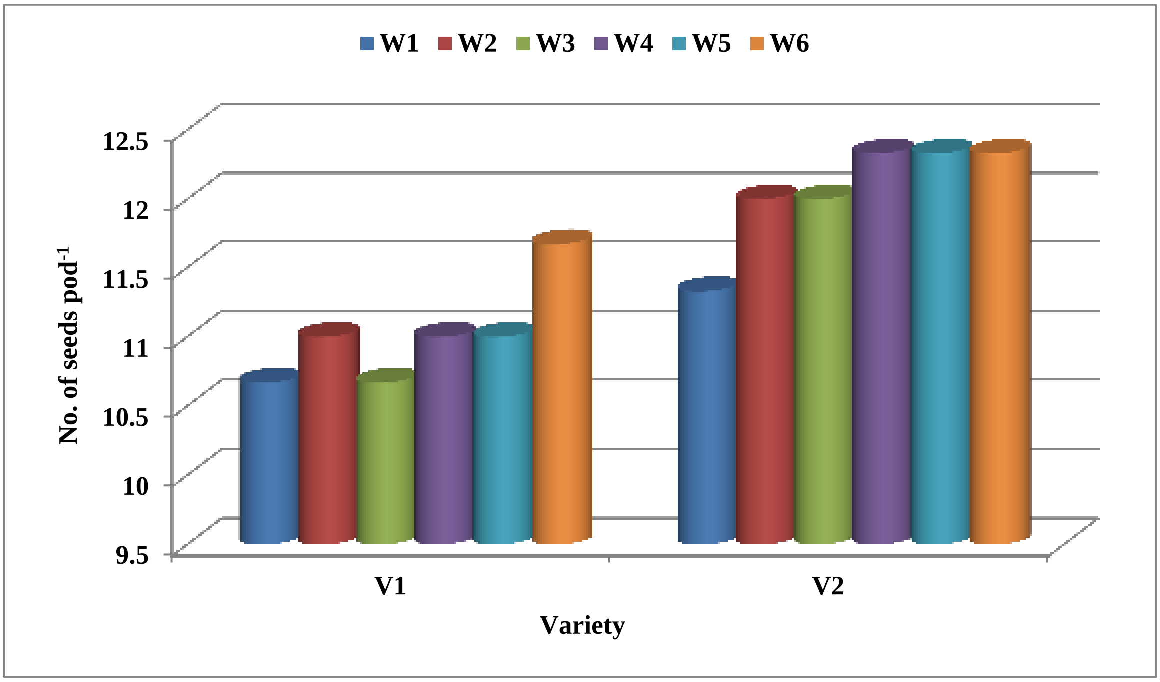
The number of seeds pod$^{-1}$ was significantly influenced by the variety (Appendix VIII and Table 7). The BARI Mung-6 ($V_2$) produced the higher number of seeds pod$^{-1}$ (12.05) and the BARI Mung-4 ($V_1$) produced the lower number of seeds pod$^{-1}$ (11.00). The result agreed with Pahlwan and Hossain (1983) and Pookpakdi *et al*. (1980) who found the higher yield from two mungbean cultivars Mubarik and CES 14 with the higher number of seeds pod$^{-1}$.

### 4.2.4.2 Effect of weed free periods

Weed free periods had no significant effect on the number of seeds pod$^{-1}$ (Appendix VIII and Table 7). The highest number of seeds pod$^{-1}$ (12.00) was recorded from the $W_6$ treatment and the lowest number of seeds pod$^{-1}$ (11.00) was recorded from the $W_1$ though the difference was statistically similar.

### 4.2.4.3 Interaction effect of variety and weed free periods

The number of seeds pod$^{-1}$ was significantly influenced by the interaction effect of variety and weed free periods (Appendix VIII and Figure 15).




$V_1$ = BARI Mung-4 and $V_2$ = BARI Mung-6

$W_1$ = No weeding; $W_4$ = 35 days weed free period;
$W_2$ = 15 days weed free period; $W_5$ = 45 days weed free period and
$W_3$ = 25 days weed free period; $W_6$ = Total weed free period

**Figure 15. Interaction effect of variety and weed free periods on the number of seeds pod$^{-1}$ of mungbean.**

The highest number of seeds pod$^{-1}$ (12.33) was obtained from the $V_2$ with the interaction of $W_6$ which was similar with the interactions of $V_2W_4$, $V_2W_5$, $V_2W_2$, $V_2W_3$, $V_1W_6$ and $V_2W_1$ while the lowest number of seeds pod$^{-1}$ (10.67) was obtained from the $V_1$ with the interaction of $W_1$ which shown similarity with the interactions of $V_1W_3$, $V_1W_2$, $V_1W_4$, $V_1W_5$, $V_1W_6$ and $V_2W_1$.

### 4.2.5 Weight of 1000-seed (g)

#### 4.2.5.1 Effect of variety

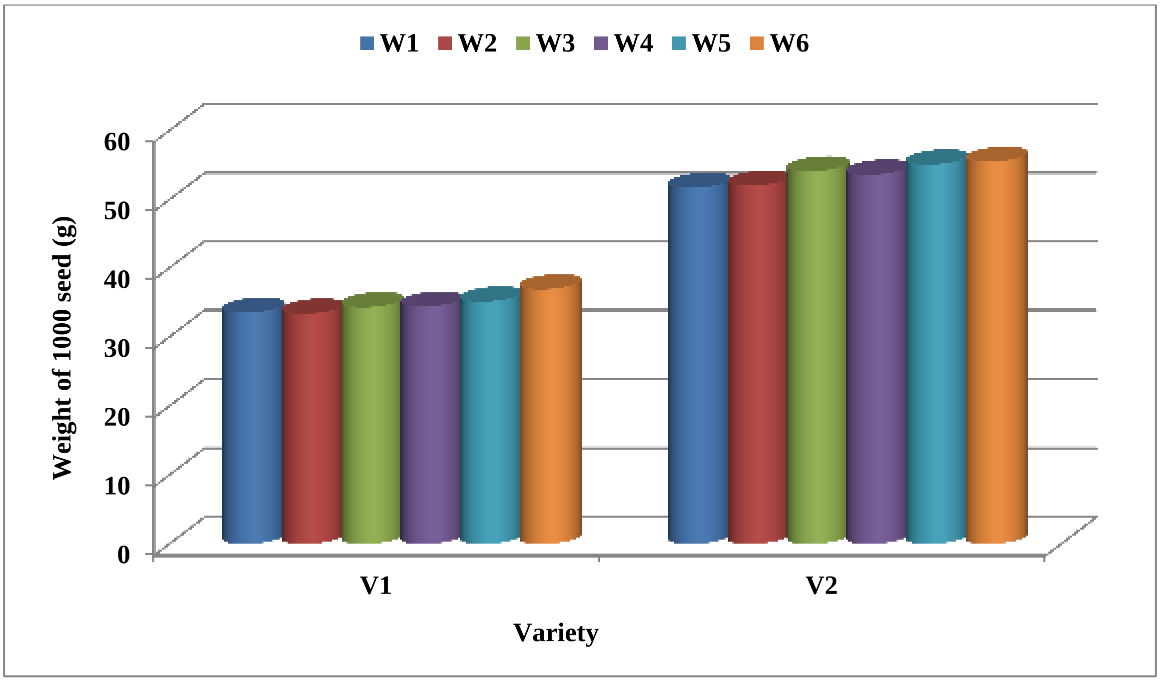
The weight of 1000-seed was significantly influenced by the variety (Appendix VIII and Table 7). The higher weight of 1000-seed (53.68 g) was obtained from BARI Mung-6 ($V_2$) and the lower weight of 1000-seed (34.62 g) was obtained from BARI Mung-4 ($V_1$). The variation in 1000-seed weight between two varieties might be due to genetic constituents of the crop. The result of the present investigation was similar with the studies conducted by Thakuria and Shaharia (1990); Trung and Yoshida (1983); Sarkar and Banik (1991); Sardana and Verma (1987); Raj and Tripathi (2005); Katial and Shah (1998); Ghosh (2007). They opined that 1000-seed weight was differed significantly among the mungbean varieties.

#### 4.2.5.2 Effect of weed free periods

Statistically significant variation was observed on the weight of 1000-seed due to different weed free periods (Appendix VIII and Table 7). The highest weight of 1000-seed (46.21 g) was recorded from the $W_6$ treatment which was statistically similar with $W_5$ and the lowest weight of 1000-seed (42.63 g) from the $W_1$ which was statistically similar with $W_2$. Muhammad *et al*. (2004) reported that weeding at 10 and 35 days after sowing significantly affected 1000 grain weight.

#### 4.2.5.3 Interaction effect of variety and weed free periods

Interaction effect between variety and weed free periods was found significant in respect of weight of 1000-seed (Appendix VIII and Figure 16). The highest weight of 1000-seed (55.49 g) was obtained from the $V_2W_6$ interaction which shown similarity with the interactions of $V_2W_5$ & $V_2W_3$. The lowest weight of 1000-seed (33.38 g) was obtained from the $V_1W_2$ which was similar with the interactions of $V_1W_1$, $V_1W_3$ & $V_1W_4$. The result was in conformity with the findings of Saha *et al.* (2002) who reported that irrespective of cultivars, seed growth was better in Kharif-1 than in Kharif-2 season due to more sunny hours prevailed during the reproductive phases as well as low rainfall in the Kharif-1 season. Lassim *et al*. (1984) also observed that field weathering caused reduction in seed yield and quality.




$V_1$ = BARI Mung-4 and $V_2$ = BARI Mung-6

$W_1$ = No weeding; $W_4$ = 35 days weed free period;
$W_2$ = 15 days weed free period; $W_5$ = 45 days weed free period and
$W_3$ = 25 days weed free period; $W_6$ = Total weed free period

**Figure 16. Interaction effect of variety and weed free periods on the weight of 1000-seed of mungbean.**

### 4.2.6 Pod yield

### 4.2.6.1 Effect of variety

The pod yield was insignificantly influenced by the variety (Appendix IX and Table 8). The maximum pod yield (2.73 t $ha^{-1}$) was obtained from the BARI Mung-6 ($V_2$) compared to the yield (2.22 t $ha^{-1}$) of BARI Mung-4 ($V_1$).

### 4.2.6.2 Effect of weed free periods

The weed free periods had significant effect on pod yield (Appendix IX and Table 8). The $W_6$ produced significantly the highest pod yield (2.86 t $ha^{-1}$) which was similar with $W_5$ and the lowest pod yield (1.70 t $ha^{-1}$) was obtained from the $W_1$ treatment.

**Table 8. Effect of variety and different weed free periods on the yield and other contributing characters of mungbean after harvest**

| Treatments | Pod yield (t $ha^{-1}$) | Seed yield (t $ha^{-1}$) | Stover yield (t $ha^{-1}$) | Biological yield (t $ha^{-1}$) | Harvest index (%) |
|---|---|---|---|---|---|
| **Variety** | | | | | |
| **$V_1$** | 2.22 | 1.35 b | 5.27 a | 7.24 a | 21.43 b |
| **$V_2$** | 2.73 | 1.73 a | 2.65 b | 4.38 b | 42.07 a |
| **$LSD_{(0.05)}$** | **NS** | **0.07** | **0.26** | **0.24** | **1.74** |
| **Weed free periods** | | | | | |
| **$W_1$** | 1.70 e | 1.07 c | 1.99 e | 3.62 e | 25.51 d |
| **$W_2$** | 2.28 d | 1.47 b | 3.64 d | 5.11 d | 29.96 c |
| **$W_3$** | 2.54 c | 1.58 b | 4.07 cd | 6.08 c | 28.83 c |
| **$W_4$** | 2.69 bc | 1.57 b | 4.49 bc | 6.46 bc | 31.39 bc |
| **$W_5$** | 2.76 ab | 1.73 a | 4.58 ab | 6.68 ab | 34.04 b |
| **$W_6$** | 2.86 a | 1.81 a | 4.98 a | 6.92 a | 40.77 a |
| **$LSD_{(0.05)}$** | **0.16** | **0.12** | **0.45** | **0.41** | **3.01** |
| **CV (%)** | **5.39** | **6.69** | **9.53** | **5.87** | **7.91** |

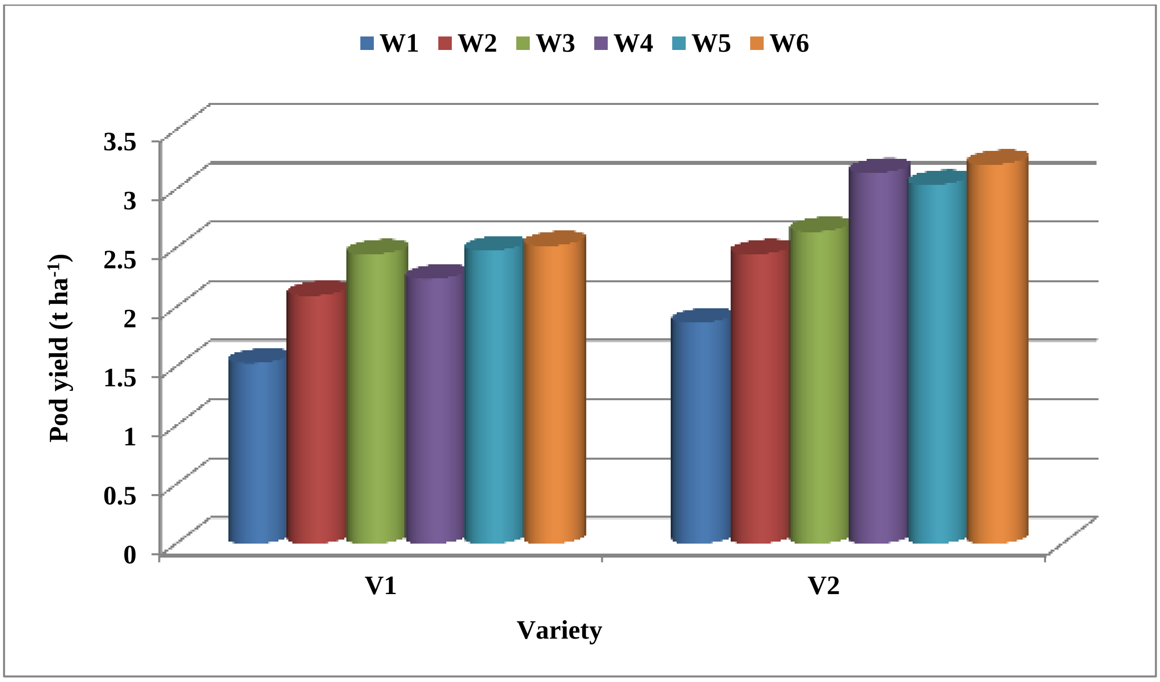
In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

$V_1$ = BARI Mung-4 and $V_2$ = BARI Mung-6

$W_1$ = No weeding; $W_4$ = 35 days weed free period;
$W_2$ = 15 days weed free period; $W_5$ = 45 days weed free period and
$W_3$ = 25 days weed free period; $W_6$ = Total weed free period

### 4.2.6.3 Interaction effect of variety and weed free periods

Interaction effect between variety and weed free periods was found significant in respect of pod yield (Appendix IX and Figure 17). The highest pod yield (3.21 t $ha^{-1}$) was obtained from the $V_2W_6$ interaction which was similar with the interactions of $V_2W_4$ & $V_2W_5$. The lowest pod yield (1.53 t $ha^{-1}$) was obtained from the $V_1W_1$ interaction.




$V_1$ = BARI Mung-4 and $V_2$ = BARI Mung-6

$W_1$ = No weeding; $W_4$ = 35 days weed free period;
$W_2$ = 15 days weed free period; $W_5$ = 45 days weed free period and
$W_3$ = 25 days weed free period; $W_6$ = Total weed free period

**Figure 17. Interaction effect of variety and weed free periods on the pod yield of mungbean.**

## 4.2.7 Seed yield

### 4.2.7.1 Effect of variety

The seed yield of mungbean was significantly influenced by the variety (Appendix IX and Table 8). The maximum seed yield (1.73 t $ha^{-1}$) was obtained from BARI Mung-6 which was higher than BARI Mung-4 (1.35 t $ha^{-1}$). The higher seed yield in BARI

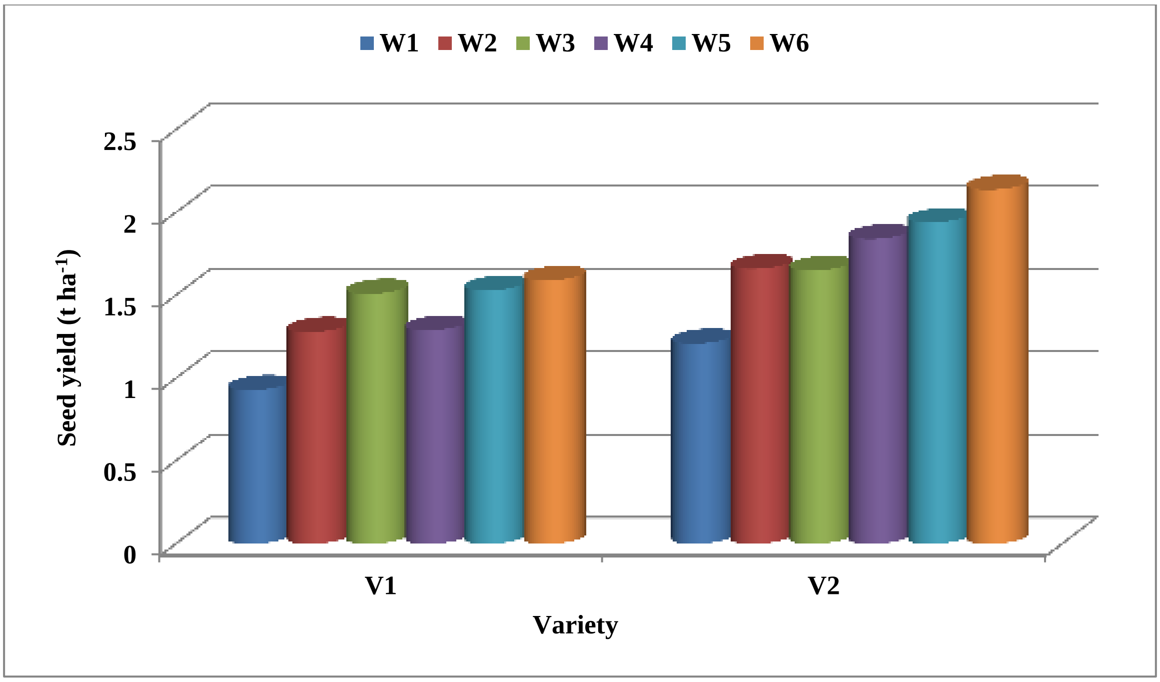
Mung-6 might be due to the contribution of higher pod length, more number of seeds pod$^{-1}$ and individual seed weight. The finding was in agreement with BARI (1982), ICRISAT (1991) and Singh and Singh (1988) who reported that cultivars played a key role in increasing yield. These results also have agreement with the reports of Ashraf and Warrick (2003); Prasad and Ram (1982); Thakuria and Shaharia (1990). They noted that different varieties of mungbean differed significantly in case of seed yield. Pahlwan and Hossain (1983) reported that the highest yield from the variety Mubarik was attributed to the highest number of pods plant$^{-1}$ and seeds plant$^{-1}$. Quaderi *et al.* (2006) reported that mungbean varieties, Binamoog-5 performed better than that of Binamoog-4 in context of yield. Tickoo *et al.* (2006) recorded that the cultivar Pusa Vishal recorded higher grain yield (1.63 t ha$^{-1}$) compared to cv. Pusa 105. Bhati *et al*. (2005) showed that K-851 gave better yield than Asha and the local cultivar.

### 4.2.7.2 Effect of weed free periods

The weed free periods had significant effect on the seed yield (Appendix IX and Table 8). The $W_6$ produced significantly the highest seed yield (1.81 t ha$^{-1}$) which was similar with $W_5$ and the lowest seed yield (1.07 t ha$^{-1}$) was obtained from the $W_1$ treatment. Yield losses due to uncontrolled weed growth in mungbean ranged from 27 to 100% (AVRDC, 1976). Muhammad *et al*. (2004) reported that weeding at 10 and 35 days after sowing significantly affected grain yield. Sarker and Mondal (1993) reported that seed yield was reduced by 49 to 55% when weeds were not removed at all. Mungbean should be kept weed free during the first 45 days of sowing to increase yield was reported by Jha *et al.* (1997). The highest seed yield (1762 kg ha$^{-1}$) of mungbean was obtained in plots of 33 plants m$^{-2}$ that was weeded at emergence and the lowest yield (1137 kg ha$^{-1}$) in plots of 50 plants m$^{-2}$ that remained unweeded was reported by Talukder *et al*. (1993). He also opined that the critical period of weed control appeared to be between 7 and 14 DAE. Unrestricted growth of weeds reduced mungbean seed yield by 30% to 33%.

#### 4.2.7.3 Interaction effect of variety and weed free periods

Interaction effect between variety and weed free periods was found significant in respect of seed yield (Appendix IX and Figure 18). The highest seed yield (2.04 t/ha) was obtained from the $V_2W_6$ interaction which was similar with the interaction of $V_2W_5$ and the lowest seed yield (0.93 t $ha^{-1}$) was obtained from the $V_1W_1$ interaction.




$V_1$ = BARI Mung-4 and $V_2$ = BARI Mung-6

| | |
|---|---|
| $W_1$ = No weeding; | $W_4$ = 35 days weed free period; |
| $W_2$ = 15 days weed free period; | $W_5$ = 45 days weed free period and |
| $W_3$ = 25 days weed free period; | $W_6$ = Total weed free period |

**Figure 18. Interaction effect of variety and weed free periods on the seed yield of mungbean.**

### 4.2.8 Stover yield

#### 4.2.8.1 Effect of variety

Statistically significant variation was recorded for stover yield by the variety (Appendix IX and Table 8). The higher stover yield (5.27 t $ha^{-1}$) was recorded from BARI Mung-4 ($V_1$) and the lower stover yield (2.65 t $ha^{-1}$) from BARI Mung-6 ($V_2$).

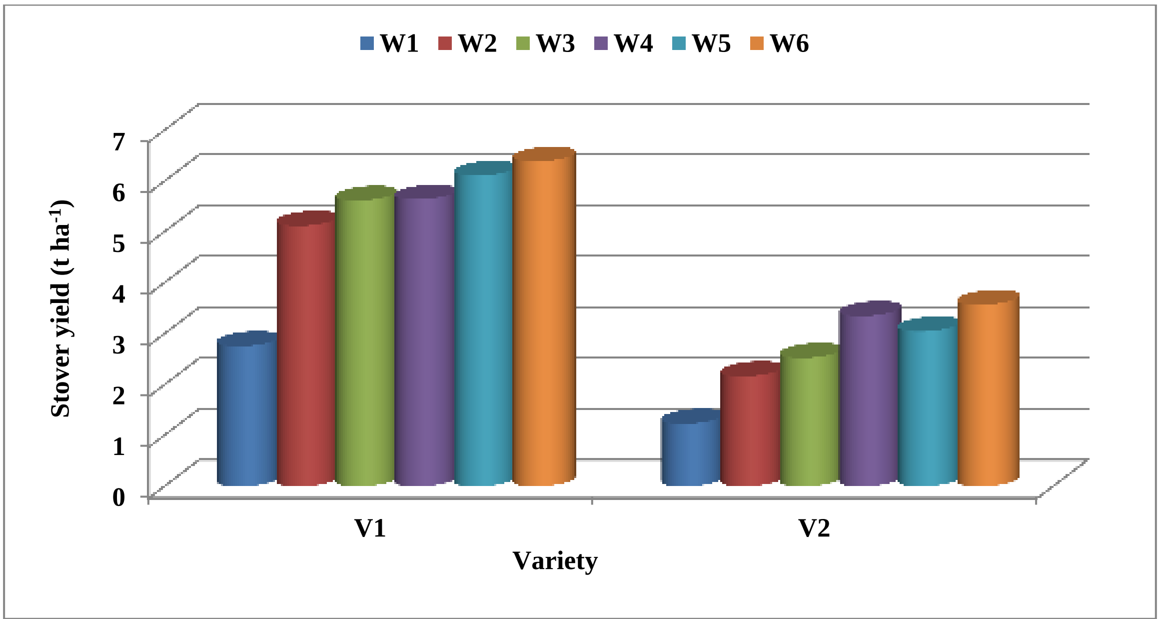
Bhati *et al*. (2005) reported that mungbean cv. PDM-54 showed 13.7% higher fodder yield than the local cultivar.

### 4.2.8.2 Effect of weed free periods

The different weed free periods had significant effect on stover yield (Appendix IX and Table 8). The $W_6$ produced significantly the highest stover yield (4.98 t $ha^{-1}$) which was similar to $W_5$ and the lowest stover yield (1.99 t $ha^{-1}$) was obtained from the $W_1$ treatment.

### 4.2.8.3 Interaction effect of variety and weed free periods

Interaction effect between variety and weed free periods was found significant in respect of stover yield (Appendix IX and Figure 19). The highest stover yield (6.39 t $ha^{-1}$) was obtained from the $V_1W_6$ interaction which was similar to the interaction of $V_1W_5$.




$V_1$ = BARI Mung-4 and $V_2$ = BARI Mung-6

$W_1$ = No weeding; $W_4$ = 35 days weed free period;
$W_2$ = 15 days weed free period; $W_5$ = 45 days weed free period and
$W_3$ = 25 days weed free period; $W_6$ = Total weed free period

**Figure 19. Interaction effect of variety and weed free periods on the stover yield of mungbean.**

The lowest stover yield (1.23 t $ha^{-1}$) was obtained from the $V_2W_1$ interaction which was similar to the interactions of $V_2W_2$, $V_2W_3$ and $V_1W_1$. It might be due to the highest number of leaves $plant^{-1}$, taller plants, higher no. of branches $plant^{-1}$ and higher number of pods $plant^{-1}$ that contributed to the highest stover yield.

### 4.2.9 Biological yield

#### 4.2.9.1 Effect of variety

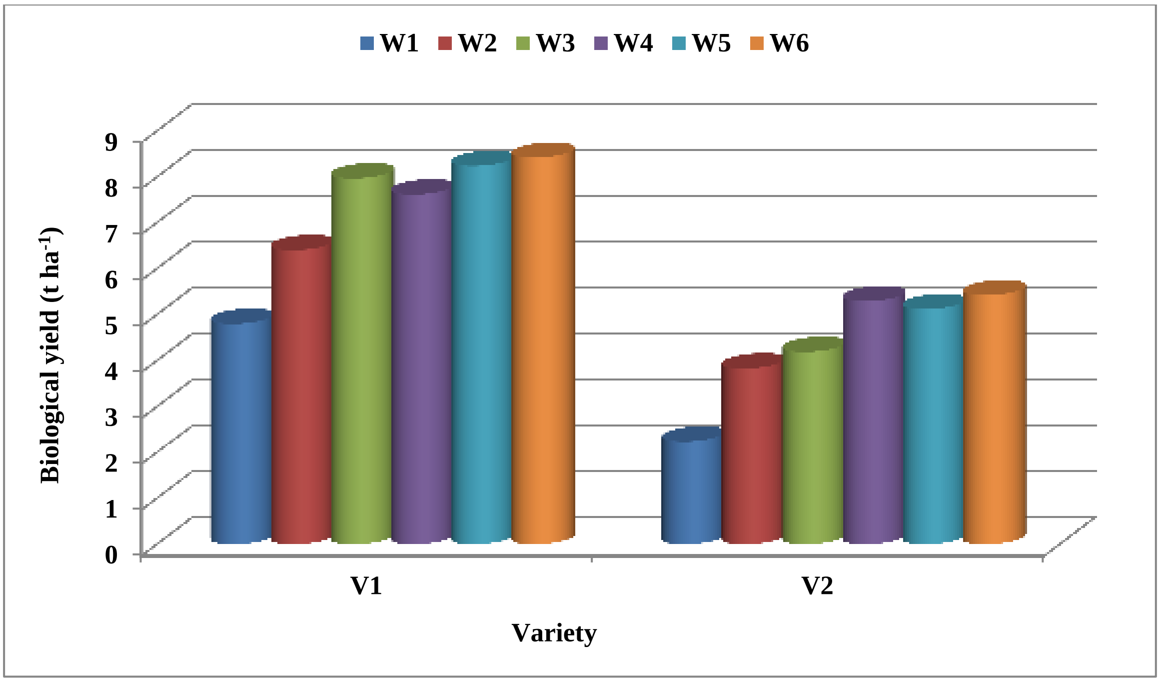
The biological yield of mungbean was significantly influenced by the variety (Appendix IX and Table 8). The higher biological yield (7.24 t $ha^{-1}$) was obtained from BARI Mung-4 ($V_1$) and the lower biological yield (4.38 t $ha^{-1}$) was obtained from BARI Mung-6 ($V_2$). The higher biological yield in BARI Mung-4 might be due to the contribution of more number of pods $plant^{-1}$ and higher stover yield.

#### 4.2.9.2 Effect of weed free periods

The weed free periods had significant effect on biological yield (Appendix IX and Table 8). The $W_6$ produced significantly the highest biological yield (6.92 t $ha^{-1}$) which was similar to the $W_5$ treatment and the lowest biological yield (3.62 t $ha^{-1}$) was obtained from the $W_1$ treatment.

#### 4.2.9.3 Interaction effect of variety and weed free periods

Interaction effect between variety and weed free periods was found significant in respect of biological yield (Appendix IX and Figure 20). The highest biological yield (8.42 t $ha^{-1}$) was obtained from the $V_1W_6$ interaction which was similar to the interactions of $V_1W_5$ & $V_1W_3$ and the lowest biological yield (2.44 t $ha^{-1}$) was obtained from the $V_2W_1$ interaction.




$V_1$ = BARI Mung-4 and $V_2$ = BARI Mung-6

| | |
|---|---|
| $W_1$ = No weeding; | $W_4$ = 35 days weed free period; |
| $W_2$ = 15 days weed free period; | $W_5$ = 45 days weed free period and |
| $W_3$ = 25 days weed free period; | $W_6$ = Total weed free period |

**Figure 20. Interaction effect of variety and weed free periods on the biological yield of mungbean.**

### 4.2.10 Harvest index

### 4.2.10.1 Effect of variety

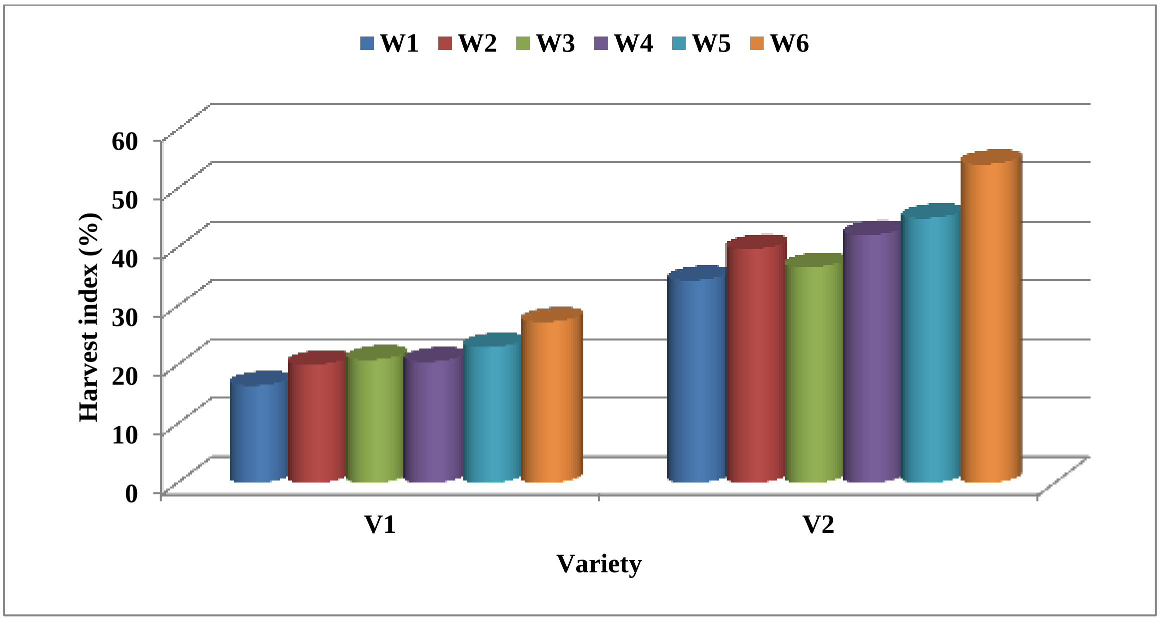
The harvest index was significantly influenced by the variety (Appendix IX and Table 8). The higher harvest index (42.07%) was found in BARI Mung-6 ($V_2$) and the lower harvest index (21.43%) was in BARI Mung-4 ($V_1$). The result was agreed with the findings of Aguliar and Villarea (1989) and Ghosh (2007) who reported that the harvest index of mungbean was significantly influenced by the variety.

### 4.2.10.2 Effect of weed free periods

The weed free periods had significant effect on harvest index (Appendix IX and Table 8). The $W_6$ produced significantly the highest harvest index (40.77%) and the lowest harvest index (25.51%) was obtained from the $W_1$ treatment.

### 4.2.10.3 Interaction effect of variety and weed free periods

Interaction effect between variety and weed free periods was found significant in respect of harvest index (Appendix IX and Figure 21). The highest harvest index (54.19%) was obtained from the $V_2W_6$ interaction and the lowest harvest index (16.54%) was obtained from the $V_1$ with the interaction of $W_1$ which was similar to the interactions of $V_1W_2$ & $V_1W_4$.




$V_1$ = BARI Mung-4 and $V_2$ = BARI Mung-6

$W_1$ = No weeding; $W_4$ = 35 days weed free period;
$W_2$ = 15 days weed free period; $W_5$ = 45 days weed free period and
$W_3$ = 25 days weed free period; $W_6$ = Total weed free period

**Figure 21. Interaction effect of variety and weed free periods on the harvest index of mungbean.**

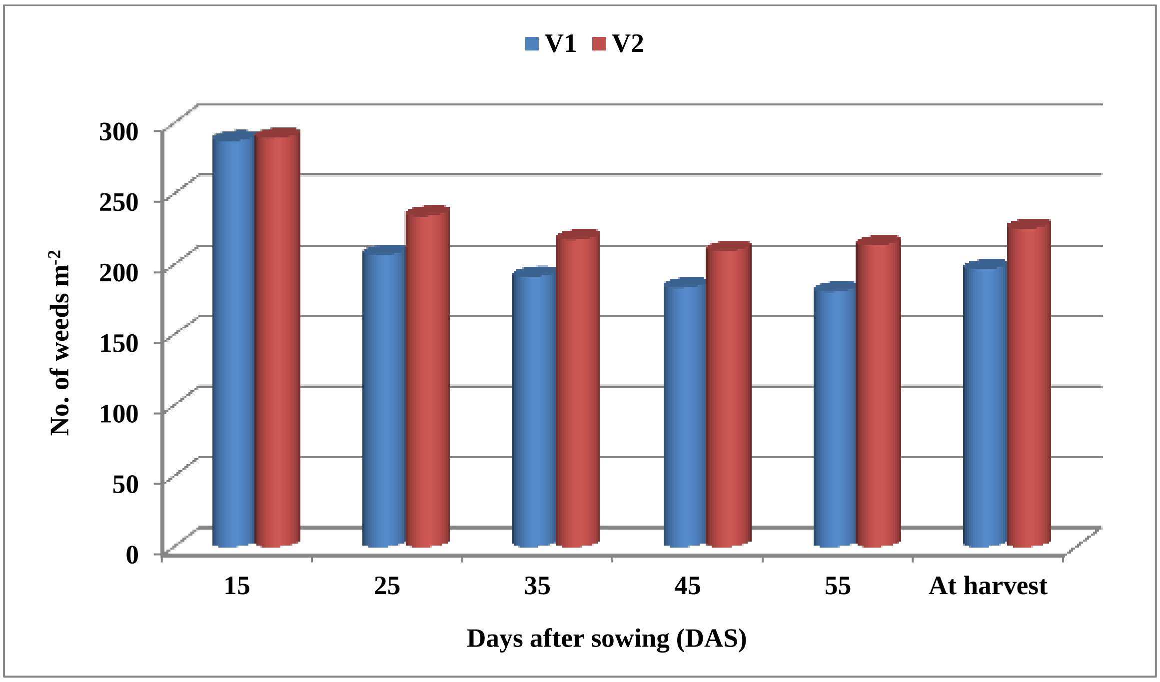
## 4.3 Weed characters

### 4.3.1 Number of weeds $m^{-2}$

### 4.3.1.1 Effect of variety

The number of weeds $m^{-2}$ was significantly influenced by the variety at 25, 35, 45, 55 DAS and at harvest but was insignificant at 15 DAS (Appendix X and Figure 22).

The higher number of weeds m$^{-2}$ (234.44, 217.72, 209.72, 213.67 and 225.33, respectively) was found in BARI Mung-6 ($V_2$) and the lower number of weeds m$^{-2}$ (206.89, 191.61, 183.83, 181.0 and 196.67, respectively) was observed in BARI Mung-4 ($V_1$) at 25, 35, 45, 55 DAS and at harvest.

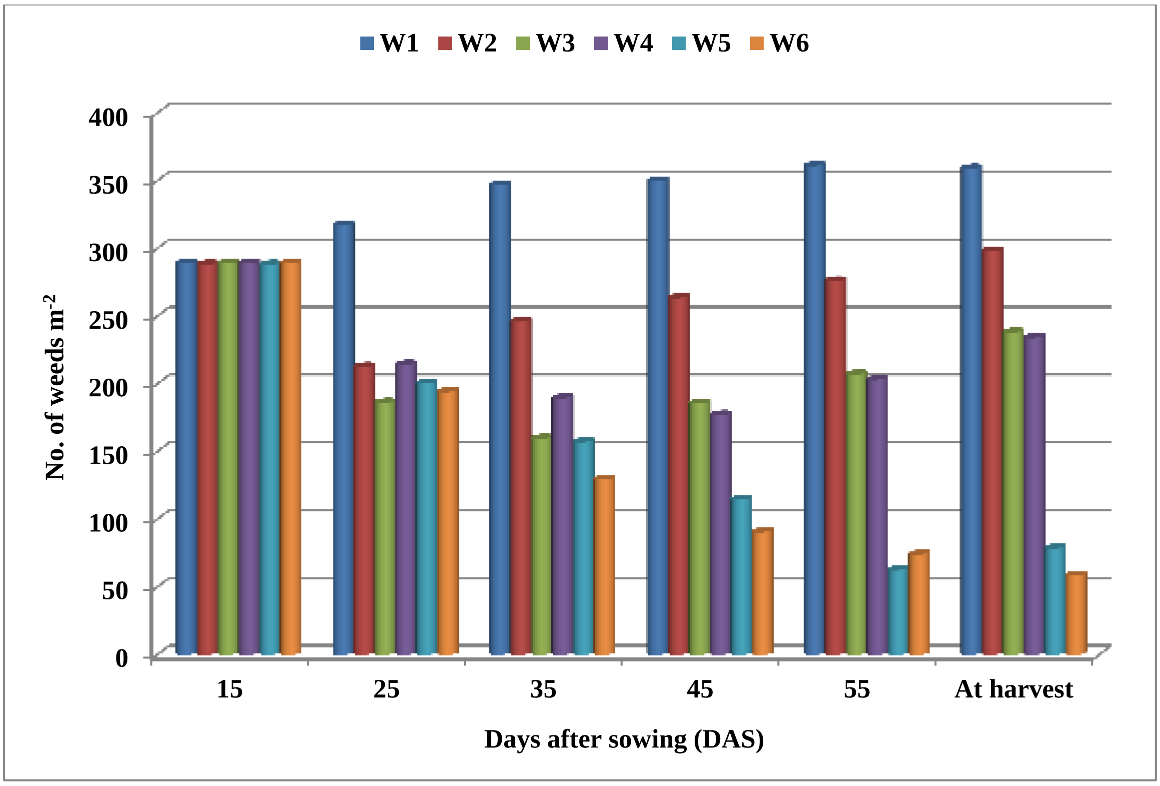



$V_1$ = BARI Mung-4 and $V_2$ = BARI Mung-6

**Figure 22. Effect of variety on the number of weeds m$^{-2}$ of mungbean at different days after sowing (LSD $_{(0.05)}$ = 16.69, 15.76, 13.07, 13.81 and 11.99 at 25, 35, 45, 55 DAS and at harvest, respectively).**

### 4.3.1.2 Effect of weed free periods

The different weed free periods had significant effect on the number of weeds m$^{-2}$ at different DAS except at 15 DAS. There was no significant variation observed on the number of weeds m$^{-2}$ at 15 DAS (Appendix X and Figure 23). The results revealed that at 25 DAS, the highest number of weeds m$^{-2}$ (317.0) was produced by $W_1$ and the lowest number of weeds m$^{-2}$ (186.0) was produced by the $W_3$ treatment which was statistically similar to $W_6$, $W_5$, $W_2$ & $W_4$. At 35 DAS, the highest total number of weeds m$^{-2}$ (346.67) was produced by the $W_1$ treatment and the lowest number of weeds m$^{-2}$ (129.50) was produced by the $W_6$ treatment. At 45 DAS, the highest number of weeds m$^{-2}$ (349.67) was produced by $W_1$ while the lowest number of weeds m$^{-2}$ (90.50) was produced by the $W_6$ treatment. At 55 DAS, the highest total number of weeds m$^{-2}$ (361.0) was produced by the $W_1$ treatment and the lowest number of weeds m$^{-2}$ (62.50) was produced by $W_5$ treatment which shown similarity to $W_6$. At harvest, the highest total number of weeds m$^{-2}$ (359.0) was produced by the $W_1$ treatment and the lowest number of weeds m$^{-2}$ (58.50) was produced by $W_6$ which was statistically similar to $W_5$ treatment.




$W_1$ = No weeding; $W_4$ = 35 days weed free period;

$W_2$ = 15 days weed free period; $W_5$ = 45 days weed free period and

$W_3$ = 25 days weed free period; $W_6$ = Total weed free period

**Figure 23. Effect of different weed free periods on the number of weeds m$^{-2}$ of mungbean at different days after sowing (LSD$_{(0.05)}$ = 28.90, 27.30, 22.64, 23.91 and 20.77 at 25, 35, 45, 55 DAS and at harvest, respectively).**

### 4.3.1.3 Interaction effect of variety and weed free periods

Interaction effect between variety and weed free periods was found significant in respect of the number of weeds $m^{-2}$ at different DAS except at 15 DAS (Appendix X and Table 9).

At 25 DAS, the highest number of weeds $m^{-2}$ (332.0) was produced by the $V_2W_1$ combination which was statistically similar to the interactions of $V_2W_2$ & $V_1W_1$ and the lowest number of weeds $m^{-2}$ (119.0) was produced by the interaction of $V_1W_2$ which was statistically similar to the interaction of $V_2W_6$. At 35 DAS, the highest total number of weeds $m^{-2}$ (353.33) was produced by the $V_2W_1$ interaction which shown similarity with the combinations of $V_1W_1$ & $V_2W_2$, while the lowest number of weeds $m^{-2}$ (97.0) was produced by $V_2W_6$ which shown similarity with the combination of $V_1W_5$. At 45 DAS, the highest number of weeds $m^{-2}$ (354.0) was produced by $V_1W_1$ which was statistically similar to the combinations of $V_2W_1$ & $V_2W_2$ and the lowest number of weeds $m^{-2}$ (79.0) was produced by the $V_2W_6$ interaction which was statistically similar to $V_1W_5$ & $V_1W_6$ interactions. At 55 DAS, the highest total number of weeds $m^{-2}$ (370.0) was produced by $V_2W_1$ which was statistically similar to the interactions of $V_1W_1$ & $V_2W_2$ while the lowest number of weeds $m^{-2}$ (34.0) was produced by $V_1W_5$ which shown similarity to the interaction of $V_2W_6$. At harvest, the highest total number of weeds $m^{-2}$ (368.0) was produced by $V_2W_1$ which was statistically similar to the interactions of $V_2W_2$ & $V_1W_1$ while the lowest number of weeds $m^{-2}$ (48.0)was produced by $V_1W_5$ which shown similarity to the interactions of $V_2W_6$ & $V_1W_6$.

**Table 9. Interaction effect of variety and weed free periods on the number of weeds m$^{-2}$ of mungbean**

| Treatment combinations | Number of weeds (m$^{-2}$) at | | | | | |
|---|---|---|---|---|---|---|
| | 15 DAS | 25 DAS | 35 DAS | 45 DAS | 55 DAS | harvest |
| $V_1W_1$ | 282.0 c | 302.0 a | 340.0 a | 354.0 a | 352.0 a | 350.0 a |
| $V_1W_2$ | 162.0 e | 119.0 e | 156.0 cd | 183.0 b | 207.0 b | 242.0 b |
| $V_1W_3$ | 366.0 b | 192.0 b-d | 161.0 b-d | 187.0 b | 204.0 b | 236.0 b |
| $V_1W_4$ | 351.0 b | 224.67 b | 197.67 b | 185.0 b | 208.0 b | 239.0 b |
| $V_1W_5$ | 223.0 d | 171.67 cd | 133.0 de | 92.0 d | 34.0 d | 48.0 d |
| $V_1W_6$ | 342.0 b | 232.0 b | 162.0 b-d | 102.0 d | 81.0 c | 65.0 d |
| $V_2W_1$ | 296.0 c | 332.0 a | 353.33 a | 345.33 a | 370.0 a | 368.0 a |
| $V_2W_2$ | 414.33 a | 306.0 a | 336.0 a | 344.0 a | 346.0 a | 354.0 a |
| $V_2W_3$ | 212.0 d | 180.0 cd | 158.0 cd | 184.0 b | 210.0 b | 340.0 b |
| $V_2W_4$ | 227.0 d | 224.67 b | 181.0 bc | 169.0 bc | 198.0 b | 229.0 b |
| $V_2W_5$ | 353.0 b | 229.0 b | 181.0 bc | 137.0 c | 91.0 c | 109.0 c |
| $V_2W_6$ | 236.0 d | 156.0 de | 97.0 e | 79.0 d | 67.0 cd | 52.0 d |
| **LSD $_{(0.05)}$** | **35.20** | **40.87** | **38.61** | **32.01** | **33.82** | **29.37** |
| **CV (%)** | **7.99** | **10.94** | **11.14** | **9.61** | **10.12** | **8.22** |

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

$V_1$ = BARI Mung-4 and $V_2$ = BARI Mung-6

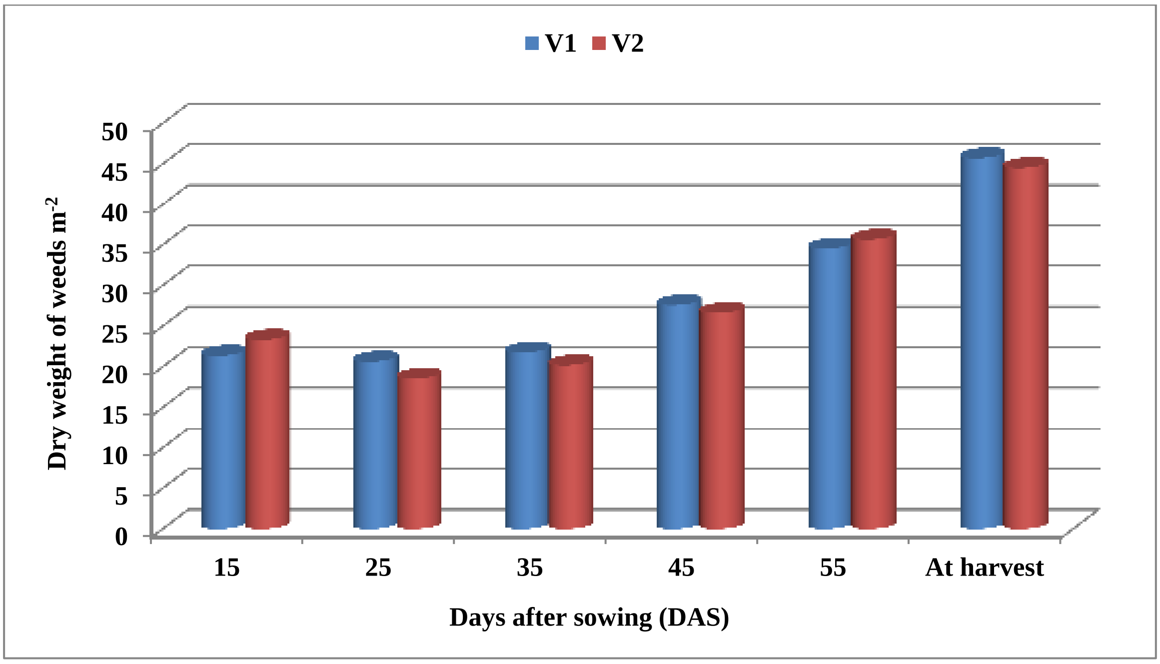
$W_1$ = No weeding; $W_4$ = 35 days weed free period;
$W_2$ = 15 days weed free period; $W_5$ = 45 days weed free period and
$W_3$ = 25 days weed free period; $W_6$ = Total weed free period

### 4.3.2 Dry weight of weeds m$^{-2}$

### 4.3.2.1 Effect of variety

The dry weight of weeds m$^{-2}$ was not significantly influenced by the variety at different days after sowing (Appendix XI and Figure 24).

The higher dry weight of weeds $m^{-2}$ (20.64 g, 21.75 g, 27.58 g and 45.72 g at 25, 35, 45 DAS and at harvest, respectively) was found in BARI Mung-4 ($V_1$) and the lower dry weight of weeds $m^{-2}$ (18.55 g, 20.19 g, 26.62 g and 44.51 g at 25, 35, 45 DAS and at harvest, respectively) was observed in BARI Mung-6 ($V_2$). But the higher dry weight of weeds $m^{-2}$ (23.32 g and 35.65 g at 15 and 55 DAS, respectively) was found in BARI Mung-6 ($V_2$) and the lower dry weight of weeds $m^{-2}$ (21.37 g and 34.54 g at 15 and 55 DAS, respectively) was observed in BARI Mung-4 ($V_1$) though all the results were statistically similar.



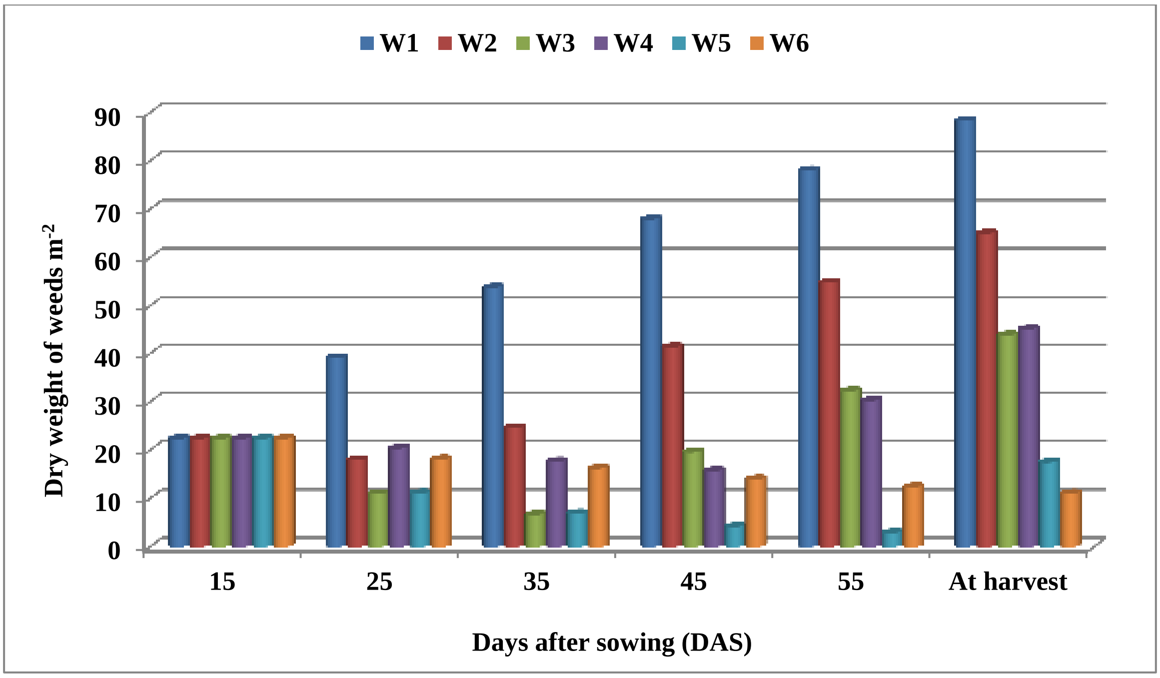

$V_1$ = BARI Mung-4 and $V_2$ = BARI Mung-6

**Figure 24. Effect of variety on the dry weight of weeds $m^{-2}$ of mungbean at different days after sowing.**

### 4.3.2.2 Effect of weed free periods

The different weed free periods had significant effect on the dry weight of weeds $m^{-2}$ at different DAS except at 15 DAS. There was no significant variation observed on the number of weeds $m^{-2}$ at 15 DAS (Appendix XI and Figure 25). The results revealed that at 25 DAS, the highest dry weight of weeds $m^{-2}$ (39.10 g) was produced by $W_1$ and the lowest dry weight of weeds $m^{-2}$ (10.97 g) was produced by the $W_3$

treatment which was statistically similar to $W_5$ treatment. At 35 DAS, the highest dry weight of weeds $m^{-2}$ (53.76 g) was produced by $W_1$ treatment and the lowest dry weight of weeds $m^{-2}$ (6.62 g) was produced by $W_3$ which shown similarity to the $W_5$ treatment. At 45 DAS, the highest dry weight of weeds $m^{-2}$ (67.89 g) was produced by $W_1$ while the lowest dry weight of weeds $m^{-2}$ (4.14 g) was produced by the $W_5$ treatment. At 55 DAS, the highest dry weight of weeds $m^{-2}$ (78.04 g) was produced by $W_1$ treatment and the lowest dry weight of weeds $m^{-2}$ (2.87 g) was produced by the $W_5$ treatment. At harvest, the highest dry weight of weeds $m^{-2}$ (88.30 g) was produced by $W_1$ treatment and the lowest dry weight of weeds $m^{-2}$ (11.03 g) was produced by the $W_6$ treatment. Das and Yaduraju (1996) observed that the weed growth rate (WGR) increased up to 35 DAS in mungbean which was assumed to be the most critical period of weed competition.




$W_1$ = No weeding; $W_4$ = 35 days weed free period;

$W_2$ = 15 days weed free period; $W_5$ = 45 days weed free period and

$W_3$ = 25 days weed free period; $W_6$ = Total weed free period

**Figure 25. Effect of different weed free periods on the dry weight of weeds $m^{-2}$ of mungbean at different days after sowing ($LSD_{(0.05)}$ = 5.22, 4.56, 3.39, 4.25 and 5.54 at 25, 35, 45, 55 DAS and at harvest, respectively).**

### 4.3.2.3 Interaction effect of variety and weed free periods

Interaction effect between variety and weed free periods was found significant in respect of the dry weight of weeds $m^{-2}$ at different DAS except at 15 DAS (Appendix XI and Table 10).

At 25 DAS, the highest dry weight of weeds $m^{-2}$ (49.65 g) was produced by the $V_1W_1$ combination and the lowest (8.47 g) was produced by the interaction of $V_1W_3$ which was statistically identical to the interactions of $V_2W_5$, $V_1W_5$, $V_2W_3$ & $V_1W_2$. At 35 DAS, the highest dry weight of weeds $m^{-2}$ (61.55 g) was produced by the $V_1W_1$ interaction and the lowest (6.28 g) was produced by $V_2W_5$ which shown similarity with the combinations of $V_2W_3$, $V_1W_3$ & $V_1W_5$. At 45 DAS, the highest dry weight of weeds $m^{-2}$ (72.87 g) was produced by $V_1W_1$ interaction and the lowest dry weight of weeds $m^{-2}$ (3.86 g) was produced by the $V_2W_5$ interaction which shown similarity to $V_1W_5$ interaction. At 55 DAS, the highest dry weight of weeds $m^{-2}$ (81.01 g) was produced by $V_1W_1$ which was statistically similar to the interaction of $V_2W_1$ and the lowest (2.60 g) was produced by $V_2W_5$ which was statistically similar to the interaction of $V_1W_5$. At harvest, the highest dry weight of weeds $m^{-2}$ (94.82 g) was produced by $V_1W_1$ interaction and the lowest dry weight of weeds $m^{-2}$ (10.94 g) was produced by the $V_1W_6$ interaction which was statistically identical to the $V_2W_6$, $V_2W_5$ & $V_1W_5$ interactions.

**Table 10. Interaction effect of variety and weed free periods on the dry weight of weeds m$^{-2}$ of mungbean**

| Treatment combinations | Dry weight of weeds (g m$^{-2}$) at | | | | | |
|---|---|---|---|---|---|---|
| | 15 DAS | 25 DAS | 35 DAS | 45 DAS | 55 DAS | harvest |
| $V_1W_1$ | 26.45 a | 49.65 a | 61.55 a | 72.87 a | 81.01 a | 94.81 a |
| $V_1W_2$ | 16.60 b | 14.78 c-g | 20.04 d | 39.50 c | 50.02 c | 64.28 c |
| $V_1W_3$ | 17.71 b | 8.47 g | 6.88 e | 18.99 de | 30.17 d | 41.46 d |
| $V_1W_4$ | 23.26 ab | 21.88 bc | 18.06 d | 16.14 d-f | 30.32 d | 45.18 d |
| $V_1W_5$ | 22.90 ab | 11.28 e-g | 7.52 e | 4.42 g | 3.14 f | 17.62 e |
| $V_1W_6$ | 21.30 ab | 17.80 c-f | 16.42 d | 13.58 f | 12.57 e | 10.94 e |
| $V_2W_1$ | 18.25 b | 28.55 b | 45.97 b | 62.91 b | 75.07 a | 81.79 b |
| $V_2W_2$ | 28.10 a | 21.20 bc | 29.26 c | 43.16 c | 59.58 b | 65.66 c |
| $V_2W_3$ | 26.97 a | 13.46 d-g | 6.36 e | 20.15 d | 34.31 d | 46.15 d |
| $V_2W_4$ | 21.42 ab | 18.81 cd | 17.26 d | 15.24 ef | 30.18 d | 44.98 d |
| $V_2W_5$ | 21.79 ab | 10.88 fg | 6.28 e | 3.86 g | 2.60 f | 17.34 e |
| $V_2W_6$ | 23.37 ab | 18.41 c-e | 15.98 d | 14.38 ef | 12.16 e | 11.12 e |
| **LSD $_{(0.05)}$** | **5.31** | **7.39** | **6.45** | **4.79** | **6.01** | **7.84** |
| **CV (%)** | **18.40** | **22.28** | **18.18** | **10.44** | **10.12** | **10.26** |

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

$V_1$ = BARI Mung-4 and $V_2$ = BARI Mung-6

$W_1$ = No weeding; $W_4$ = 35 days weed free period;
$W_2$ = 15 days weed free period; $W_5$ = 45 days weed free period and
$W_3$ = 25 days weed free period; $W_6$ = Total weed free period

# CHAPTER 5

# SUMMARY AND CONCLUSION

The field experiment was conducted at the Agronomy farm of Sher-e-Bangla Agricultural University (SAU), Dhaka, during the period from March 2015 to June 2015 to study the influence of weed free periods on growth and yield of mungbean in Kharif-1 season under the Modhupur Tract (AEZ-28). The experiment was comprised of two factors; Factor A: Variety (2) viz. BARI Mung-4 ($V_1$) and BARI Mung-6 ($V_2$) and Factor B: Weed Free Periods (6) viz. No weeding ($W_1$), 15 days weed free periods ($W_2$), 25 days weed free periods ($W_3$), 35 days weed free periods ($W_4$), 45 days weed free periods ($W_5$) and total weed free periods ($W_6$). The experiment was laid out in Randomized Complete Block Design (RCBD) in factorial arrangements with three replications.

The data on crop growth parameters like plant height (cm), number of leaflets plant$^{-1}$, number of nodules plant$^{-1}$, nodule dry weight (g), dry matter weight (g) plant$^{-1}$ were recorded at different days after sowing (DAS). Five plants were randomly selected from each unit plot for taking observations on plant height, number of leaflets plant$^{-1}$ and number of branches plant$^{-1}$ data with 15 days interval at 15, 30, 45 and 60 days after sowing (DAS). Yield and other crop characters like number of pods plant$^{-1}$, pod length (cm), number of seeds pod$^{-1}$, 1000-seed weight (g), pod yield (t ha$^{-1}$), seed yield (t ha$^{-1}$), stover yield (t ha$^{-1}$), biological yield (t ha$^{-1}$) and harvest index (%) were recorded after harvest. Central 3.15 m$^2$ areas from each plot were harvested for yield determination. Thousand seed weight was measured from the sampled seed. Data were analyzed using Statistix10 computer package program. The mean differences among the treatments were compared by Least Significant Difference (LSD) test at 5% level of significance.

Results showed that two varieties of mungbean had significant effect on crop growth characters except number of nodules plant$^{-1}$. The rapid increase of plant height and dry weight plant$^{-1}$ was observed from 45 to 60 days after sowing (DAS) which was higher in the $V_1$ (BARI Mung-4) compared to the $V_2$ (BARI Mung-6). The higher number of leaflets plant$^{-1}$ and the higher dry weight (g) of nodules was found from the $V_1$ (BARI

Mung-4) at all growth stages. The study also revealed that variety had significant influence on yield and other crop characters except number of branches plant$^{-1}$ and pod yield (t ha$^{-1}$). The higher number of pods plant$^{-1}$ (28.44) was obtained from $V_1$ and the lower number of pods plant$^{-1}$ (14.44) was from the $V_2$. The higher (9.10 cm) and lower (6.64 cm) pod length was obtained from the $V_2$ and $V_1$, respectively. The higher (12.05) and lower (11.0) number of seeds pod$^{-1}$ was found in the $V_2$ and $V_1$, respectively. The higher weight of 1000-seed (53.68 g) was obtained from the $V_2$ and the lower weight of 1000-seed (34.62 g) was found in the $V_1$. The $V_1$ produced higher stover yield (5.27 t ha$^{-1}$) and biological yield (7.24 t ha$^{-1}$) where the $V_2$ produced lower stover yield (2.65 t ha$^{-1}$) and biological yield (4.38 t ha$^{-1}$). The higher seed yield (1.73 t ha$^{-1}$) and higher harvest index (42.07%) was found from the $V_2$ and the lowest seed yield (1.35 t ha$^{-1}$) and lower harvest index (21.43%) was obtained from the $V_1$. Significant variations were observed in total number of weeds at different DAS except at 15 DAS in the two varieties but was insignificant on the dry weight of weeds m$^{-2}$ at different DAS. The higher number of weeds m$^{-2}$ (225.33) was found in BARI Mung-6 ($V_2$) and the lower (196.67) was observed in BARI Mung-4 ($V_1$) at harvest. The higher dry weight of weeds m$^{-2}$ (45.72 g) was found in BARI Mung-4 ($V_1$) and the lower (44.52) was observed in BARI Mung-6 ($V_2$) at harvest though all the results were statistically similar.

The findings showed that weed free periods also significantly influenced all growth and yield attributes. The results revealed that the $W_6$ i.e., total weed free period gave the highest plant height (50.70 cm) at all growth stages and the lowest one was found from the $W_1$ (46.23 cm) where no weed control measure was taken. In case of number of branches plant$^{-1}$, the $W_6$ gave the highest (4.67) and the $W_1$ gave the lowest (3.50) value. The $W_6$ produced highest number of leaflets plant$^{-1}$ (32.33) and the $W_1$ produced lowest number of leaflets plant$^{-1}$ (26.33). The highest (23.57 g) dry weight at harvest was recorded from the $W_6$ and the lowest (11.43 g) was recorded from the $W_1$ treatment. The highest nodules plant$^{-1}$ (14.67) and nodule dry wt. plant$^{-1}$ (0.017 g) at 30 DAS were recorded from the $W_6$ and the lowest (7.50) nodules plant$^{-1}$ and nodule dry wt. plant$^{-1}$ (0.014 g) were recorded from the $W_1$. The highest number of pods plant$^{-1}$ (28.17), pod length (8.17 cm), number of seeds pod$^{-1}$ (12.0), 1000-seed wt. (46.21 g), pod yield (2.86 t ha$^{-1}$), seed yield (1.81 t ha$^{-1}$), stover yield (4.98 t ha$^{-1}$) and biological yield (6.92 t ha$^{-1}$) were obtained from the $W_6$ and the lowest number of pods plant$^{-1}$ (14.17), pod length (7.71 cm), number of seeds pod$^{-1}$ (11.0), 1000-seed wt. (42.63 g), pod yield (1.70 t ha$^{-1}$), seed yield (1.07 t ha$^{-1}$), stover yield (1.99 t ha$^{-1}$) and biological yield (3.62 t ha$^{-1}$) were obtained from the $W_1$. The highest harvest index (40.77%) was found from the $W_6$ treatment and the lowest harvest index (25.51%) was from the $W_1$ treatment. The different weed free periods had significant influence on the total number of weeds and dry weight of weeds m$^{-2}$ at different DAS except at 15 DAS. The highest number of weeds and dry weight of weeds m$^{-2}$ (359.0 and 88.30 g) was observed in the $W_1$ treatment and the lowest (58.50 and 11.03 g) was in the $W_6$ treatment at harvest.

Interaction effect of variety and weed free periods also significantly affected growth as well as yield and yield contributing characters. The tallest plant (54.67 cm) was found in the combination of $V_1W_6$ at 60 DAS and the shortest plant (42.33 cm) was found in the $V_2W_1$ interaction. The highest (0.033 g) dry weight of nodules and highest number of nodules plant$^{-1}$ (7.00) at 60 DAS was recorded from the combination of $V_1W_6$ and the lowest (0.008 g) dry weight of nodules and lowest number (3.00) of nodules plant$^{-1}$ were recorded from the $V_1W_1$ interaction. The highest number of branches plant$^{-1}$ (4.67), number of leaflets plant$^{-1}$ (34.33), pods plant$^{-1}$ (38.67), stover yield (6.39 t ha$^{-1}$) and biological yield (8.42 t ha$^{-1}$) were obtained from the interaction of $V_1W_6$ at harvest and the lowest number of branches plant$^{-1}$ (3.33), number of leaflets plant$^{-1}$ (24.67), pods plant$^{-1}$ (11.0), stover yield (1.23 t ha$^{-1}$) and biological yield (2.44 t ha$^{-1}$) were obtained from the interaction of $V_2W_1$ at harvest. The highest pod length (9.29 cm), seeds pod$^{-1}$(12.33), 1000-seed wt. (55.49 g), pod yield (3.21 t ha$^{-1}$), seed yield (2.04 t ha$^{-1}$) and harvest index (54.19%) were obtained from the interaction of $V_2W_6$ at harvest whereas the lowest pod length (6.48 cm), seeds pod$^{-1}$ (10.67), 1000-seed wt. (33.38 g), pod yield (1.53 t ha$^{-1}$), seed yield

(0.93 t $ha^{-1}$) and harvest index (16.54%) were obtained from the $V_1W_1$ interaction. Interaction effect of variety and weed free periods had significant influence on the total number of weeds and dry weight of weeds $m^{-2}$ at different DAS except at 15 DAS. The highest number of weeds $m^{-2}$ (368.0) was found in the $V_2W_1$ interaction and the lowest (48.0) was observed in the $V_1W_5$ interaction at harvest. The highest dry weight of weeds $m^{-2}$ (94.82 g) was found in the $V_1W_1$ interaction and the lowest (10.94 g) was observed in the $V_1W_6$ interaction at harvest.

Based on the results of the present study, the following conclusions may be drawn-

- The mungbean variety, BARI Mung-6 showed higher yield (1.73 t $ha^{-1}$) than BARI Mung-4 (1.35 t $ha^{-1}$).
- The total weed free period showed higher yield (1.81 t $ha^{-1}$) than the no weed free period (1.07 t $ha^{-1}$).
- Initial 35-45 days after sowing (DAS) is necessary to keep weed free for getting higher yield of mungbean.
- The highest seed yield (2.04 t $ha^{-1}$) was recorded from the interaction of BARI Mung-6 with total weed free period that was similar upto 35 days than the interaction of BARI Mung-4 with no weed free period (0.93 t $ha^{-1}$).

However, to reach a specific conclusion and recommendation, the same experiment need to be repeated and more research work should be done over different agro-ecological zones with different weed free periods and with more varieties.

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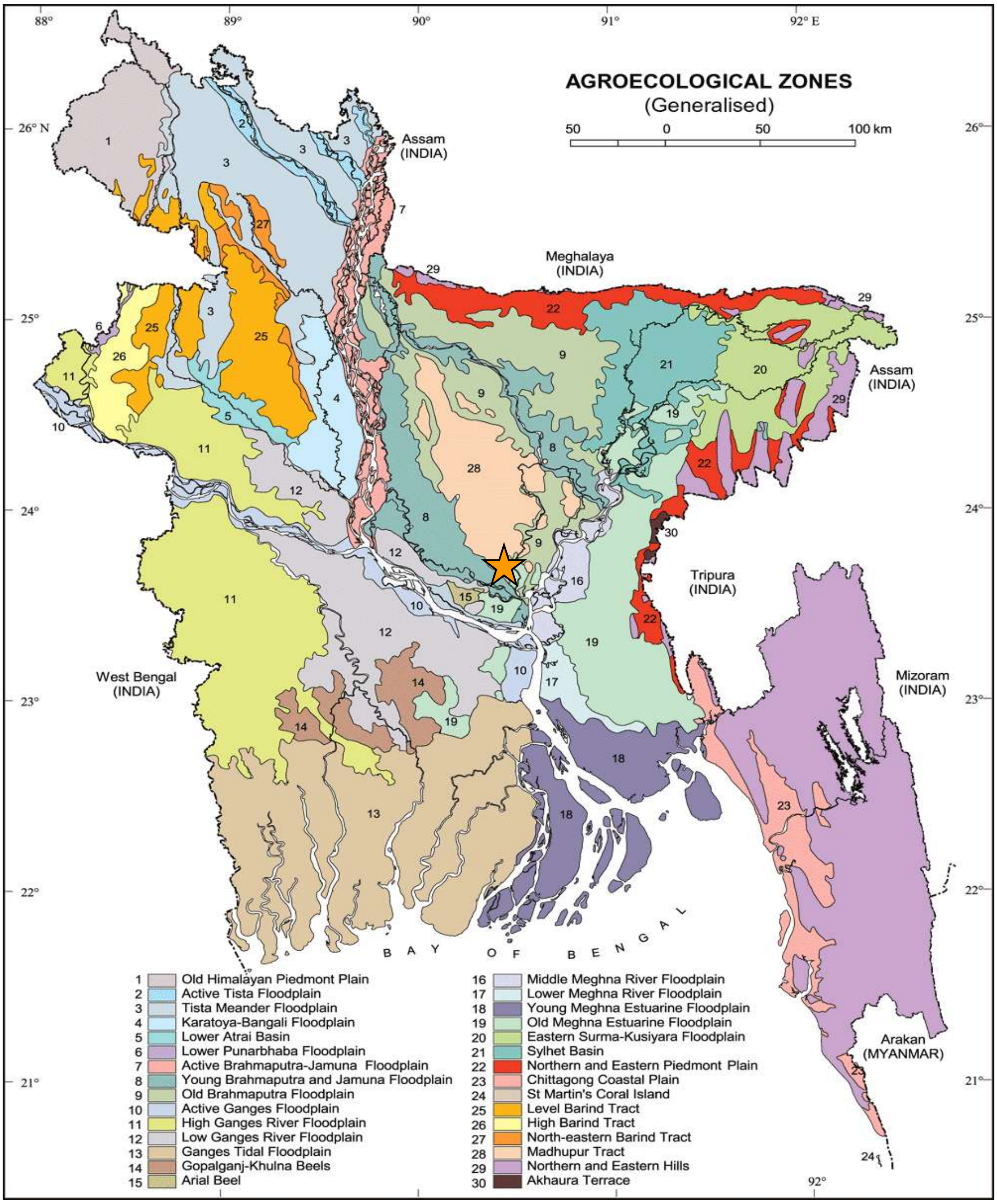
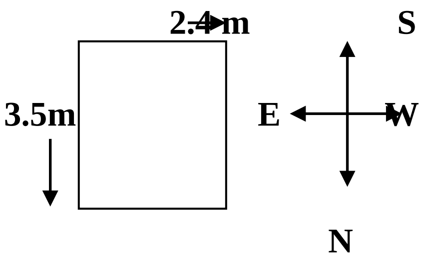
# APPENDICES

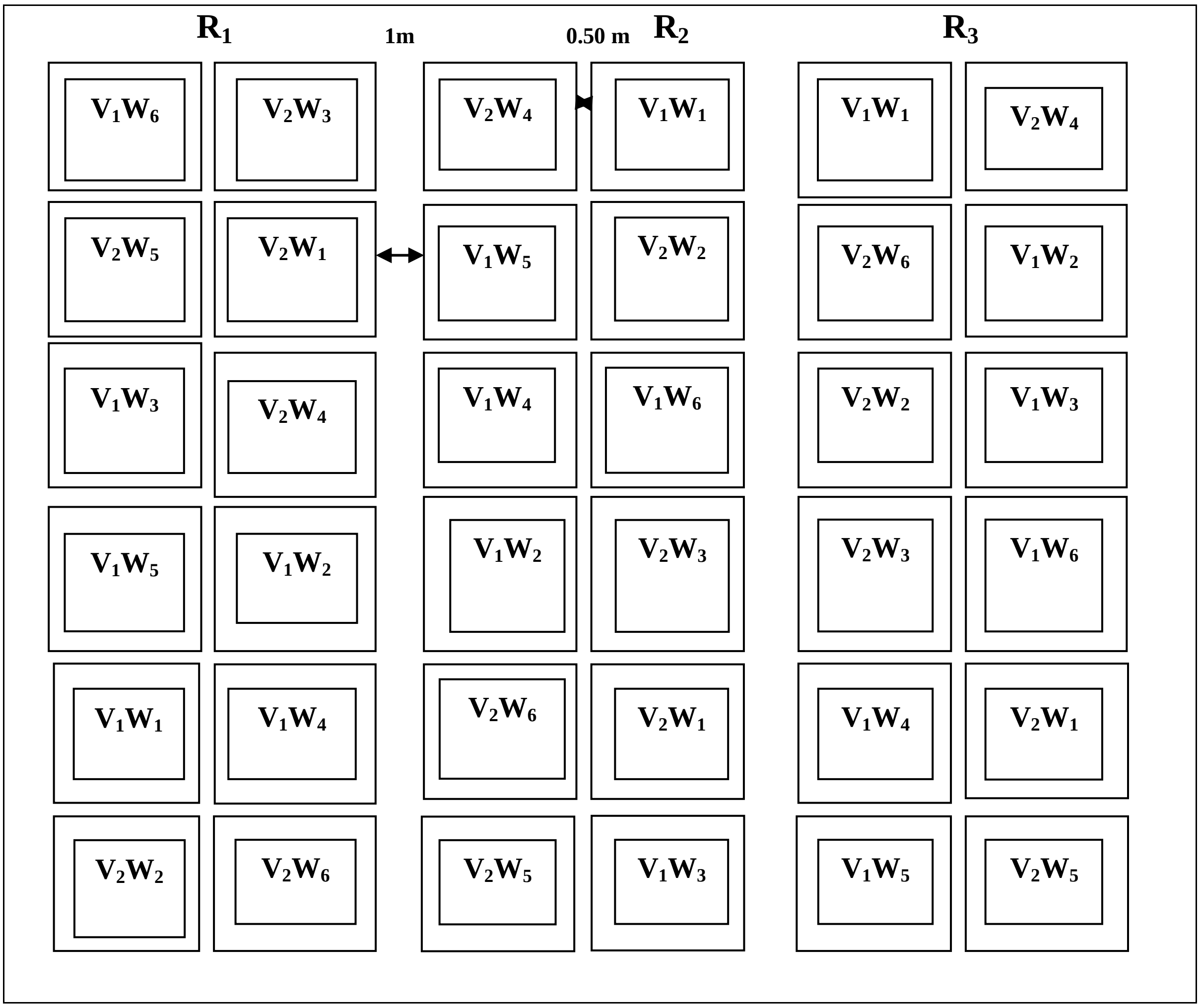
## Appendix I. Map showing the experimental sites under study




**The experimental site under study**

**Appendix II. Field layout of the experiment**



**Appendix III. Mean square values for plant height of mungbean**

| Sources of variation | Degrees of freedom | Mean square values at | | | |
|---|---|---|---|---|---|
| | | 15 DAS | 30 DAS | 45 DAS | 60 DAS |
| Replication | 2 | 6.48 | 8.44 | 8.18 | 0.44 |
| Variety (V) | 5 | 115.20* | 136.07* | 43.80* | 588.06* |
| Weeding (W) | 5 | 22.38* | 17.33* | 28.56* | 14.82* |
| V X W | 5 | 10.02* | 2.80* | 7.02* | 3.45* |
| Error | 22 | 3.86 | 1.98 | 3.73 | 0.10 |

* Significant at 5% level

$^{NS}$ Not significant

**Appendix IV. Mean square values for no. of leaflets plant$^{-1}$ of mungbean**

| Sources of variation | Degrees of freedom | Mean square values at | | | |
|---|---|---|---|---|---|
| | | 15 DAS | 30 DAS | 45 DAS | 60 DAS |
| Replication | 2 | 9.92 | 6.08 | 7.75 | 0.86 |
| Variety (V) | 1 | 0.25$^{NS}$ | 100.0* | 110.25* | 81.0* |
| Weeding (W) | 5 | 0.18$^{NS}$ | 25.0* | 26.85* | 29.18* |
| V X W | 5 | 0.05 $^{NS}$ | 0.60* | 2.18* | 0.93* |
| Error | 22 | 0.15 | 1.81 | 3.63 | 2.56 |

* Significant at 5% level

$^{NS}$ Not significant

**Appendix V. Mean square values for dry matter weight of mungbean**

| Sources of variation | Degrees of freedom | Mean square values at 15 DAS | 30 DAS | 45 DAS | 60 DAS |
|---|---|---|---|---|---|
| **Replication** | 2 | 0.0012 | 0.659 | 10.13 | 11.50 |
| **Variety (V)** | 1 | 0.0283* | 0.062$^{NS}$ | 2.04$^{NS}$ | 51.84* |
| **Weeding (W)** | 5 | 0.0063* | 6.186* | 53.13* | 94.05* |
| **V X W** | 5 | 0.0003* | 0.540* | 2.89* | 17.18* |
| **Error** | 22 | 0.0002 | 0.384 | 3.48 | 9.03 |

* Significant at 5% level

$^{NS}$ Not significant

**Appendix VI. Mean square values for nodule number and dry weight of nodules of mungbean**

| Sources of variation | Degrees of freedom | Mean square values at | | | | | |
|---|---|---|---|---|---|---|---|
| | | 30 DAS | 45 DAS | 60 DAS | 30 DAS | 45 DAS | 60 DAS |
| | | Nodule number | | | Nodule dry weight | | |
| **Replication** | 2 | 2.58 | 0.44 | 0.86 | $2.78x10^{-8}$ | $3.08x10^{-6}$ | $6.86x10^{-6}$ |
| **Variety (V)** | 1 | 0.03$^{NS}$ | 3.36 $^{NS}$ | 2.25$^{NS}$ | $8.40x10^{-5}$* | $3.25x10^{-3}$* | $4.84x10^{-4}$* |
| **Weeding (W)** | 5 | 44.92* | 49.09* | 10.43* | $2.0x10^{-4}$* | $4.02x10^{-3}$* | $2.31x10^{-4}$* |
| **V X W** | 5 | 5.36* | 13.23* | 0.78* | $8.88x10^{-5}$* | $3.89x10^{-3}$* | $5.74x10^{-5}$* |
| **Error** | 22 | 4.10 | 1.41 | 0.92 | $4.48x10^{-6}$ | $6.29x10^{-6}$ | $3.80x10^{-6}$ |

* Significant at 5% level

$^{NS}$ Not significant

**Appendix VII. Mean square values for total no. of branches plant$^{-1}$ of mungbean**

| Sources of variation | Degrees of freedom | Mean square values at | | |
|---|---|---|---|---|
| | | 30 DAS | 45 DAS | 60 DAS |
| **Replication** | 2 | 0.58 | 0.03 | 0.19 |
| **Variety (V)** | 1 | 7.11* | 1.0$^{NS}$ | 0.03$^{NS}$ |
| **Weeding (W)** | 5 | 0.80* | 1.11* | 1.16* |
| **V X W** | 5 | 0.18* | 0.13* | 0.23* |
| **Error** | 22 | 0.22 | 0.24 | 0.26 |

* Significant at 5% level

$^{NS}$ Not significant

**Appendix VIII. Mean square values for yield and other crop characters of mungbean at harvest**

| Source of variation | Degrees of freedom | Mean square values at harvest | | | |
|---|---|---|---|---|---|
| | | Pod plant$^{-1}$ | Pod length | Seeds pod$^{-1}$ | 1000-seed weight |
| **Replication** | 2 | 2.03 | 0.002 | 0.53 | 0.79 |
| **Variety (V)** | 1 | 1764.0* | 54.37* | 10.03* | 3269.55* |
| **Weeding (W)** | 5 | 152.18* | 0.16* | 0.69$^{NS}$ | 11.46* |
| **V X W** | 5 | 56.13* | 0.021* | 0.16* | 0.76* |
| **Error** | 22 | 5.97 | 0.005 | 0.44 | 1.05 |

* Significant at 5% level $^{NS}$ Not significant

**Appendix IX. Mean square values for yield and other contributing characters of mungbean after harvest**

| Source of variation | Degrees of freedom | Mean square values after harvest | | | | |
|---|---|---|---|---|---|---|
| | | Pod yield | Seed yield | Stover yield | Biological yield | Harvest index |
| Replication | 2 | 0.009 | 0.0007 | 0.25 | 0.008 | 1.72 |
| Variety (V) | 1 | 2.31$^{NS}$ | 1.24* | 61.78* | 73.67* | 3834.9* |
| Weeding (W) | 5 | 1.11* | 0.41* | 6.84* | 9.32* | 164.97* |
| V X W | 5 | 0.10* | 0.031* | 0.56* | 0.47* | 21.79* |
| Error | 22 | 0.018 | 0.011 | 0.14 | 0.12 | 6.31 |

* Significant at 5% level

$^{NS}$ Not significant

**Appendix X. Mean square values for total no. of weeds $m^{-2}$ of mungbean**

| Sources of variation | Degrees of freedom | Mean square values at 15 DAS | 25 DAS | 35 DAS | 45 DAS | 55 DAS | harvest |
|---|---|---|---|---|---|---|---|
| **Replication** | 2 | 890.4 | 476.3 | 632.6 | 1124.5 | 114.2 | 77.2 |
| **Variety (V)** | 1 | 38.0 $^{NS}$ | 6833.8* | 6136.1* | 6032.1* | 9604.0* | 7396.0* |
| **Weeding (W)** | 5 | 1.4 $^{NS}$ | 14058.5* | 38483.7* | 55691.8* | 79885.0* | 85852.2* |
| **V X W** | 5 | 39321.2 $^{NS}$ | 12288.4* | 10590.8* | 7438.1* | 5047.0* | 3583.0* |
| **Error** | 22 | 531.5 | 582.6 | 520.0 | 357.5 | 398.9 | 300.8 |

* Significant at 5% level

$^{NS}$ Not significant

**Appendix XI. Mean square values for dry weight of weeds $m^{-2}$ of mungbean**

| Sources of variation | Degrees of freedom | Mean square values at 15 DAS | 25 DAS | 35 DAS | 45 DAS | 55 DAS | harvest |
|---|---|---|---|---|---|---|---|
| **Replication** | 2 | 18.97 | 18.13 | 10.15 | 9.30 | 4.57 | 11.22 |
| **Variety (V)** | 1 | 34.11 $^{NS}$ | 39.33 $^{NS}$ | 21.90 $^{NS}$ | 8.41 $^{NS}$ | 11.12 $^{NS}$ | 13.15 $^{NS}$ |
| **Weeding (W)** | 5 | 0.0002 $^{NS}$ | 639.31* | 1831.6* | 3303.0* | 4583.22* | 5023.99* |
| **V X W** | 5 | 81.42 $^{NS}$ | 148.52* | 94.74* | 33.03* | 41.06* | 55.50* |
| **Error** | 22 | 16.91 | 19.06 | 14.53 | 8.01 | 12.60 | 21.44 |

* Significant at 5% level

$^{NS}$ Not significant

# PLATES

Plate 1. Experimental field under study at 30 days after sowing (DAS)


Plate 2. Experimental field under study at 45 days after sowing (DAS)


Plate 3. Field view of BARI mung 4 ($V_1$) with no weed free period ($W_1$)


Plate 4. Field view of BARI mung 6 ($V_2$) with 15 days weed free period ($W_2$)