INFLUENCE OF WEED CONTROL METHODS ON THE GROWTH AND YIELD OF SOYBEAN VARIETIES

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INFLUENCE OF WEED CONTROL METHODS ON THE GROWTH AND YIELD OF SOYBEAN VARIETIES

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CERTIFICATE

This is to certify that the thesis entitled ***'Influence of Weed Control Methods on the Growth and Yield of Soybean Varieties'*** *submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfilment of the requirements for the degree of* ***Master of Science*** *in* ***Agronomy****, embodies the result of a piece of bona fide research work carried out by* ***Roksana Akter****, Registration number:* ***08-02991*** *under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

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

Dated:
Dhaka, Bangladesh

Prof. Dr. A. K. M. Ruhul Amin
Department of Agronomy
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Dedicated to

My
Beloved Parents

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INFLUENCE OF WEED CONTROL METHODS ON THE GROWTH AND YIELD OF SOYBEAN (*Glycine max* L.) VARIETIES

ABSTRACT

The experiment was conducted at the farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, Bangladesh during the period from December 2013 to April 2014 to study the influence of weed control methods on the growth and yield of soybean. The experiment comprised of two factors- Factor A: Soybean variety (3 varieties): Sohag (V_1), BARI soybean 6 (V_2) and BINA soybean 1 (V_3); Factor B: Weed control methods (4 levels): No weeding (W_0), Hand weeding at 20 and 40 DAS (W_1), Chemical control by whip super 9EC herbicide application at 20 DAS (W_2) and Bioherbicide-Siam weed extract (W_3). The experiment was laid out in Split plot Design with three replications. Results of the experiment showed that at 30, 45, 60 and 75 DAS, the maximum number of weed population (25.00, 31.22, 25.22 and 20.44, respectively) was observed in W_0 while the minimum number (11.78, 14.67, 14.44 and 14.11, respectively) in W_2. In case of variety, at 30, 45, 60, 75 DAS and at harvest, the tallest plant (17.90, 34.35, 54.09, 58.63 and 65.39 cm, respectively) was found from V_2, while the shortest plant (16.46, 29.26, 46.41, 52.81 and 56.12 cm, respectively) was observed from V_1.The highest seed yield (1.99 t ha^{-1}) was recorded in V_2 while the lowest seed yield (1.52 t ha^{-1}) was observed in V_1. For weed control methods, at 30, 45, 60, and 75 DAS and at harvest, the tallest plant (18.56, 35.51, 56.80, 61.99 and 68.17 cm, respectively) was observed in W_2, whereas the shortest plant (15.04, 25.95, 38.70, 45.30 and 52.46 cm, respectively) from W_0. The highest seed yield (2.01 t bha^{-1}) was observed in W_2, whereas the lowest seed yield (1.41 t ha^{-1}) from W_0. Interaction effect of varieties and weed control methods showed that at 30, 45, 60, and 75 DAS and at harvest, the tallest plant (19.86, 38.65, 61.66, 66.45 and 73.10 cm, respectively) was found in V_2W_2 while the shortest plant (14.51, 24.55, 36.58, 44.06 and 46.69 cm, respectively) from V_1W_0. The highest seed yield (2.23 t ha^{-1}) was recorded in V_2W_2 while the lowest seed yield (1.26t ha^{-1}) from V_1W_0.

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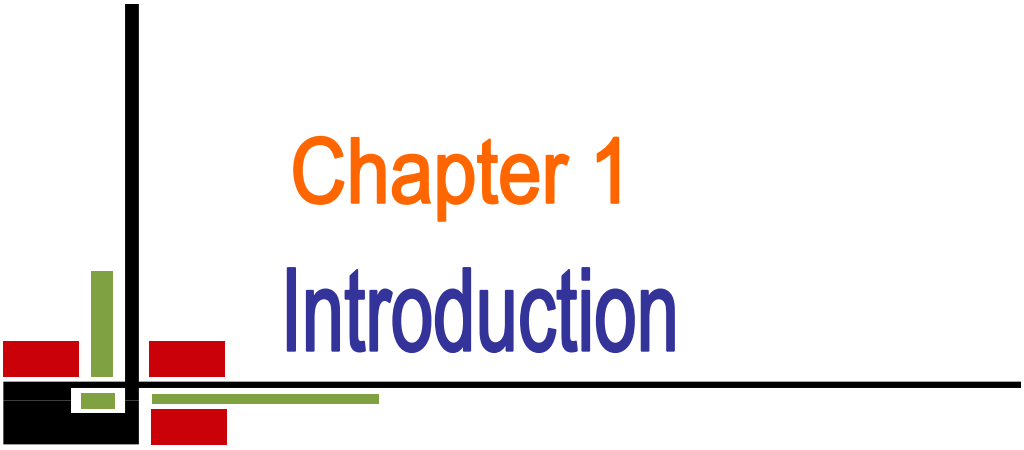
LIST OF ABBREVIATED TERMS

ABBREVIATION	FULL NAME
AEZ	Agro-Ecological Zone
et al.	and others
BBS	Bangladesh Bureau of Statistics
Cm	Centimeter
^{0}C	Degree Celsius
Etc	Etcetera
FAO	Food and Agriculture Organization
MP	Muriate of Potash
m^2	Square meter
UNDP	United Nations Development Program
SAU	Sher-e-Bangla Agricultural University



Chapter 1

Introduction

CHAPTER I

INTRODUCTION

Soybean (*Glycine max* L.*)* belongs to the family leguminosae, sub-family papilionidae is one of the leading oil and protein containing crops of the world. The crop is cultivated about 90.19 million hectares of land and annual production is approximately 220.5 metric tons in the world (FAO, 2009). As a grain legume crop it is gaining an important position in the agriculture of tropical countries including India, Sri Lanka, Thailand and Bangladesh. In Bangladesh, soybean is called the *Golden bean*. Soybean grain contains 29.6-50.3% protein, 13.5-24.2% fat and 3.3-6.4% ash (Purseglove, 1984) and 24-26% carbohydrate (Gowda and Kaul, 1982). Besides, it also contains various vitamins and minerals. It provides around 60% of the world supply of vegetable protein and 30% of the oil (Fehr, 1989). It also meets up different nutritional needs. Furthermore, soybean oil is cholesterol free and is easily acceptable in our daily diet.

On an average, about 8-10% of the protein intake in Bangladesh diet originates from animal sources (Begum, 1989) and the rest can be met from plant sources especially from the pulse crops like lentil, soybean. Soybean is said to be originated from the hot areas of South-East Asia, but more than 50% of its production today comes from the United States and South America. Per hectare yield of soybean in Bangladesh is only 1.2 t ha^{-1} (BARI, 2007) as compared to other soybean producing countries of the world like USA with seed yield of 3.5 t ha^{-1} (James *et al*., 1999). Yield of soybean is very low in Bangladesh and such low yield however is not an indication of low yielding potentiality of this crop, but may be attributed to a number of reasons, viz., unavailability of seeds of high yielding varieties with good quality, delayed sowing, fertilizer management, disease and insect infestation, improper or limited irrigation facilities, weeds and others stress condition. Among different

factor variety and weed control methods are also the most important factor for low yield.

In Bangladesh, several research Institutes like BARI, BINA and BAU have developed a couple of varieties of soybean, which are high yielding compared to local landrace. But the farmers are reluctant to soybean cultivation for poor economic return compared to cereals and vegetable crops. Recently, BINA has developed several promising soybean mutants of high yield potentials. These mutants need to be assessed for their physiological growth and morphological maneuvering compared to the existing soybean cultivars.

Weeds compete with crop plants and utilize considerable amount of moisture, nutrients and space in photosphere and atmosphere, thus deprive opportunities for the crop to express its potential yield. Weed infestation removed 21.4 kg N and 3.4 kg P ha^{-1} in soybean (Pandya *et al.,* 2005). Soybean are not strong competitors in the early part of the season, therefore weeds that germinated at the same time as soybeans, grow faster and maintain a canopy above and below the top of the soybean canopy. Therefore, they intercept photosynthetically active radiation (PAR) hamper soybean plant to grow properly. This results to elongation of soybean stems with a decrease in diameter, causing lodging (Jannink *et. al.,* 2000). The most critical period of weed competition in soybean is the early stage of growth (Sodangi *et al.,* 2007). Soybean usually develops a full canopy cover at 8 weeks after emergence and can then compete with weeds up to maturity. Little or no reduction in yield occurs if soybean are kept weed free for the first 4 weeks this is the critical period for weed competition in soybeans (Jannink *et. al.,* 2000). The reduction in soybean yield due to weed infestation varies from 20-77 % depending on the type of soil, season and intensity of weed infestation (Daugovish *et. al.,* 2003 and Kuruchania *et al.,* 1996). The higher reduction in seed yield due to weeds is more as compared to other limiting factors the soybean production. It has been estimated that soybean growers lost an average of 1.8 million US$ per year due to yield reductions from weed infestation (Anderson and Bridges, 1992).

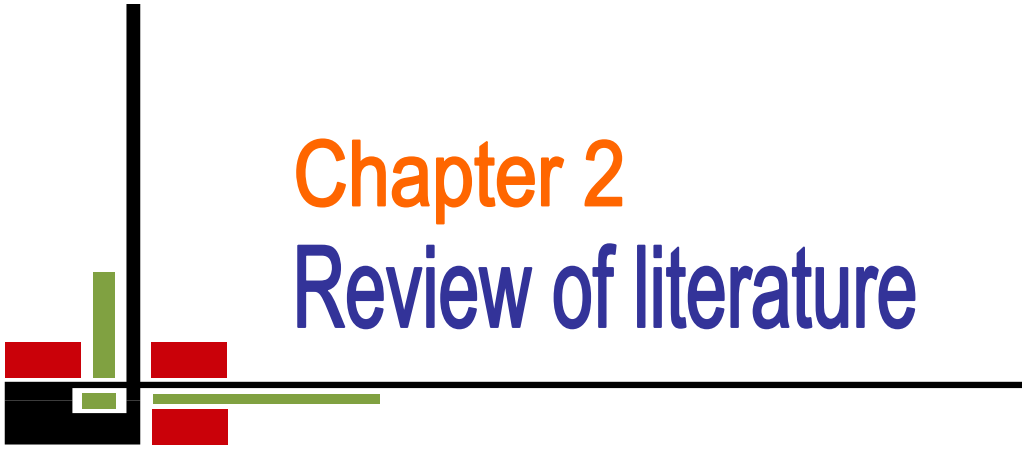
In Bangladesh agriculture, farmers weed control is usually achieved by hand-pulling, or hoe-weeding. Manual removal of weeds is the major traditional method of weed control in the tropics (Akobundu, 1987). This is usually done 2 or 3 times for effective weed control (Akobundu and Poku, 1987). It is estimated that about 40-60% of production cost is spent on manual weeding (Remison, 1979). In addition high seed cost, labour availability is uncertain, thus making timeliness of weeding difficult to attain, leading to greater yield loss (Adigun and Lagoke, 2003).Although herbicide use is one of the developments which was introduced later to control weeds in crop production. It is more adapted to large scale production and labour saving (Anon, 1994). Other factors that have made chemical weed control more popular than manual weeding include reduction of drudgery in chemical weed control, it protects crops from the adverse effects of early weed competition which can avert economic losses in soybean that needs early weed control in the first four weeks as this is the critical period of weed competition in soybean (Gesimba and Langart, 2005). It is a faster weed control method (Akobundu, 1987). Regarding chemical weed control, selective herbicides may be effective against annual weeds and achieve high soybean and legume yield (Hassanein, 2000; El-Metwally and Saad El-Din, 2003; Sha, 2004; El-Razik, 2006). Under these circumstances effective weed control methods needed to be developed to reduce yield loss due to weed infestation.

Under the above perspective and soybean situation the present experiment was conducted with different variety and weed control methods to achieve objectives:

a. To evaluate yield potentiality of the soybean varieties;

b. To determine the effective weed control methods for growth and yield of soybean; and

c. To find out the combined effect (if any) of the soybesn variety and weed control method.



Chapter 2
Review of literature

CHAPTER II

REVIEW OF LITERATURE

Soybean is one of the leading oil and protein containing crops of the world and as well as Bangladesh. The crop has conventional less attention by the researchers on various aspects because normally it grows with minimum care or management practices. Based on this a very few research have been carried out in our country. However, researches are now a days going home and abroad and became more resourceful about soybean and are trying to maximize the yield of soybean with different management practices especially on NPK fertilizer, spacing, variety, weeding, biofertilizers etc. Variety and weed control methods play an important role in improving soybean growth and yield. But research works related to variety and weed control methods are limited and not conclusive in Bangladesh context. However, some of the important and informative works and research findings related to the variety and weed control methods so far been done at home and abroad have been reviewed in this chapter under the following headings-

2.1. Effect of variety

Variety play an important role in crop production and the potential yield of a genotype within the genetic limit is determined by its environment. The release of high yielding varieties has contributed a great deal towards the improvement of soybean yields. The yield potential of these high yielding varieties can be further exploited through better agronomic practices including plant densities. Performance of soybean genotypes with respect to growth and yield has been briefly discussed here.

Rahim *et al*. (2012) studied on the effect of plant density on yield, yield components and protein content of three durum wheat cultivars in Agriculture Research Center of Mehran Station, Iran in 2009-10 growing season. Cultivars (Yavaros, Karkheh and Seymareh) were assigned main plot and plant density

(300, 350, 400 and 450 plant m^{-2}) were assigned sub plot. The results showed that among cultivar were affect on all trains except which were attributed by 1000-grain weight. Yavaros cultivar had the highest grain yield (4387 kg ha^{-1}), number of spike per m^{-2} (348.2 spikes), number of grain per spike (34.4 g) and harvest index (48.6%).

Umeh *et al*. (2011) conducted an experiment on growth and yield response of soybean varieties under Umudike ecological conditions. Pot experiment was conducted in 2008 outside the green house of Michael Okpara University of Agriculture, Umudike. Two varieties of soybean (Tropical Glycine Max–TGX 1440 and TGX 1740) were used for this study. Plant height, number of branches, number of seed, dry matter weight and dry pod weight differed significantly in both the varieties where the variety TGX 1740 produced the better results compare to Max–TGX 1440. But pod number per plant and number of seed per plant decreased with this variety.

Jandong *et al*. (2011) conducted an experiment to study adaptation and stability of soybean varieties over six soil pH regimes. The genotypes, Kyado and TGX1448–2E were the most superior for seed yield $plant^{-1}$ in 2004 and 2005 plantings, respectively while cultivar Gembu performed poorly in both years. Genotype Gembu was consistently poor in yield performance, hence the high stability observed.

Jamal *et al*. (2011) determined the effects of row spacing on yield components of three cultivars of winter canola and planting them in the test treatments and variety factorial experiment in randomized complete block design in three replicates in which the planting distance in 3 levels: 30, 40 and 50 cm in 3 levels and three varieties, including new lines. This experiment was carried out in 2010–11 crop season. The results showed that the Cultivar effect is significant on all traits measured in this paper. Simple variance analysis showed that was significant on plant height. In mean comparison the zarfam variety has maximum grain yield (2454 kg ha^{-1}).

An experiment was conducted at the Soil Science farm of Bangladesh Agricultural University (BAU) Mymensingh during the period from January to May 2000 (Anwar *et al*., 2010). The crop used in this study was soybean (*Glycine max* L. Merr.). The varieties of the crop were PB–1 (Shohag) and G–2. The overall results of the field experiment showed that *Bradyrhizobium* inoculation was beneficial in nodulation, plant fresh weight, dry matter production, plant height, seed yield and hay yield of soybean varieties PB–1 and G–2. The G–2 variety of soybean and bradyrhizobial inoculants BINA–SB–102 gave better results than other variety and other inoculants, respectively.

Ahmed and Jabereldar (2010) were studied on growth and yield of three cultivars (Buff, Haydoob and Eien Elgazal) were the local cultivar (buff) had a significantly taller, greater number of leaves per plant, leaf area index, heavier 100–seed weight, greater seed yield plant^{-1}, greater final seed yield (t ha^{-1}) and late in maturity. The improved cultivar (Ein Elgazal) scored the highest values of harvest index.

A field experiment was carried out by Ahmed *et al*. (2010) to investigate the effects of four intra–row spacing (50, 75, 100 and 125 cm) and three varieties of (Dahab Elgoaze, Eien Elghzal and Buff). The results showed that Dahb Elgoaze was early in flowering and maturity. Eien Elgazal gave a highest harvest index.

Shamsi and Kobraee (2009) to study the effect of different densities on the trend of growth, yield and its components of three varieties of soybean. Three varieties, i.e. Williams, Zan and Clark were assigned in this study. The highest dry weight was obtained from variety Clark. Comparison of changes in the relative growth rate (RGR) showed that variety Williams at density D_3 (lowest) had the highest RGR among all the varieties and densities. In this study density increase caused an increase in plant height, the interface of the first sub–branch from soil surface, length of inter node, number of nodes in main branch,

number of grain in pod plant^{-1} grain yield unit area^{-1}, and biological yield performance.

Cultivar evaluation is essential to ascertain the superiority of the newly developed genotypes over the established cultivars in terms of yield (Aduloju *et al*., 2009). They found grain yield was consistently and it was significantly higher for TGX 1448–2E than for other genotypes including the established cultivar, TGX 923–2E over the two cropping seasons. Significant year × genotype effect indicated that grain yields were significantly different between the two cropping seasons for TGX 1830–20E, TGX 1740–2F and TGX 1871–12E in 2004, while there was no significant variation for grain yield for TGX 1448–2E, TGX 1844–18E and TGX 1869–31E for the two years.

Okpara *et al*. (2007) conducted an experiment during the 2003 and 2004 cropping seasons at Umudike, Southeastern Nigeria, to assess the effect of liming on the performance of four high yielding soybean [*Glycine max* (L.) Merril] varieties (early maturing TGX 1485–1D, TGX 1799–8F, TGX 1805–8F and medium maturing TGX 1440–1E). The medium maturing TGX 1440–1E gave, on the average, significantly higher number of leaves and number of pods plant–1 and grain yield than other varieties. There were generally no significant effects of lime and crop variety interactions on soybean growth and yield.

A plant density experiment for common bean (*Phaseolus vulgaris* L.) was carried out by Njoka *et al*. (2005) at Egerton University, Njoro, over 2 years. Two bean cultivars, GLP2 and GLP24, were established at various spacing treatments. There was significant difference ($p< 0.05$) on grain yield among various densities. Seed weight, number of pods/plant and number of seeds pod^{-1} decreased with increase in plant density while plant mortality rate increased with increase in plant population. GLP24 showed higher yield potential in all plant spacing and/or plant population densities than GLP2. There was a high

negative correlation between plant mortality and yield components. There was high positive correlation between grain yield and yield components.

Truyen *et al*. (2004) studied on five soybean genotypes where the genotypes differing in growth duration (TN12 and M103 as early, and CM60, 95389 and MSBR20 as late maturity types) were sown to investigate the effects of genotype on growth of soybean. Grain yield differed among genotypes where CM60 produced the highest yield of 2.4 t ha^{-1}. M103 and TN12 produced 1.67 and 1.6 t ha^{-1} while 95389 and MSBR20 yielded 1.47 and 1.29 t ha^{-1}, respectively. The results suggest that CM60 was the most promising variety for the region.

Henry *et al.* (2003) reported that in Rajasthan, Gujarath and Delhi cultivar V–585 showed a unique response under fluctuating environmental conditions. V–585 was medium late in maturity, however it was not high yielder. Genotype GC–3 was suitable for adverse weather conditions. However, under such situations, genotypes GC–8910 and GC–8926 had better yielding ability. Genotypes CA2C–9, CA2C–10, CA2C–1 were found to respond more to favourable growing conditions and had high yielding ability.

Purushotham *et al.* (2001) reported that among different cultivars UPC–921, UPC–952, UPC–953, IFC–9502, IFC–9503, UPC–5286 and Bund lobia (control), the highest mean dry matter was registered by IFC–9503 (18.1 q ha^{-1}). Nirmal *et al.* (2001) reported that in Varnasi, yield potential of IHR Sel–11 and Sel–2–1 genotype was highest among 20 tested cultivars. Higher protein content was recorded in local genotypes like red seeded climbing cowpea local–1 and Kasajhambla (bush).

Kalpana (2000) reported that the cowpea genotypes belonging to different growth habit indicated that the determinate genotypes had higher values of photosynthetic rate, transpiration rate, stomatal conductance, as compared to the indeterminate genotypes. The genotypes KM–5 and KM–4 among the

determinate and C–44 and C–22 among indeterminate had higher seed yield and also recorded higher values for photosynthetic rate and transpiration rate.

2.2. Effect of weed control methods

Weed density

Imoloame (2014) showed that herbicide treatments significantly reduced weed infestation compared to the weedy check. This weed control method also resulted in significantly better growth and higher yield.

Chattha *et al.* (2007) reported that use of herbicide tribunal 70 WP (methabenzthiazuron) @ 2 kg ha^{-1} at 2-3 leaf stage of weeds + hand-weeding at 50 DAS gave promising results in terms of weed reduction. Maximum reduction in density and biomass of the weeds was observed by chemical-weeding at 2-3 leaf stage of weeds + hand-weeding at 50 DAS.

Application of the previous treatments was effective in controlling weed and consequently competition was limited and lighter, and water and nutrients were available to promote soybean growth compared to other treatments. These results are in agreement with those recorded by Galal (2003) and Mohamed (2004).

Chauhan *et al.* (2002) revealed that the application of alachlor at 1.5 kg and, pendimethalin 1.5 kg/ha as pre-emergence and two hand weeding at 20 and 35 DAS in soybean crop drastically reduced weed density, weed biomass and increased the yield of crop.

Plant height

Pohlan (1986), Pandey *et al.* (1996) and Kuruchania *et al.* (1996) observed continuous decrease in plant height with the increasing of weeds competition which was attributed to growth habit of a variety.

Dry weight $plant^{-1}$

Abdelhamid and El-Metwally (2008) indicated that the herbicides at rates higher than the recommended markedly decreased the root, shoot and total dry

weight plant^{-1}, while application of two hand hoeing treatments significantly increased these traits.

Number of pods plant^{-1}

Several studies indicate a reduction in the number of pods of soybean plants under weed competition (Martins, 1994). Reductions in seed yield per pod during competition between weeds and soybeans (Silva *et al.,* 2008).

Abdelhamid and El-Metwally (2008) revealed that two hand hoeing treatments gave the highest values of number of pods per plant^{-1}, weight of pods per plant^{-1} and number of seeds per plant^{-1} by 140.7, 150.0 and 59.8%, respectively, compared to the unweeded treatment.

In addition, there is an important role of hoeing in improving soil properties, i.e. soil structure, aeration, water penetration and the availability of some nutrients. In this respect, the increments due to application of hand weeding twice than weedy check were reported in branches and pods number plant^{-1} (Kushwah and Vyas, 2005).

1000-seed weight

Significant reductions in terms of 1000-seed weight of soybeans was recorded when the crop suffers the competition from weeds (Silva *et al.*, 2008) especially at higher densities of infestation.

Seed yield

Peer *et al.* (2013) that hand weeding twice and both fluchoralin and pendimethalin integrated with hand weeding recorded far superior yields of soybean seed. Sodangi *et al.* (2013) revealed that hoe weeding three times at 3, 5 and 7WAS produced the highest grain yields.

Abdelhamid and El-Metwally (2008) found that, oxadiargyl at the recommended rate (480 g ha^{-1}) was the best treatment for promoting seed yield (g plant^{-1}) and seed yield (kg ha^{-1}) compared to the nonweeded treatment by 87.3 and 85.0, respectively.

Nepomuceno *et al.* (2007) evaluated weed interference in soybean in conventional sowing system and reported a 32% drop in the yield of the crop when it coexisted with weeds throughout their cycle.

Sodangi *et al.* (2006) also reported a soybean yield loss of 90% due to weed infestation in the Sudan Savanna zone of Nigeria. The increments due to application of hand weeding twice than weedy check were reported in seed yield (Pandya *et al.* 2005).

Pires *et al.* (2005), assessing the competitive potential of soybean cultivars against weeds, observed reductions of approximately 480 kg ha^{-1}, regardless of the variety used in average levels of productivity of 2.570 kg ha^{-1}.

Pandya *et al.* (2004) found that two hand weedings and clomazone with hand weeding produced higher grain yield. Crop geometrics failed to record significant influence on grain yield.

Rohitshav *et al.* (2003) reported that pre-emergence application of pendimethalin 1.5 kg /ha produced soybean grain yields similar to weed free treatment.

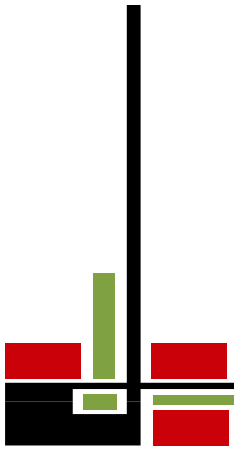
Jannink *et al.* (2000) reported that root and shoot interference is the main factors that cause soybean yield reduction.

Stover yield

Abdelhamid and El-Metwally (2008) reported that two hand hoeing treatments and pre-emergence herbicides at the recommended rates markedly increased soybean yield and its attributes.

Biological yield

Abdelhamid and El-Metwally (2008) found that, oxadiargyl at the recommended rate (480 g ha^{-1}) was the best treatment for promoting biological yield (g $plant^{-1}$) compared to the non weeded treatment by 88.2%.



Chapter 3

Materials and Methods

CHAPTER III

MATERIALS AND METHODS

The experiment was conducted during the period from December 2013 to April 2014 to study the influence of weed control methods on the growth and yield of soybean (*Glycine max* L.). This chapter includes materials and methods that were used in conducting the experiment are presented below under the following headings:

3.1. Experimental site

The experiment was conducted at the farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, Bangladesh. The experimental site is situated between $23^0 74^/$N latitude and $90^0 35^/$E longitude (Anon., 1989). The Map of the experimental site presented in Appendix I.

3.2. Soil characteristics

The soil of the experimental site belongs to Tejgaon series under the Agro-ecological zone, Madhupur Tract (AEZ-28), which falls into Deep Red Brown Terrace Soils. Soil samples were collected from the experimental plots to a depth of 0-15 cm from the surface before initiation of the experiment and analyzed in the laboratory. The soil was having a texture of silty-clay with pH and Catayan Exchange capacity 5.6 and 2.64 meq 100 g $soil^{-1}$, respectively. The morphological characteristics of the experimental field and physical and chemical properties of initial soil are given in Appendix II.

3.3. Climatic conditions of the location

The climate of experimental site is subtropical, characterized by three distinct seasons, the monsoon from November to February and the pre-monsoon period or hot season from March to April and the monsoon period from May to October. The monthly average temperature, humidity and rainfall during the crop growing period were collected from Weather Yard, Bangladesh Meteorological Department, and presented in Appendix III.

3.4. Planting material

Three varieties namely Sohag, BARI soybean 6 and BINA soybean 1 was used as the test crops. The seeds were collected from the Agronomy Division of Bangladesh Agricultural Research Institute, Joydebpur, Gazipur and Bangladesh Institute of Nuclear Institute (BINA), Mymensingh.

3.5. Land preparation

The land was irrigated before ploughing. After having 'zoe' condition the land was first opened with the tractor drawn disc plough. Ploughed soil was brought into desirable fine tilth by 3 ploughing and cross-ploughing, harrowing and laddering. The stubble and weeds were removed. The first ploughing and the final land preparation were done on 19th and 23th December 2013, respectively. Experimental land was divided into unit plots following the design of experiment.

3.6. Treatments of the experiment

The experiment comprised of two factors

Factor A: Soybean variety levels 3

i) Sohag (V_1)

ii) BARI soybean 6 (V_2)

iii) BINA soybean 1 (V_3)

Factors B: weed control method levels 4

i) No weeding i.e. control (W_0)

ii) Hand weeding at 20 and 40 DAS (W_1)

iii) Chemical control by whip super 9EC herbicide application at 20 DAS (W_2)

iv) Bioherbicide-Siam weed extract (W_3)

There were in total 12 (4×3) treatment combinations such as V_1W_0, V_1W_1, V_1W_2, V_1W_3, V_2W_0, V_2W_1, V_2W_2, V_2W_3, V_3W_0, V_3W_1, V_3W_2 and V_3W_3.

3.7. Fertilizer application

Urea, Triple super phosphate (TSP), Muriate of potash (MoP), gypsum, boric acid and molybdenum were used as a source of nitrogen, phosphorous, potassium, sulphur, boron and molybdenum, respectively. The fertilizers urea, TSP, MoP, and boric acid were applied at the rate of 60, 175, 120 and 10 kg hectare^{-1}, respectively following the Bangladesh Agricultural Research Institute (BARI) recommendation (BARI, 2007). Sulphur and molybdenum were from thesources of gypsum and sodium molybdate. All of the fertilizers were applied in broadcast during final land preparation.

3.8. Experimental design and layout

The two factors experiment was laid out in Split plot Design with three replications assignins varieties in the main plot and weed control methods in the sub plot. An area of 20.5 m × 16.0 m was divided into three blocks. The 12 treatment combinations were assigned in the each plot of each block. The size of the each unit plot was 3.0 m × 2.0 m. The space between two blocks and two plots were 1.0 m and 0.5 m, respectively. The layout of the experiment is shown in Figure 1.

3.9. Sowing of seeds in the field

The seeds of soybean were sown on December 23, 2013 in rows in the furrows having a depth of 2-3 cm and row to row distance was 30 cm and after emergence plant to plant distance was kept 5-6 cm.

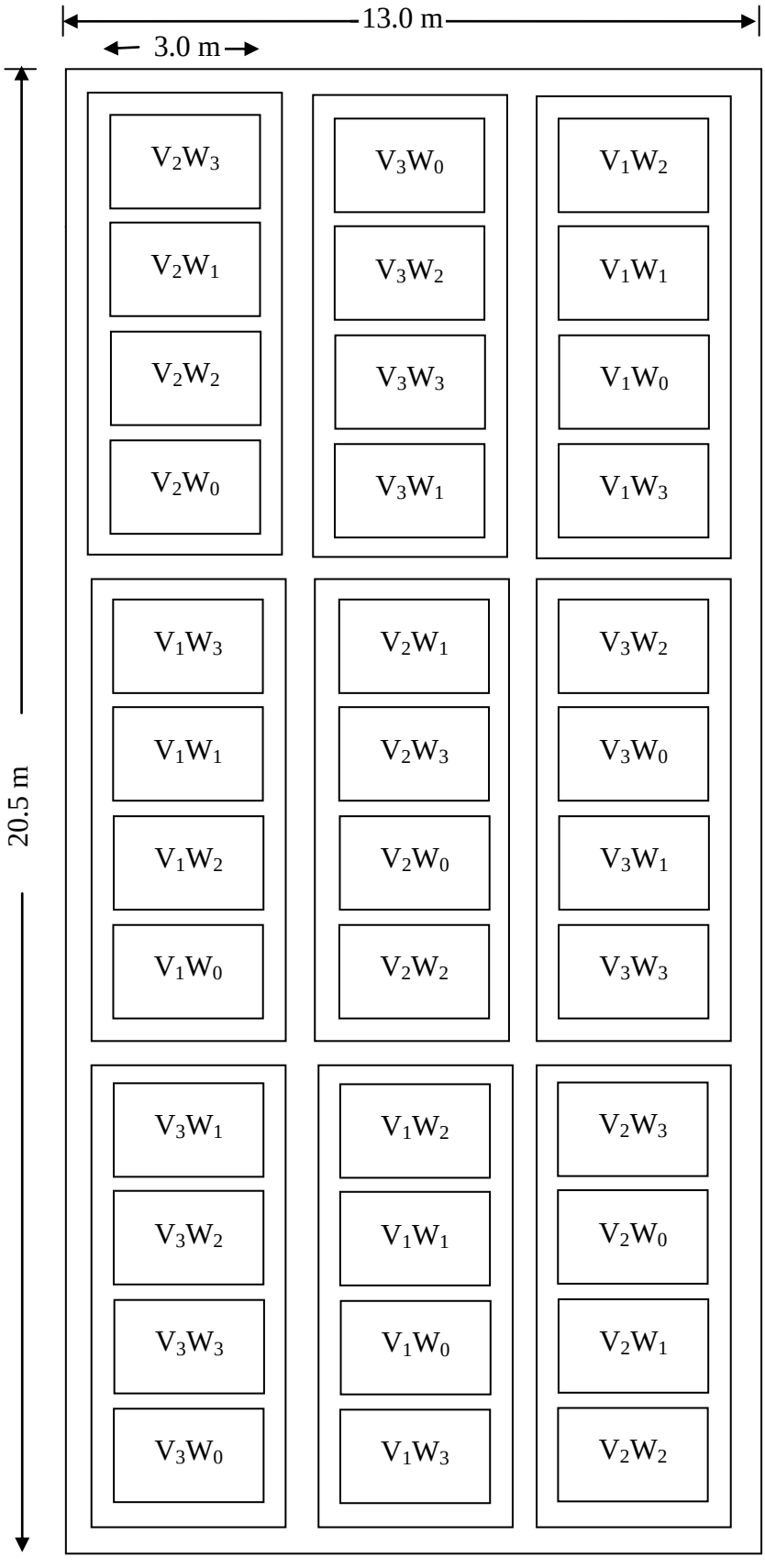
3.10. Intercultural operations

3.10.1 Thinning

Seeds started germination within four days after sowing (DAS). Thinning was done at 23 DAS to maintain optimum plant population in each plot.

3.10.2 Irrigation and weeding

Irrigation was provided two times at 25 DAS and 55 DAS for all experimental plots equally. The crop field was weeded at 20 DAS and 40 DAS.



Plot size: 3.0 m × 2.0 m

Plot to plot spacing: 0.50 m

Between block: 1.00 m

Factor A: Soybean variety (3 varieties)

V_1: Sohag

V_2: BARI soybean 6

V_3: BINA soybean 1

Factors B: Levels of weed control methods (4 levels)

W_0: No weeding i.e. control

W_1: Hand weeding at 20 and 40 DAS

W_2: Chemical control by whip super 9EC herbicide application at 20 DAS

W_3: Bioherbicide-Siam weed extract

Figure 01. Layout of the experimental plot

3.10.3 Protection against insect and pest

At early stage of growth few worms (*Agrotis ipsilon*) infested the young plants and at later stage of growth pod borer (*Maruca testulalis*) attacked the plant. Ripcord 10 EC was sprayed at the rate of 1 mm with 1 litre water for two times at 15 days interval after seedlings germination to control the insects.

3.11. Crop sampling and data collection

Five plants from each treatment were randomly selected and marked with sample Tag. Plant height and number of branches plant^{-1} were recorded from selected plants at an interval of 15 days started from 30 DAS to 75 DAS and at harvest.

3.12. Harvest and post harvest operations

The crop was harvested when 90% of the pods became brown in color**.** The matured pods were collected by hand picking from each unit plot.

3.13. Data collection

The following data were recorded

i. Weed population
ii. Plant height (at 30, 45, 60, 75 DAS and at harvest)
iii. Number of leaves plant^{-1} (at 30, 45, 60, 75 DAS and at harvest)
iv. Dry matter content plant^{-1} (at 30, 45, 60, 75 DAS and at harvest)
v. Days to harvest
vi. Pod length (cm)
vii. Number of pods plant^{-1}
viii. Number of seeds pod^{-1}
ix. Weight of 100 seeds (g)
x. Seed yield
xi. Stover yield
xii. Biological yield

xiii. Harvest index

3.14. Procedure of data collection

3.14.1 Weed population

From the 1 m^2 area of every plot, the total weeds were uprooted and counted at 30, 45, 60 and 75 DAS.

3.14.2 Plant height

The plant height was measured from 5 selected plants at 30, 45, 60, 75 DAS and at harvest with a meter scale from the ground level to the top of the plants and the mean height was expressed in cm.

3.14.3 Number of leaves plant^{-1}

The total number of leaves plant^{-1} was counted from each selected plant. Data were recorded as the average of 5 plants selected of each plot at 30, 45, 60, 75 DAS and at harvest.

3.14.4 Dry matter content plant^{-1}

Fresh 5 plant samples in each plot were uprooted and put into envelop and placed in an oven and maintained its temperature at 70^0C for 72 hours. The sample was then transferred into desiccators and allowed to cool down at room temperature. The final weight of the sample was taken and recorded in gram.

3.14.5 Days to harvest

The experimental plot was kept under close observation to count days to harvest of soybean. Total number of days from the date of sowing to the harvest was recorded.

3.14.6 Pod length

Pod length was taken from randomly selected ten pods from each plot and the mean length was expressed on pod^{-1} basis.

3.14.7 Number of pods plant^{-1}

Numbers of total pods of selected plants from each plot were counted and the mean numbers were expressed as plant^{-1} basis. Data were recorded as the average of 10 plants selected at random from the inner rows of each plot.

3.14.8 Number of seeds pod^{-1}

The number of seeds pods^{-1} was recorded from randomly selected 10 pods at the time of harvest. Data were recorded as the average of 10 pods from each plot.

3.14.9 Weight of 100 seeds

One hundred cleaned, dried seeds were counted from each harvest sample and weighed by using a digital electric balance and weight was expressed in gram (g).

3.14.10 Seed yield hectare^{-1}

The seeds collected from 2.0 square meter of each plot. The seeds were separated from the plant and cleaned and dried in the sun. The weight of seeds was taken and converted the yield in t ha^{-1}.

3.14.11 Stover yield hectare^{-1}

The stover collected from 2.0 square meter area of each plot then sun dried properly. The weight of stover was taken and converted the yield in t ha^{-1}.

3.14.12 Biological yield

Grain yield and stover yield together were regarded as biological yield of soybean. The biological yield was calculated with the following formula:

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

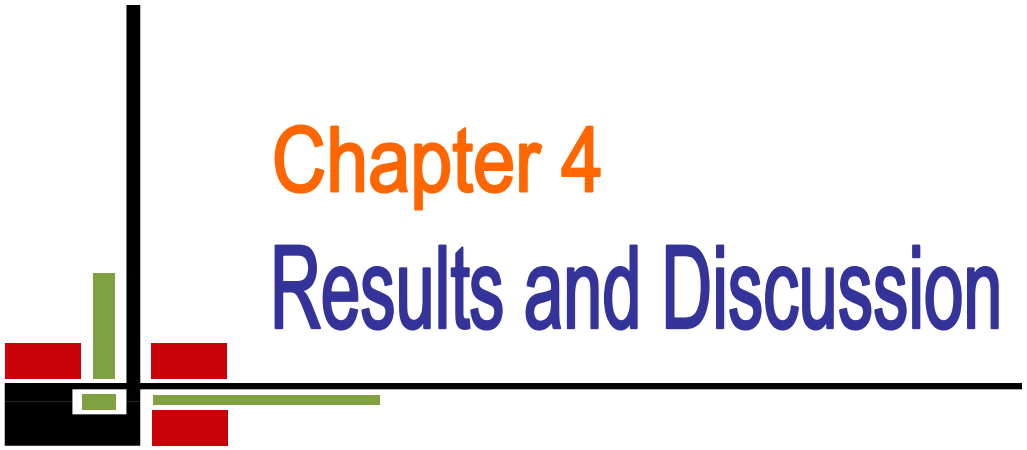
3.14.13 Harvest index

Harvest index was calculated from the seed and stover yield of soybean expressed in percentage.

$$HI = \frac{\text{Economic yield (seed weight)}}{\text{Biological yield (Total dry weight)}} \times 100$$

3.15. Statistical analysis

The data obtained for different parameters were analyzed statistically following MSTAT computer package program. The significance of the difference among the treatment means was estimated by the Duncan's Multiple Range Test(DMRT) at 5% level of probability (Gomez and Gomez, 1984).



Chapter 4

Results and Discussion

CHAPTER IV

RESULTS AND DISCUSSION

The experiment was conducted to find out the effect of different weed control method on the growth and yield of soybean varieties. Data on number of weed population, different yield contributing characters and yield were recorded. The analyses of variance (ANOVA) of the data on the recorded parameters have been presented in Appendix IV-IX. The results have been presented and possible interpretations also given under the following headings:

4.1. Weed Parameters

4.1.1 Weed species in the experimental field

Twenty weed species belonging to eleven families were found in the experimental field. Local name, English name, botanical name, family and morphological type of the weed species have been presented in Table 1. The density and dry weight of weeds varied considerably in different weed control treatments. The most prevalent weeds of the experimental plots were *Lindernia procumbens, Echinochloa colonum, Vicia sativa, Cynodon dactylon, Digitaria sanguinalis, Chenopodium album, Cyperus rotundus, Eleusine indica*. Among the twenty species fifteen were broad leaved, four were grasses and one was sedge (Table 1). Kushwah and Vyas (2006) found *Caesulia axillaris, Echinochloa colona*, *Cyperus iria*, *Cyperus rotandus*, *Commelina benghalensis, Digitaria sanguinalis* and *Acalypha indica* in soybean crop field. Malik *et al.* (2006) identified *Celosia argentea*, *Digera arvensis*, *Echinochloa colona, Dactyloctenium aegyptium*, *Cyperus rotandus* and *Trianthema portulacastrum* in soybean field. Idapuganti *et al.* (2005) observed *Echinochloa colona, Cyperus rotandus, Trianthema portulacastrum*, *Digera arvensis*, *Commelina benghalensis*, *Digitaria sanguinalis*, *Phyllanthus niruri* and *Dactyloctenium aegyptium* in soybean crop. Guliqbal (2005) reported *Cyperus* rotandus, *Dactyloctenium aegyptium*, *Eragrostis piolsa* and *Commelina benghalensis* in soybean field. Balyan and Malik (2003) noticed *Trianthema monogyna*, *Echinochloa colona*, *Celosia argentea*, *Digera arvensis*,

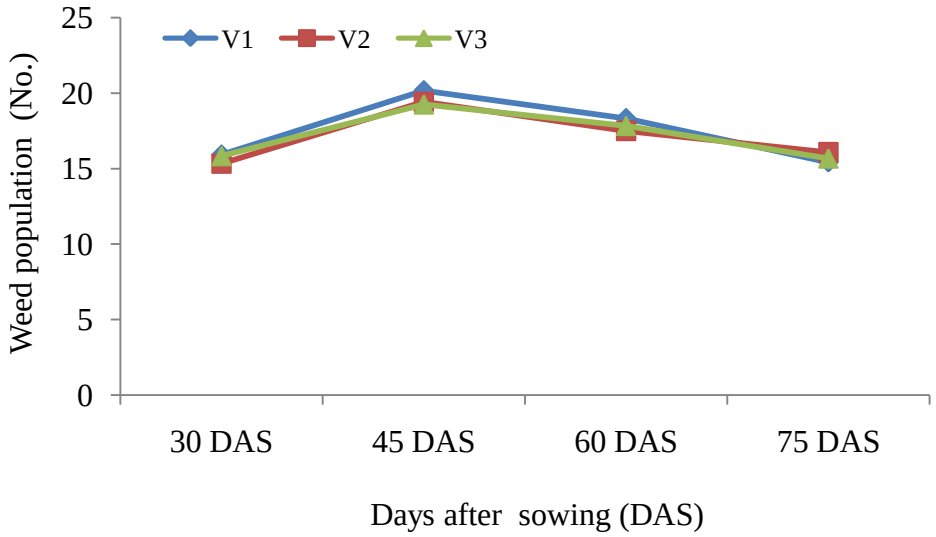
Table 1. List of weeds with Local, English , Botanical names family and types(Leaf) that were found in the experimental plot

SL. No.	Local name	English Name	Botanical Name	Family	Types(Leaf)
1	Durba	Bermuda grass	*Cynodon dactylon*	Poaceae	Grass
2	Bathua	Lambs quarter	*Chenopodium album*	Chenopodiaceae	Broad Leaf
3	Mutha	Nutgrass	*Cyperus rotundus*	Cyperaceae	Sedge
4	Khetpapri	Prostate false pimpernel	*Lindernia procumbens*	Scrophulariaceae	Broad Leaf
5	Malncha	Alligator weed	*Alternanthera philoxeroides*	Amaranthaceae	Broad Leaf
6	Bon Masur	Wild lentil	*Vicia sativa*	Fabaceae	Broad Leaf
7	Boro Anguli	Scrab grass	*Digitaria sanguinalis*	Poaceae	Grass
8	Khude Shama	Jungle rice	*Echinochloa colonum*	Poaceae	Grass
9	Chapra	Indian goosegrass	*Eleusine indica*	Poacease	Grass
10	Hatishur	Wild clary	*Heliotropium indicum*	Boraginaceae	Broad Leaf
11	Bon Mula	Wild raddish	*Raphanus raphanistrum*	Brassicaceae	Broad Leaf
12	Shetlomi	Common cudweed	*Gnaphalium luteoalbum*	Asteraceae	Broad Leaf
13	Bon sarisha	Wild mustard	*Brassica kaber*	Brassicaceae	Broad Leaf
14	Chanchi	Sessile joyweed	*Alternanthera sessilis*	Amaranthaceae	Broad Leaf
15	Chochalo Begun	Spiny night shade	*Solanum rostratum*	Solanaceae	Broad Leaf
16	Foska begun	Clammy ground chery	*Physalis heterophylla*	Solanaceae	Broad Leaf
17	Kheshuti	White eclipta	*Eclipta prostrata*	Asteraceae	Broad Leaf
18	Arich	Tora weed	*Cassia tora*	Fabaceae	Broad Leaf
19	Shushni Shak	4-leaved water clover	*Marsilia quadrifolia*	Marsileaceae	Broad Leaf
20	Helencha	Harkuch	*Enhydra fluctuans*	Asteraceae	Broad Leaf

Cyperus rotandus, *Physalis minima* and *Dactyloctenium aegyptiumin* soybean crop. Rohitashav *et al*. (2003) observed *Trianthema monogyna*, *Echinochloa colona*, *Celosia argentea*, *Dactyloctenium aegyptium*, *Eleusine indica*, *Cleome viscosa*, *Cucumis trigonus* and *Commelina benghalensis* in soybean field. Gaikwad and Pawar (2003) found, *Brachiaria ramosa*, *Cyanodon dactylon*, *Echinochlo acrus galli*, *Convolvulus arvensis* and *Acalyphain dica* in soybean crop. The present result varied a little bit and there might be due to seasonal and location variation along with environmental factors.

4.1.2 Weed population

No statistical significant variation was observed in terms of weed population at 30, 45, 60 and 75 DAS among the varieties (Fig. 2)and Appendix –iv At 30, 45, 60 and 75 DAS, the maximum number of weed population (15.92, 20.17, 18.33 and 15.42, respectively) was found in plots of V_1 (Shohag), whereas the minimum number of weed population (15.33, 19.42, 17.50 and 15.42, respectively) was recorded from V_2 (BARI soybean 6) and in the plot of V_3 (BINA soybean 1) the number of weed population was recorded 15.83, 19.42, 17.83 and 15.67, respectively at same DAS. Data revealed that the numbers of weed populations for different variety of soybean are more or less similar (Fig.2)

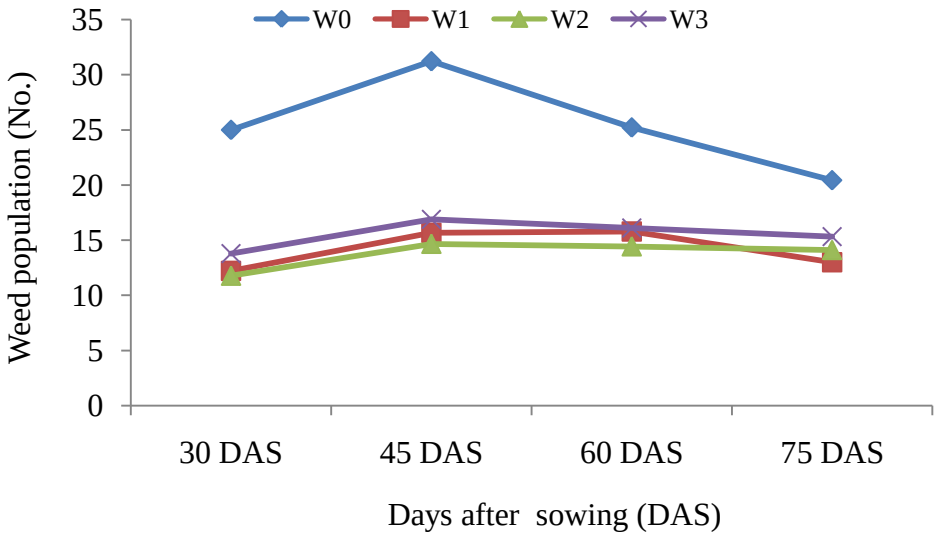


V_1: Sohag 6 V_2: BARI soybean

V_3: BINA soybean 1

Fig. 2. Effect of different varieties on weed population of soybean. Vertical bars represent. SE = 0.451, 0.315, 0.403 and 0.287 at 30, 45, 60 and 75 DAS.

Weed population varied significantly due to different weed control methods at 30, 45, 60 and 75 DAS (Fig. 3) and Appendix-iv. At 30, 45, 60 and 75 DAS, the maximum number of weed population (25.00, 31.22, 25.22 and 20.44, respectively) was observed from W_0 (no weeding i.e. control), while the minimum number (11.78, 14.67, 14.44 and 14.11, respectively) was found from W_2 (Chemical control by whip super 9EC herbicide application at 20 DAS), and that was statistically similar (12.22, 15.67, 15.78 and 13.00, respectively) to W_1 (Hand weeding at 20 and 40 DAS) and closely followed (13.78, 16.89, 16.11 and 15.33, respectively) by W_3 (Bioherbicide Siam weed extract) at 30, 45, 60 and 75 DAS. Imoloame (2014) reported similar results that herbicide treatments significantly reduced weed infestation compared to the weedy check.



W_0: No weeding i.e. control W_1: Hand weeding at 20 and 40 DAS

W_2: Chemical control by whip super 9EC herbicide application at 20 DAS

Fig. 3. Effect of different weed control methods on weed population of soybean. SE = 0.432, 0.417, 0.606 and 0.272 at 30, 45, 60 and 75 DAS, respectively)

Interaction effect of varieties and weed control methods showed significant differences on weed population of soybean at 30, 45, 60 and 75 DAS (Table 2). At 30, 45, 60 and 75 DAS, the maximum number of weed population (27.33, 33.00, 26.67 and 21.33, respectively) was observed from V_3W_0 (BINA soybean 1 with no weeding) and the minimum number (10.67, 13.67, 13.67 and 12.33, respectively) was recorded from V_3W_2 (BINA soybean 1 with chemical control by whip super 9EC herbicide application at 20 DAS).

4.2 Crop Growth Characters

4.2.1 Plant height

Statistically significant variation was observed in terms of plant height of soybean varieties at 30, 45, 60, and 75 DAS and at harvest due to different variety (Fig. 4). At 30, 45, 60, 75 DAS and at harvest, the tallest plant (17.90, 34.35, 54.09, 58.63 and 65.39 cm, respectively) was found from V_2 which was statistically similar (17.32, 33.75, 52.87, 58.13 and 64.36 cm, respectively) to

V_3, while the shortest plant (16.46, 29.26, 46.41, 52.81 and 56.12 cm, respectively) was observed from V_1. Different genotypes produced different plant height on the basis of their varietal characters. Umeh *et al*. (2011) reported that plant height differed significantly between two varieties where the variety TGX 1740 produced the better results compare to Max–TGX 1440.

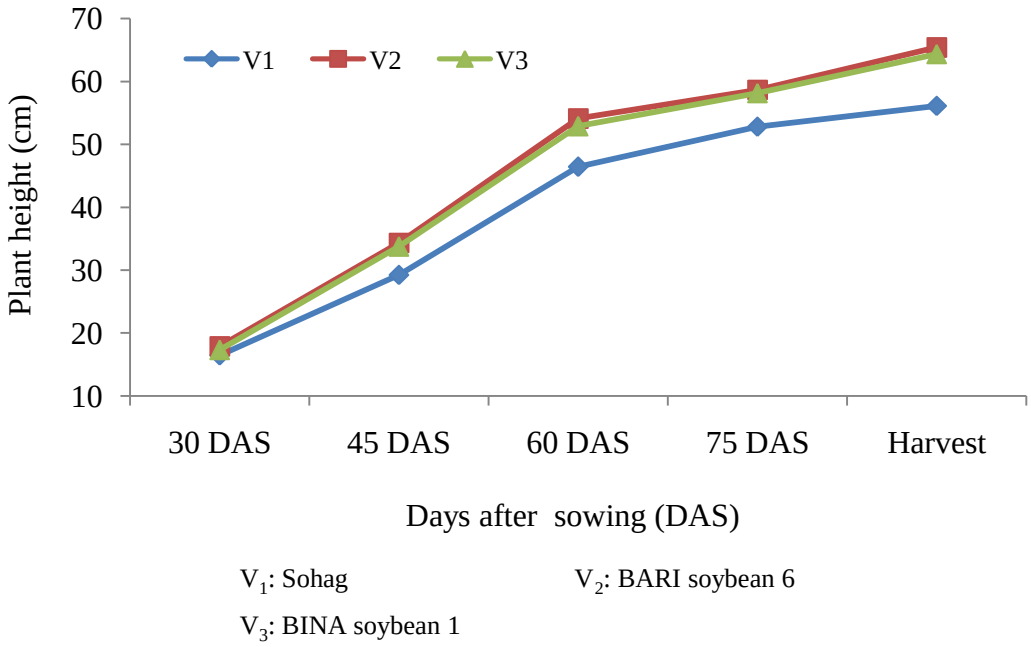
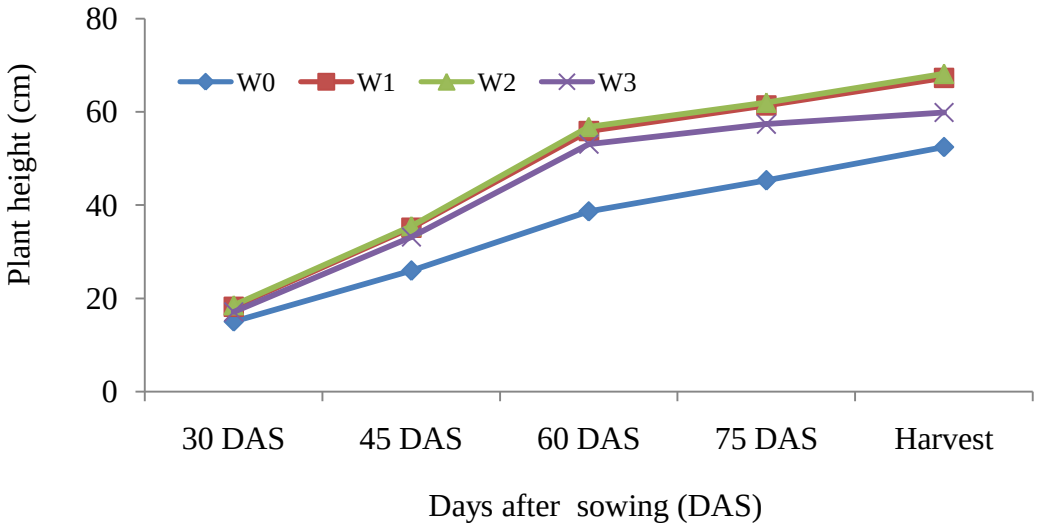


Fig. 4. Effect of different varieties on plant height of soybean. SE = 0.232, 0.435, 0.625, 0.436 and 0.731 at 30, 45, 60, 75 DAS and at Harvest.

Plant height of soybean varieties at 30, 45, 60, and 75 DAS and at harvest showed statistically significant variation due to different weed control methods (Fig. 5). At 30, 45, 60, and 75 DAS and at harvest, the tallest plant was observed from W_2 (18.56, 35.51, 56.80, 61.99 and 68.17 cm, respectively), which was statistically similar to W_1 (18.21, 35.17, 55.91, 61.42 and 67.32 cm, respectively) and closely followed by W_3 (17.10, 33.18, 53.09, 57.38 and 59.88 cm, respectively), whereas the shortest plant was found from W_0 (15.04, 25.95, 38.70, 45.30 and 52.46 cm, respectively). Pohlan (1986), Pandey *et al.*

(1996) and Kuruchania *et al.* (1996) observed continuous decrease in plant height with the increasing of weeds competition.



W_0: No weeding i.e. control W_1: Hand weeding at 20 and 40 DAS

W_2: Chemical control by whip super 9EC herbicide application at 20 DAS

W_3: Bioherbicide-Siam weed extract

Fig. 5. Effect of different weed control methods on plant height of soybean. SE = 0.292, 0.632, 0.831, 0.900 and 0.930 at 30, 45, 60, 75 DAS and at harvest.

Table 2. Interaction effect of different variety and weed control methods on number of weed population in soybean field at different days after sowing (DAS)

Treatment	Weed population (No.)			
	30 DAS	45 DAS	60 DAS	75 DAS
V_1W_0	25.33 a	32.33 a	25.67 ab	20.33 ab
V_1W_1	11.33 de	16.00 cde	16.00 c	14.00 def
V_1W_2	11.67 de	15.00 cde	14.67 c	13.33 efg
V_1W_3	15.33 c	17.33 c	16.00 c	14.67 cde
V_2W_0	22.33 b	28.33 b	23.33 b	19.67 b
V_2W_1	13.33 cd	17.00 c	16.00 c	14.00 def
V_2W_2	13.00 cde	15.33 cde	15.00 c	15.00 cd
V_2W_3	12.67 de	17.00 c	15.67 c	15.67 c
V_3W_0	27.33 a	33.00 a	26.67 a	21.33 a
V_3W_1	12.00 de	14.00 de	15.33 c	12.67 fg
V_3W_2	10.67 e	13.67 e	13.67 c	12.33 g
V_3W_3	13.33 cd	16.33 cd	16.67 c	15.67 c
SE(±)	0.747	0.722	1.050	0.472
CV(%)	8.25	6.38	10.16	5.19

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

V_1: Sohag
V_2: BARI soybean 6
V_3: BINA soybean 1

W_0: No weeding i.e. control
W_1: Hand weeding at 20 and 40 DAS
W_2: Chemical control by whip super 9EC herbicide application at 20 DAS
W_3: Bioherbicide-Siam weed extract

Interaction effect of varieties and weed control methods showed significant differences in terms of plant height at 30, 45, 60, and 75 DAS and at harvest (Table 3). At 30, 45, 60, and 75 DAS and at harvest, the tallest plant was observed from V_2W_2 (19.86, 38.65, 61.66, 66.45 and 73.10 cm, respectively), while the shortest plant was recorded from V_1W_0 (14.51, 24.55, 36.58, 44.06 and 46.69 cm, respectively).These results indicated that in unweeded plots the soybean varieties were suppressed by higher number of weed plants.

4.2.2 Number of leaves plant^{-1}

Number of leaves plant^{-1} at 30, 45, 60, and 75 DAS and at harvest showed statistically significant variation due to different variety (Fig. 6). At 30, 45, 60, 75 DAS and at harvest, the highest number of leaves plant^{-1} was observed from V_2 (8.70, 15.29, 18.58, 20.73 and 21.77 respectively) which was statistically similar to V_3 (8.33, 14.91, 18.25, 20.30 and 21.43 respectively), whereas the lowest number of leaves plant^{-1} was recorded from V_1 (7.97, 13.29, 16.27, 18.58 and 19.58 respectively).

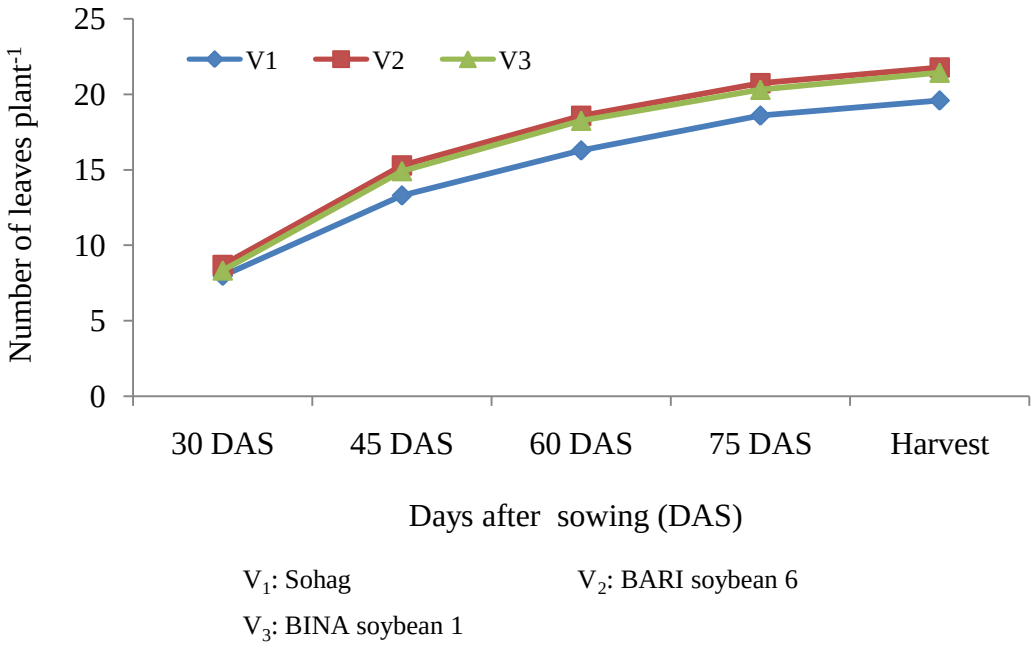
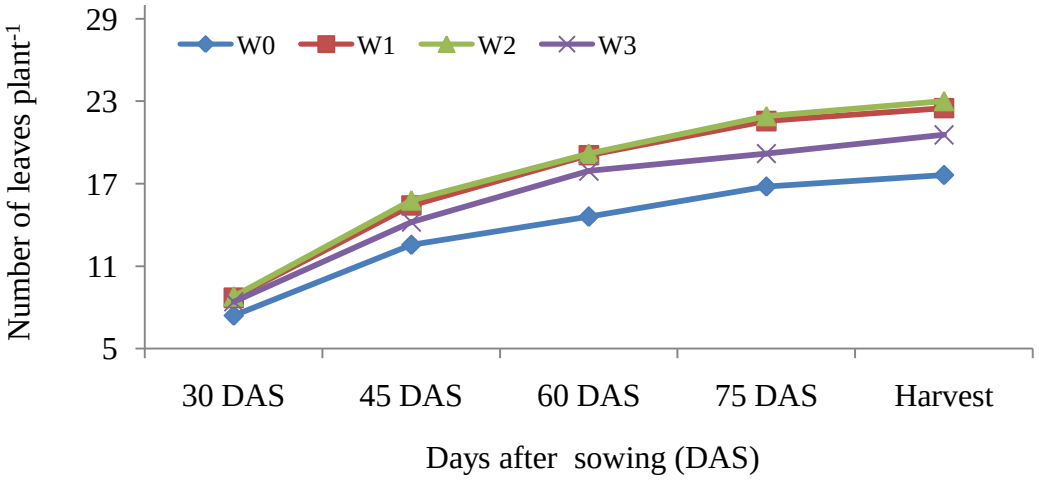


Fig. 6. Effect of different varieties on number of leaves plant^{-1}. SE = 0.110, 0.383, 0.323, 0.244 and 0.284 at 30, 45, 60, 75 DAS and at harvest.

Weed control methods showed statistically significant differences in terms of number of leaves plant^{-1} of soybean at 30, 45, 60, and 75 DAS and at harvest (Fig. 7). At 30, 45, 60, and 75 DAS and at harvest, the highest number of leaves plant^{-1} was found from W_2 (8.80, 15.79, 19.19, 21.93 and 23.01 respectively), which was statistically similar to W_1 (8.71, 15.43, 19.08, 21.56 and 22.51 respectively) and closely followed by W_3 (8.42, 14.21, 17.93, 19.20 and 20.56 respectively), while the lowest number of leaves plant^{-1} was attained from W_0 (7.40, 12.56, 14.60, 16.80 and 17.63 respectively).



W_0: No weeding i.e. control W_1: Hand weeding at 20 and 40 DAS

W_2: Chemical control by whip super 9EC herbicide application at 20 DAS

W_3: Bioherbicide-Siam weed extract

Fig. 7. Effect of different weed control methods on number of leaves plant^{-1} of soybean. SE = 0.103, 0.251, 0.231, 0.378 and 0.311 at 30, 45, 60, 75 DAS and at harvest.

Statistically significant variation was observed due to the interaction effect of varieties and weed control methods in terms of number of leaves plant^{-1} at 30, 45, 60, and 75 DAS and at harvest (Table 4). At 30, 45, 60, and 75 DAS and at harvest, the highest number of leaves plant^{-1} was recorded from V_2W_2 (9.26, 17.07, 20.60, 23.80 and 24.73 respectively) and the lowest number of leaves plant^{-1} was found from V_1W_0 (7.20, 11.23, 14.50, 17.27 and 18.03 respectively).

Table 3. Interaction effect of different variety and weed control methods on plant height of soybean at different days after sowing (DAS)

Treatment	Plant height (cm) at				
	30 DAS	45 DAS	60 DAS	75 DAS	Harvest
V_1W_0	14.51 f	24.55 d	36.58 e	44.06 e	46.69 e
V_1W_1	16.79 de	31.46 b	50.02 d	56.49 cd	61.05 bc
V_1W_2	17.15 cd	31.63 b	51.48 cd	57.63 bcd	61.71 bc
V_1W_3	17.41 cd	29.40 bc	47.55 d	53.06 d	55.05 d
V_2W_0	15.33 ef	25.91 d	38.68 e	43.61 e	53.75 d
V_2W_1	19.63 ab	37.75 a	60.10 ab	65.24 a	72.27 a
V_2W_2	19.86 a	38.65 a	61.66 a	66.45 a	73.10 a
V_2W_3	16.78 de	35.10 a	55.93 bc	59.22 bc	62.44 b
V_3W_0	15.27 ef	27.41 cd	40.85 e	48.23 e	56.93 cd
V_3W_1	18.21 bcd	36.30 a	57.60 ab	62.52 ab	68.65 a
V_3W_2	18.66 abc	36.25 a	57.24 ab	61.89 ab	69.70 a
V_3W_3	17.12 cd	35.04 a	55.79 bc	59.86 bc	62.15 b
SE(±)	0.507	1.094	4.276	1.560	1.610
CV(%)	5.10	5.84	4.88	4.78	4.50

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

V_1: Sohag
V_2: BARI soybean 6
V_3: BINA soybean 1

W_0: No weeding i.e. control
W_1: Hand weeding at 20 and 40 DAS
W_2: Chemical control by whip super 9EC herbicide application at 20 DAS
W_3: Bioherbicide-Siam weed extract

Table 4. Interaction effect of different variety and weed control methods on number of leaves plant^{-1} of soybean at different days after sowing (DAS)

Treatment	Number of leaves plant^{-1} at				
	30 DAS	45 DAS	60 DAS	75 DAS	Harvest
V_1W_0	7.20 g	11.23 f	14.50 d	17.27 e	18.03 de
V_1W_1	8.27 de	14.20 cd	17.03 c	19.40 cd	20.30 bc
V_1W_2	8.40 cde	14.67 c	17.33 c	20.00 bc	20.87 b
V_1W_3	8.00 ef	13.07 de	16.20 c	17.67 de	19.13 cd
V_2W_0	7.46 fg	12.03 ef	14.50 d	15.73 e	16.77 e
V_2W_1	9.20 ab	16.70 ab	20.43 a	23.33 a	24.07 a
V_2W_2	9.26 a	17.07 a	20.60 a	23.80 a	24.73 a
V_2W_3	8.87 abc	15.37 bc	18.80 b	20.07 bc	21.53 b
V_3W_0	7.53 fg	14.40 cd	14.80 d	17.40 de	18.10 de
V_3W_1	8.67 bcd	15.40 bc	19.77 ab	21.93 ab	23.17 a
V_3W_2	8.73 abcd	15.63 bc	19.63 ab	22.00 ab	23.43 a
V_3W_3	8.40 cde	14.20 cd	18.80 b	19.87 bc	21.00 b
SE(±)	0.179	0.434	1.187	0.654	0.539
CV(%)	6.72	5.19	4.91	5.70	4.46

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

V_1: Sohag
V_2: BARI soybean 6
V_3: BINA soybean 1

W_0: No weeding i.e. control
W_1: Hand weeding at 20 and 40 DAS
W_2: Chemical control by whip super 9EC herbicide application at 20 DAS
W_3: Bioherbicide-Siam weed extract

4.2.3 Dry matter plant^{-1}

Statistically significant variation was observed in terms of dry matter content of soybean plant^{-1} at 30, 45, 60, and 75 DAS and at harvest due to different variety (Fig. 8). At 30, 45, 60, 75 DAS and at harvest, the highest dry matter content plant^{-1} was found from V_2 (4.44, 8.90, 13.90, 19.59 and 22.44 g plant^{-1} respectively) which was statistically similar to V_3 (4.36, 8.72, 13.59, 18.92 and 21.83, respectively), while the lowest dry matter content plant^{-1} was observed from V_1 (3.77, 7.72, 11.92, 16.62 and 18.81, respectively). Umeh *et al*. (2011) reported that dry matter weight differed significantly in both varieties where the variety TGX 1740 produced the better results compare to Max–TGX 1440.

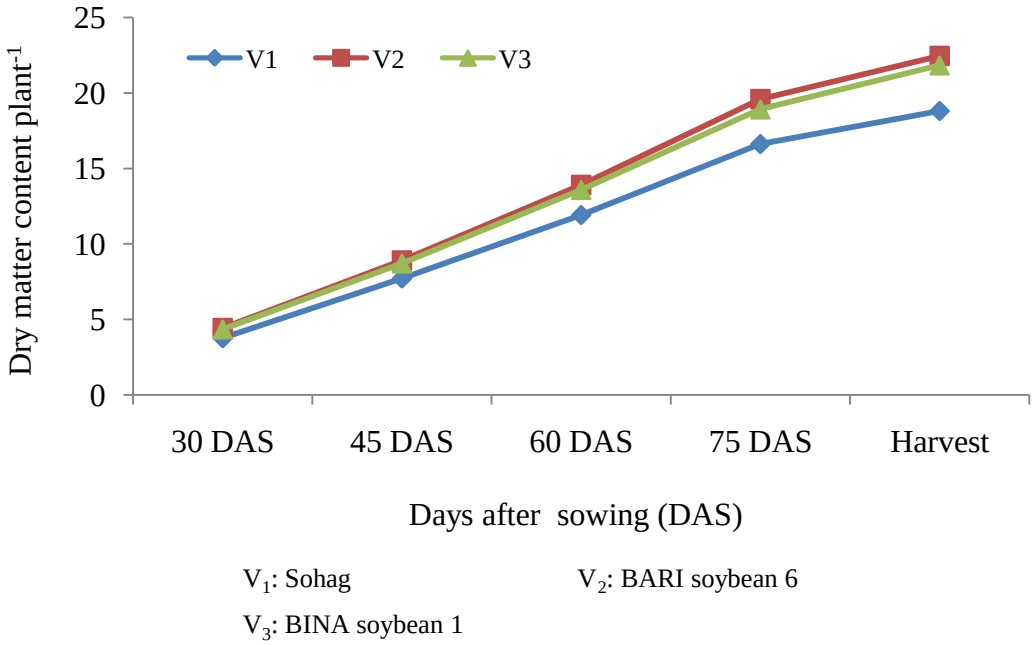
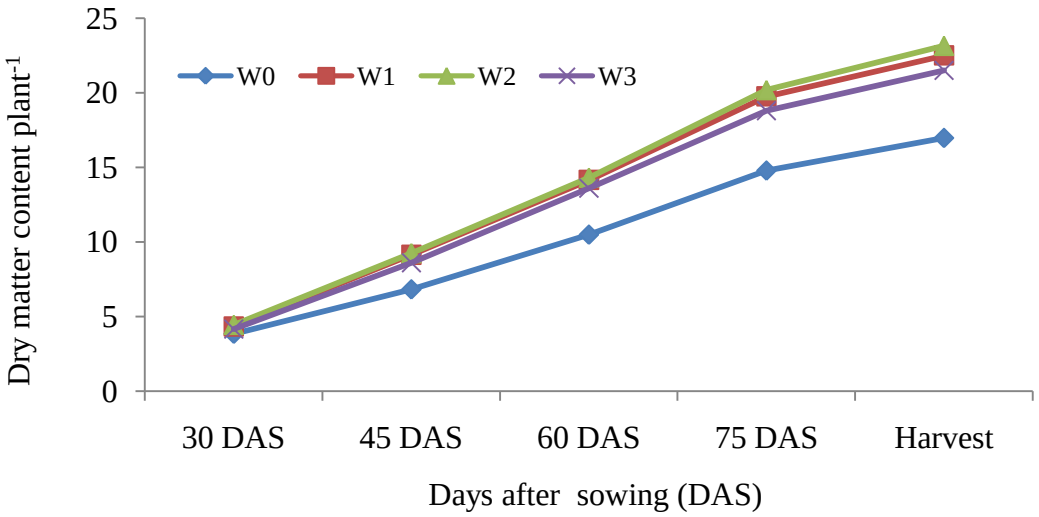


Fig. 8. Effect of different varieties on dry matter content plant^{-1} . SE = 0.072, 0.137, 0.061, 0.233 and 0.199 at 30, 45, 60, 75 DAS and at harvest.

Dry matter content plant^{-1} of soybean at 30, 45, 60, and 75 DAS and at harvest showed statistically significant variation due to different weed control methods (Fig. 9). At 30, 45, 60, and 75 DAS and at harvest, the highest dry matter content plant^{-1} was recorded from W_2 (4.44, 9.25, 14.31, 20.18 and 23.15 g respectively), which was statistically similar to W_1 (4.33, 9.13, 14.15, 19.75

and 22.49 g respectively) and closely followed by W_3 (4.16, 8.60, 13.61, 18.80 and 21.50 g respectively), whereas the lowest dry matter content plant^{-1} (3.83, 6.81, 10.48, 14.78 and 16.9 g, respectively) was observed from W_0. Abdelhamid and El-Metwally (2008) indicated that the herbicides at rates higher than the recommended markedly decreased the total dry weight plant^{-1}.



W_0: No weeding i.e. control W_1: Hand weeding at 20 and 40 DAS

W_2: Chemical control by whip super 9EC herbicide application at 20 DAS

W_3: Bioherbicide-Siam weed extract

Fig. 9. Effect of different weed control methods on dry matter content plant^{-1} of soybean. SE = 0.045, 0.120, 0.104, 0.238 and 0.177 for 30, 45, 60, 75 DAS and at harvest.

Interaction effect of varieties and weed control methods showed significant differences in cases of dry matter plant^{-1} at 30, 45, 60, and 75 DAS and at harvest (Table 5). At 30, 45, 60, and 75 DAS and at harvest, the highest dry matter plant^{-1} was recorded from V_2W_2 (4.75, 9.95, 15.34, 21.48 and 24.64, respectively), while the lowest dry matter content plant^{-1} was found from V_1W_0 (3.57, 6.62, 10.50, 13.65 and 15.22, respectively).

Table 5. Interaction effect of different variety and weed control methods on dry matter content plant^{-1} of soybean at different days after sowing (DAS)

Treatment	Dry matter content plant^{-1} (g) at				
	30 DAS	45 DAS	60 DAS	75 DAS	
V_1W_0	3.57 e	6.62 d	10.50 e	13.65 e	15.22 f
V_1W_1	3.84 cd	8.15 c	12.44 d	17.78bc	20.03 d
V_1W_2	3.96 cd	8.34 c	12.63 d	18.32 b	20.46 d
V_1W_3	3.72 de	7.76 c	12.12 d	16.73 c	19.53 d
V_2W_0	3.88 cd	6.85 d	10.63 e	15.24 d	17.83 e
V_2W_1	4.62 a	9.75 a	15.14 a	21.03 a	24.33 a
V_2W_2	4.75 a	9.95 a	15.34 a	21.48 a	24.64 a
V_2W_3	4.53 a	9.05 b	14.47bc	20.63 a	22.96 b
V_3W_0	4.05 bc	6.96 d	10.30 e	15.46 d	17.85 e
V_3W_1	4.54 a	9.48 ab	14.87ab	20.45 a	23.10 b
V_3W_2	4.60 a	9.46 ab	14.97ab	20.73 a	24.34 a
V_3W_3	4.24 b	8.97 b	14.24 c	19.06 b	22.02 c
SE(±)	0.077	0.208	0.181	0.412	0.307
CV(%)	3.24	4.27	5.39	4.89	5.53

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

V_1: Sohag
V_2: BARI soybean 6
V_3: BINA soybean 1

W_0: No weeding i.e. control
W_1: Hand weeding at 20 and 40 DAS
W_2: Chemical control by whip super 9EC herbicide application at 20 DAS
W_3: Bioherbicide-Siam weed extract

4.2.4 Days to harvest

Different variety exerted statistically significant variation in terms of days to harvest of soybean (Table 6). The maximum days to harvest recorded in V_1 (108.00), while the minimum days to harvest was observed in V_2 (104.25) which was statistically similar to V_3 (105.50). Days to harvest varied for different varieties might be due to genetical and environmental influences as well as management practices.

Statistically significant variation was recorded in terms of days to harvest of soybean due to different weed control methods (Table 6). The highest days to harvest was observed from W_2 (107.11), which was statistically similar to W_1 (106.78) and W_3 (106.78), whereas the lowest days to harvest (103.33) was found from W_0.

Days to harvest varied significantly due to the interaction effect of varieties and weed control methods (Table 7). The highest days to harvest was observed from V_1W_2 (109.67), while the lowest days to harvest was recorded from V_3W_0 (103.00).

4.2.5 Pod length

Statistically significant variation was recorded in terms of pod length of soybean due to different variety (Table 6). The highest pod length was observed from V_2 (3.54 cm) which was statistically similar to V_3 (3.47 cm) and the lowest pod length was found from V_1 (2.98 cm).

Pod length of soybean showed statistically significant variation due to different weed control methods (Table 6). The highest pod length was recorded from W_2 (3.62 cm), which was statistically similar to W_1 (3.51 cm) and closely followed by W_3 (3.37 cm), while the lowest pod length was observed from W_0 (2.82 cm).

Interaction effect of varieties and weed control methods showed significant differences in terms of pod length (Table 7). The highest pod length was observed from V_2W_2 (3.96 cm) and the lowest pod length from V_1W_0 (2.79cm).

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Table 6. Effect of different variety and weed control methods on days to harvest, pod length, number of pods plant^{-1} and number of seeds pod^{-1} of soybean

Treatment	Days to harvest (days)	Pod length (cm)	Pods plant^{-1} (No.)	Seeds pod^{-1} (No.)
Varieties				
V_1	108.00 a	2.98 b	40.97 b	2.43 b
V_2	104.25 b	3.54 a	48.81 a	2.87 a
V_3	105.50 b	3.47 a	45.89 a	2.81 a
SE(±)	0.574	0.079	1.032	0.077
CV(%)	3.73	2.78	5.32	3.56
Methods of weed control				
W_0	103.33 b	2.82 c	35.31 c	2.29 c
W_1	106.78 a	3.51 ab	48.84 ab	2.87 a
W_2	107.11 a	3.62 a	50.82 a	2.93 a
W_3	106.44 a	3.37 b	45.92 b	2.72 b
SE(±)	0.976	0.068	1.120	0.041
CV(%)	5.76	6.14	7.43	4.54

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

V_1: Sohag
V_2: BARI soybean 6
V_3: BINA soybean 1

W_0: No weeding i.e. control
W_1: Hand weeding at 20 and 40 DAS
W_2: Chemical control by whip super 9EC herbicide application at 20 DAS
W_3: Bioherbicide-Siam weed extract

Table 7. Interaction effect of different variety and weed control methods on days to harvest, pod length, number of pods plant^{-1} and number of seeds pod^{-1} of soybean

Treatment	Days to harvest (days)	Pod length (cm)	Pods plant^{-1} (No.)	Seeds pod^{-1} (No.)
V_1W_0	104.00 ab	2.79 c	34.40 e	2.17 e
V_1W_1	109.00 a	2.95 c	44.13 cd	2.60 bc
V_1W_2	109.67 a	3.14 c	45.73 c	2.67 b
V_1W_3	109.33 a	3.02 c	39.63 de	2.30 de
V_2W_0	103.00 b	2.84 c	34.87 e	2.30 de
V_2W_1	105.00 ab	3.83 ab	55.40 ab	3.07 a
V_2W_2	105.00 ab	3.96 a	56.47 a	3.13 a
V_2W_3	104.00 ab	3.56 b	48.50 c	2.97 a
V_3W_0	103.00 b	2.82 c	36.67 e	2.40 cd
V_3W_1	106.33 ab	3.77 ab	47.00 c	2.93 a
V_3W_2	106.67 ab	3.76 ab	50.27 bc	3.00 a
V_3W_3	106.00 ab	3.52 b	49.63 bc	2.90 a
SE(±)	1.690	0.118	1.939	0.071
CV(%)	5.76	6.14	7.43	4.54

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

V_1: Sohag
V_2: BARI soybean 6
V_3: BINA soybean 1

W_0: No weeding i.e. control
W_1: Hand weeding at 20 and 40 DAS
W_2: Chemical control by whip super 9EC herbicide application at 20 DAS
W_3: Bioherbicide-Siam weed extract

4.2.6 Pods plant^{-1}

Number of pods plant^{-1} of soybean varied significantly due to different varieties (Table 6). The highest number of pods plant^{-1} was found from V_2 (48.81) which was statistically similar to V_3 (45.89), while the lowest number of pods plant^{-1} was recorded from V_1 (40.97). Umeh *et al*. (2011) reported that number of seed differed significantly between two varieties where the variety TGX 1740 produced the better results compare to Max–TGX 1440.

Different weed control methods showed statistically significant variation in terms of number of pods plant^{-1} of soybean (Table 6). The highest number of pods plant^{-1} was found from W_2 (50.82), which was statistically similar to W_1 (48.84) and closely followed by W_3 (45.92), whereas the lowest number of pods plant^{-1} (35.31) was observed from W_0. Several studies indicate a reduction in the number of pods of soybean plants under weed competition (Martins, 1994;

Statistically significant variation was recorded due to the interaction effect of varieties and weed control methods in terms of number of pods plant^{-1} (Table 7). The highest number of pods plant^{-1} was found from V_2W_2 (56.47), while the lowest number of pods plant^{-1} was observed from V_1W_0 (34.40).

4.2.7 Seeds pod^{-1}

Statistically significant variation was recorded in terms of number of seeds pod^{-1} of soybean due to different variety (Table 6). The highest number of seeds pod^{-1} was found from V_2 (2.87) which was statistically similar to V_3 (2.81), again the lowest number of seeds pod^{-1} was found from V_1 (2.43).

Number of seeds pod^{-1} of soybean showed statistically significant variation due to different weed control methods (Table 6). The highest number of seeds pod^{-1} was observed from W_2 (2.93), which was statistically similar to W_1 (2.87) and closely followed by W_3 (2.72), while the lowest number of seeds pod^{-1} was found from W_0 (2.29). Abdelhamid and El-Metwally (2008) revealed that two

hand hoeing treatments gave the highest values of number of seeds per plant^{-1} by 59.8% compared to the non weeded treatment.

Interaction effect of varieties and weed control methods showed significant differences in terms of number of seeds pod^{-1} (Table 7). The highest number of seeds pod^{-1} was observed from V_2W_2 (3.13), whereas the lowest number of seeds pod^{-1} was recorded from V_1W_0 (2.17).

4.2.8 Weight of 100-seed

Hundred seed weights of different varieties showed significant variations among them (Fig. 10). The maximum weight of 100-seeds was observed from V_2 (14.26 g) which was statistically similar to V_3 (14.05 g).The lowest weight of 100-seeds was recorded from V_1 (13.46 g). Umeh *et al*. (2011) reported that pod weight differed significantly different .They also found that the variety TGX 1740 produced better yield compare to Max–TGX 1440.

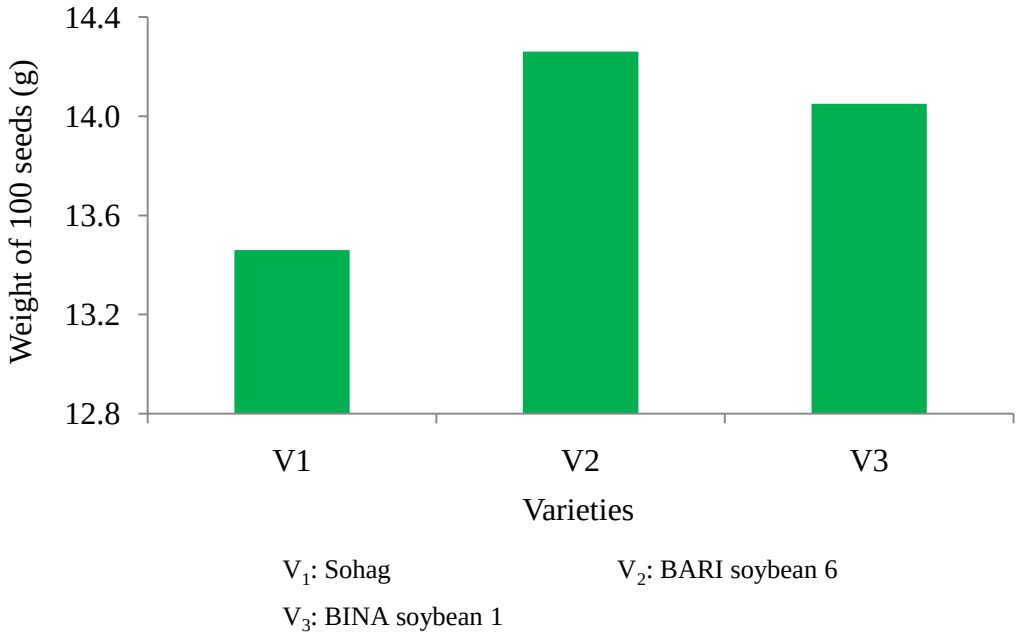
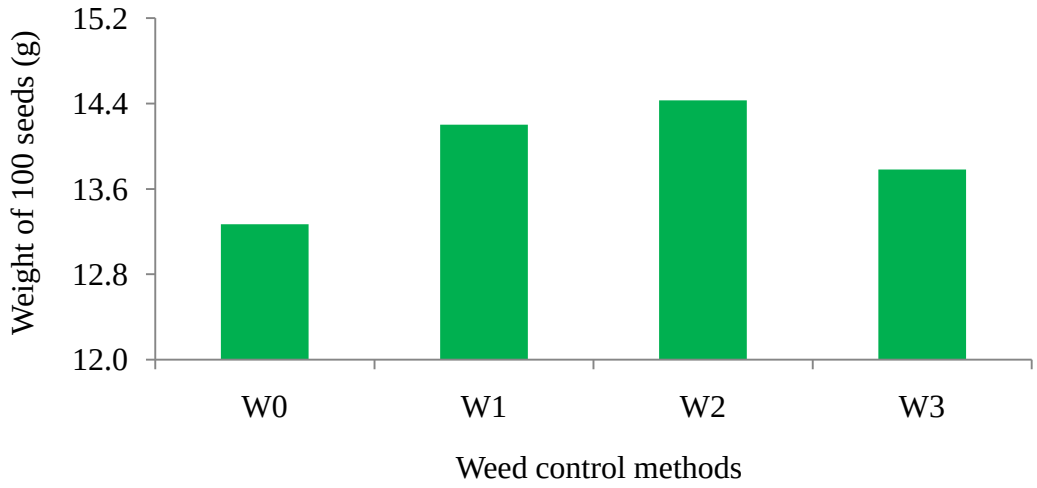


Fig. 10. Effect of different sowing dates on weight of 100 seeds of soybean. SE = 0.125.

Different treatments of weed control methods affected 100 seed weight significantly (Fig. 11). The highest weight of 100-seeds was observed from W_2 (14.43 g), which was statistically similar to W_1 (14.20 g) and closely followed

by W_3 (13.78 g).The lowest weight of 100-seeds was recorded from W_0 (13.27 g). Significant reductions in terms of 1000-seed weight of soybeans was recorded when the crop suffers the competition from weeds (Silva *et al.*, 2008). The lowest seed weight of 100 seeds is indicated that no weeding i.e. in control plots weeds drastically affected the plants and its 100 seed weight.



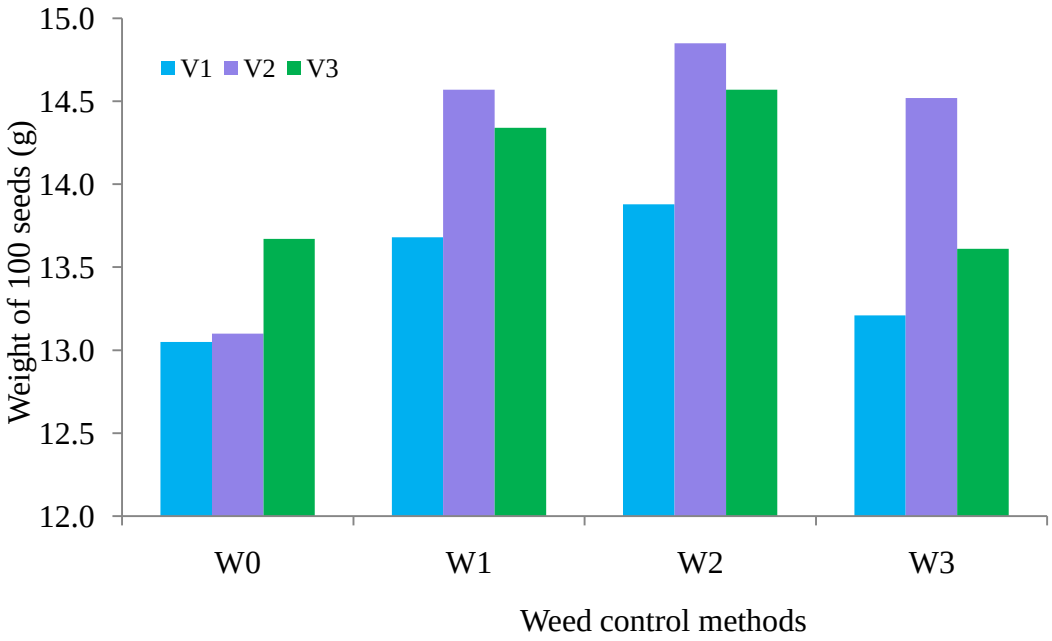
W_0: No weeding i.e. control W_1: Hand weeding at 20 and 40 DAS

W_2: Chemical control by whip super 9EC herbicide application at 20 DAS

W_3: Bioherbicide-Siam weed extract

Fig. 11. Effect of different varieties on weight of 100 seeds of soybean. SE = 0.117.

Statistically significant variation was recorded due to the interaction effect of varieties and weed control methods in terms of weight of 100-seed (Fig. 12). The highest weight of 100-seeds was observed from V_2W_2 (14.85 g), while the lowest weight of 100-seeds was recorded from V_1W_0 (13.05 g).



V_1: Sohag, V_2: BARI soybean 6 and V_3: BINA soybean 1
W_0: No weeding i.e. control W_1: Hand weeding at 20 and 40 DAS
W_2: Chemical control by whip super 9EC herbicide application at 20 DAS
W_3: Bioherbicide-Siam weed extract

Fig. 12. Interaction effect of different varieties and weed control methods on weight of 100 seeds of soybean.
SE = 0.203.

4.2.9 Seed yield

Seed yields of soybean varieties varied significantly (Table 8), Appendix ix. The highest seed yield was obtained in V_2 (1.99 t ha^{-1}) which was statistically similar to V_3 (1.87 t ha^{-1}), while the lowest seed yield was recorded from V_1 (1.52 t ha^{-1}). Truyen *et al.* (2004) reported that grain yield differed among genotypes where CM60 produced the highest yield of 2.4 t ha^{-1}. M103 and TN12 produced 1.67 and 1.6 t ha^{-1} while 95389 and MSBR20 yielded 1.47 and 1.29 t ha^{-1}, respectively. The maximum seed yield in V_2 was contributed both by its higher 100 seed weight and also by weed control method W_2.

Statistically significant variation was recorded in terms of seed yield of soybean due to different weed control methods (Table 8). The highest seed yield was recorded in weed control method W_2 (2.01 t bha^{-1}), which was followed by W_1 (1.92 t ha^{-1}) and W_3 (1.84 t ha^{-1}) and they were statistically similar, whereas the

lowest seed yield was found from W_0 (1.41 t ha^{-1}). Nepomuceno *et al.* (2007) evaluated weed interference in soybean in conventional sowing system and reported a 32% drop in the yield of the crop when it coexisted with weeds throughout their life cycle v.e. crop duration.

Interaction effect of varieties and weed control methods showed significant differences in terms of seed yield (Table 9). The highest seed yield was observed from V_2W_2 (2.23 t ha^{-1}), while the lowest seed yield was recorded from V_1W_0 (1.26t ha^{-1}).The interaction results indicated that the variety V_2 with weed control method W_2 together contributed the highest seed yield.

4.2.10 Stover yield

Statistically significant variation was recorded in terms of stover yield of soybean due to different variety (Table 8). The highest stover yield was found from V_2 (2.42 t ha^{-1}) which was statistically similar to V_3 (2.35 t ha^{-1}) and the lowest stover yield was found from V_1 (2.04 t ha^{-1}).

Stover yield of soybean showed statistically significant variation due to different weed control methods (Table 8). The highest stover yield was observed from W_2 (2.43 t ha^{-1}), which was statistically similar to W_1 (2.36 t ha^{-1}) and closely followed by W_3 (2.25 t ha^{-1}), while the lowest stover yield was recorded from W_0 (2.05 t ha^{-1}).

Table 8. Effect of different variety and weed control methods on seed, stover and biological yield and harvest index of soybean

Treatment	Seed yield (t ha^{-1})	Stover yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
Varieties				
V_1	1.52 b	2.04 b	3.56 b	42.60
V_2	1.99 a	2.42 a	4.41 a	45.02
V_3	1.87 a	2.35 a	4.22 a	44.12
SE(±)	0.042	0.063	0.090	0.749
CV(%)	8.23	9.22	7.6	6.20
Methods of weed control				
W_0	1.41 c	2.05 c	3.46 d	40.75 b
W_1	1.92 b	2.36 a	4.28 b	44.81 a
W_2	2.01 a	2.43 a	4.44 a	45.26 a
W_3	1.84 b	2.25 b	4.08 c	44.84 a
SE(±)	0.030	0.030	0.049	0.423
CV(%)	4.86	5.83	4.61	4.89

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

V_1: Sohag
V_2: BARI soybean 6
V_3: BINA soybean 1

W_0: No weeding i.e. control
W_1: Hand weeding at 20 and 40 DAS
W_2: Chemical control by whip super 9EC herbicide application at 20 DAS
W_3: Bioherbicide-Siam weed extract

Table 9. Interaction effect of different variety and weed control methods on seed, stover and biological yield and harvest index of soybean

Treatment	Seed yield (t ha^{-1})	Stover yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
V_1W_0	1.26 f	1.92 d	3.18 f	39.70 f
V_1W_1	1.57 de	2.08 cd	3.65 de	43.17 cd
V_1W_2	1.69 d	2.15 bc	3.84 d	43.94 abcd
V_1W_3	1.56 de	2.00 cd	3.55 e	43.58 bcd
V_2W_0	1.51 e	2.07 cd	3.58 de	42.23 de
V_2W_1	2.17 ab	2.53 a	4.70 ab	46.18 a
V_2W_2	2.23 a	2.61 a	4.84 a	46.09 a
V_2W_3	2.06 b	2.46 a	4.53 b	45.59 abc
V_3W_0	1.45 e	2.15 bc	3.60 de	40.31 ef
V_3W_1	2.03 bc	2.47 a	4.50 b	45.07 abc
V_3W_2	2.12 ab	2.52 a	4.64 ab	45.74 ab
V_3W_3	1.89 c	2.28 b	4.16 c	45.35 abc
SE(±)	0.052	0.052	0.086	0.733
CV(%)	4.86	5.83	4.61	4.89

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

V_1: Sohag
V_2: BARI soybean 6
V_3: BINA soybean 1

W_0: No weeding i.e. control
W_1: Hand weeding at 20 and 40 DAS
W_2: Chemical control by whip super 9EC herbicide application at 20 DAS
W_3: Bioherbicide-Siam weed extract

Interaction effect of varieties and weed control methods showed significant differences in terms of stover yield (Table 9). The highest stover yield was observed from V_2W_2 (2.61 t ha^{-1}), again the lowest stover yield was observed from V_1W_0 (1.92 t ha^{-1}).

4.2.11 Biological yield

Statistically significant variation was recorded in terms of biological yield of soybean due to different variety (Table 8). The highest biological yield was attained from V_2 (4.41 t ha^{-1}) which was statistically similar to V_3 (4.22 t ha^{-1}), while the lowest biological yield was observed from V_1 (3.56 t ha^{-1}).

Biological yield of soybean showed statistically significant variation due to different weed control methods (Table 8). The highest biological yield was observed from W_2 (4.44 t ha^{-1}), which was closely followed by W_1 (4.28 t ha^{-1}), whereas the lowest biological yield was recorded from W_0 (3.46 t ha^{-1}) which was closely followed by W (4.08 t ha^{-1}) $_3$. Abdelhamid and El-Metwally (2008) found that, oxadiargyl at the recommended rate (480 g ha^{-1}) was the best treatment for promoting biological yield (g $plant^{-1}$) compared to the non weeded treatment by 88.2%.

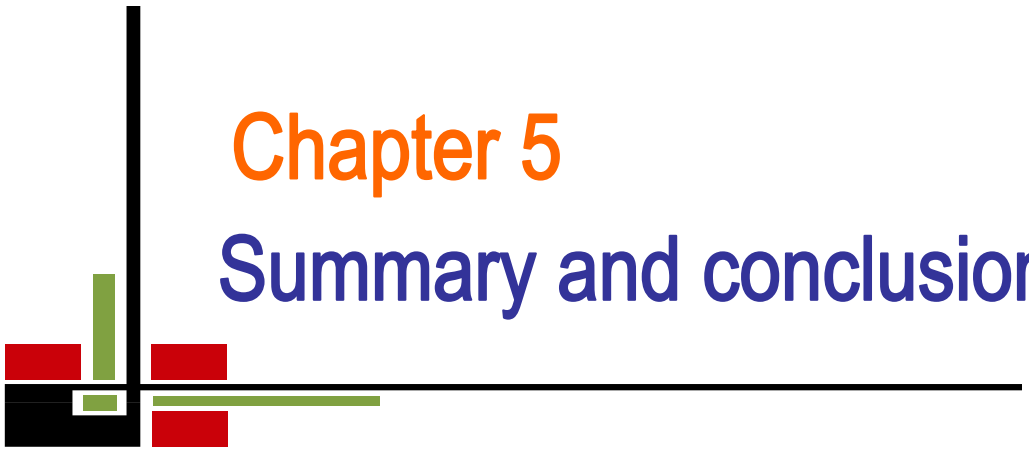
Interaction effect of varieties and weed control methods showed significant differences in terms of biological yield (Table 9). The highest biological yield was found from V_2W_2 (4.84 t ha^{-1}), while the lowest biological yield was recorded from V_1W_0 (3.18 t ha^{-1}).

4.2.12 Harvest index

Statistically non significant variation was recorded in terms of harvest index of soybean due to different variety (Table 8). The highest harvest index was observed from V_2 (45.02%) and the lowest harvest index was recorded from V_1 (42.60 %).

Harvest index of soybean showed statistically significant variation due to different weed control methods (Table 8). The highest harvest index was recorded from W_2 (45.26%), which was statistically similar to W_1 (44.81%) and W_3 (44.81%), while the lowest harvest index was found from W_0 (40.75%).

Interaction effect of varieties and weed control methods showed significant differences in terms of harvest index (Table 9). The highest harvest index was found from V_2W_2 (46.09%), whereas the lowest harvest index was observed V_1W_0 (39.70%).



Chapter 5

Summary and conclusion

CHAPTER V

SUMMARY AND CONCLUSION

The experiment was conducted at the farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, Bangladesh during the period from December 2013 to April 2014 to study the influence of weed control methods on the growth and yield of soybean. The experiment comprised of two factors- Factor A: Soybean variety (3 varieties); V_1: Sohag, V_2: BARI soybean 6 and V_3: BINA soybean 1; Factors B: Levels of weed control methods (4 levels)- W_0: No weeding i.e. control, W_1: Hand weeding at 20 and 40 DAS,W_2: Chemical control by whip super 9EC herbicide application at 20 DAS W_3: Bioherbicide-Siam weed extract. The experiment was laid out in Split plot Design with three replications.

In case of weed population, at 30, 45, 60 and 75 DAS, the maximum number of weed population (15.92, 20.17, 18.33 and 15.42, respectively) was found from V_1, whereas the minimum number (15.33, 19.42, 17.50 and 15.42, respectively) from V_2 and in the plot of V_3, the number of weed population was recorded 15.83, 19.42, 17.83 and 15.67, respectively. At 30, 45, 60 and 75 DAS, the maximum number of weed population (25.00, 31.22, 25.22 and 20.44, respectively) was observed from W_0, while the minimum number (11.78, 14.67, 14.44 and 14.11, respectively) from W_2. Interaction effect of varieties and weed control methods, at 30, 45, 60 and 75 DAS, the maximum number of weed population (27.33, 33.00, 26.67 and 21.33, respectively) was observed from V_3W_0 and the minimum number (10.67, 13.67, 13.67 and 12.33, respectively) was recorded from V_3W_2.

In case of variety, at 30, 45, 60, 75 DAS and at harvest, the tallest plant (17.90, 34.35, 54.09, 58.63 and 65.39 cm, respectively) was found from V_2, while the shortest plant (16.46, 29.26, 46.41, 52.81 and 56.12 cm, respectively) was observed from V_1. At 30, 45, 60, 75 DAS and at harvest, the highest number of leaves plant^{-1} (8.70, 15.29, 18.58, 20.73 and 21.77 respectively) from $V_{2\ 3}$,

whereas the lowest number of leaves plant^{-1} (7.97, 13.29, 16.27, 18.58 and 19.58 respectively) was recorded from V_1. At 30, 45, 60, 75 DAS and at harvest, the highest dry matter content plant^{-1} (4.44, 8.90, 13.90, 19.59 and 22.44 respectively) was found from V_2, while the lowest (3.77, 7.72, 11.92, 16.62 and 18.81, respectively) from V_1. The highest days to harvest (108.00) was found from V_1, while the lowest days (104.25) from V_2. The highest pod length (3.54 cm) was observed from V_2 and the lowest (2.98 cm) from V_1. The highest number of pods plant^{-1} (48.81) was found from V_2, while the lowest number (40.97) from V_1. The highest number of seeds pod^{-1} (2.87) was found from V_2, again the lowest number (2.43) from V_1. The highest weight of 100-seeds (14.26 g) was observed from V_2, while the lowest weight (13.46 g) from V_1. The highest seed yield (1.99 t ha^{-1}) was found from V_2, while the lowest seed yield (1.52 t ha^{-1}) was observed from V_1. The highest stover yield (2.42 t ha^{-1}) was found from V_2 and the lowest stover yield (2.04 t ha^{-1}) was found from V_1. The highest biological yield (4.41 t ha^{-1}) was attained from V_2, while the lowest biological yield (3.56 t ha^{-1}) was observed from V_1. The highest harvest index (45.02%) was observed from V_2 and the lowest harvest index (42.60 %) from V_1.

For weed control methods, at 30, 45, 60, and 75 DAS and at harvest, the tallest plant (18.56, 35.51, 56.80, 61.99 and 68.17 cm, respectively) was observed from W_2, whereas the shortest plant (15.04, 25.95, 38.70, 45.30 and 52.46 cm, respectively) from W_0. At 30, 45, 60, and 75 DAS and at harvest, the highest number of leaves plant^{-1} (8.80, 15.79, 19.19, 21.93 and 23.01 respectively) was found from W_2, while the lowest number (7.40, 12.56, 14.60, 16.80 and 17.63 respectively) was attained from W_0. At 30, 45, 60, and 75 DAS and at harvest, the highest dry matter content plant^{-1} (4.44, 9.25, 14.31, 20.18 and 23.15 respectively) was recorded from W_2, whereas the lowest (3.83, 6.81, 10.48, 14.78 and 16.97, respectively) was observed from W_0. The highest days to harvest (107.11) was observed from W_2, whereas the lowest days (103.33) from W_0. The highest pod length (3.62 cm) was recorded from W_2, while the

lowest pod length (2.82 cm) was observed from W_0. The highest number of pods plant^{-1} (50.82) was found from W_2, whereas the lowest number (35.31) from W_0. The highest number of seeds pod^{-1} (2.93) was observed from W_2, while the lowest number of seeds pod^{-1} (2.29) was found from W_0. The highest weight of 100-seeds (14.43) was observed from W_2, whereas the lowest weight (13.27) from W_0. The highest seed yield (2.01 t bha^{-1}) was observed from W_2, whereas the lowest seed yield (1.41 t ha^{-1}) from W_0. The highest stover yield (2.43 t ha^{-1}) was observed from W_2, while the lowest stover yield (2.05 t ha^{-1}) from W_0. The highest biological yield (4.44 t ha^{-1}) was observed from W_2, whereas the lowest biological yield (3.46 t ha^{-1}) from W_0. The highest harvest index (45.26%) was recorded from W_2, while the lowest harvest index (40.75%) was found from W_0.

Due to the interaction effect of varieties and weed control methods at 30, 45, 60, and 75 DAS and at harvest, the tallest plant (19.86, 38.65, 61.66, 66.45 and 73.10 cm, respectively) was observed from V_2W_2, while the shortest plant (14.51, 24.55, 36.58, 44.06 and 46.69 cm, respectively) from V_1W_0. At 30, 45, 60, and 75 DAS and at harvest, the highest number of leaves plant^{-1} (9.26, 17.07, 20.60, 23.80 and 24.73 respectively) was recorded from V_2W_2 and the lowest number (7.20, 11.23, 14.50, 17.27 and 18.03 respectively) from V_1W_0. At 30, 45, 60, and 75 DAS and at harvest, the highest number of leaves plant^{-1} (4.75, 9.95, 15.34, 21.48 and 24.64, respectively) was recorded from V_2W_2, while the lowest d (3.57, 6.62, 10.50, 13.65 and 15.22, respectively) from V_1W_0. The highest days to harvest (109.67) was observed from V_1W_2, while the lowest days to harvest (103.00) from V_3W_0. The highest pod length (3.96 cm) was observed from V_2W_2 and the lowest pod length (2.79 cm) from V_1W_0. The highest number of pods plant^{-1} (56.47) was found from V_2W_2, while the lowest number (34.40) was observed from V_1W_0. The highest number of seeds pod^{-1} (3.13) was observed from V_2W_2, whereas the lowest number (2.17) from V_1W_0. The highest weight of 100-seeds (14.85) was observed from V_2W_2, while the lowest (13.05) from V_1W_0. The highest seed yield (2.23 t ha^{-1}) was

observed from V_2W_2, while the lowest (1.26t ha^{-1}) from V_1W_0. The highest stover yield (2.61 t ha^{-1}) was observed from V_2W_2, again the lowest stover yield (1.92 t ha^{-1}) from V_1W_0. The highest biological yield (4.84 t ha^{-1}) was found from V_2W_2, while the lowest biological yield (3.18 t ha^{-1}) was recorded from V_1W_0. The highest harvest index (46.09%) was found from V_2W_2, whereas the lowest harvest index (39.70%) was observed V_1W_0.

Conclusion:

- Among the variety and BARI soybean 6 was superior other than the variety used in this experiment.
- Chemical control by whip super 9EC herbicide application at 20 DAS and 40 DAS was superior among the different weed control methods.

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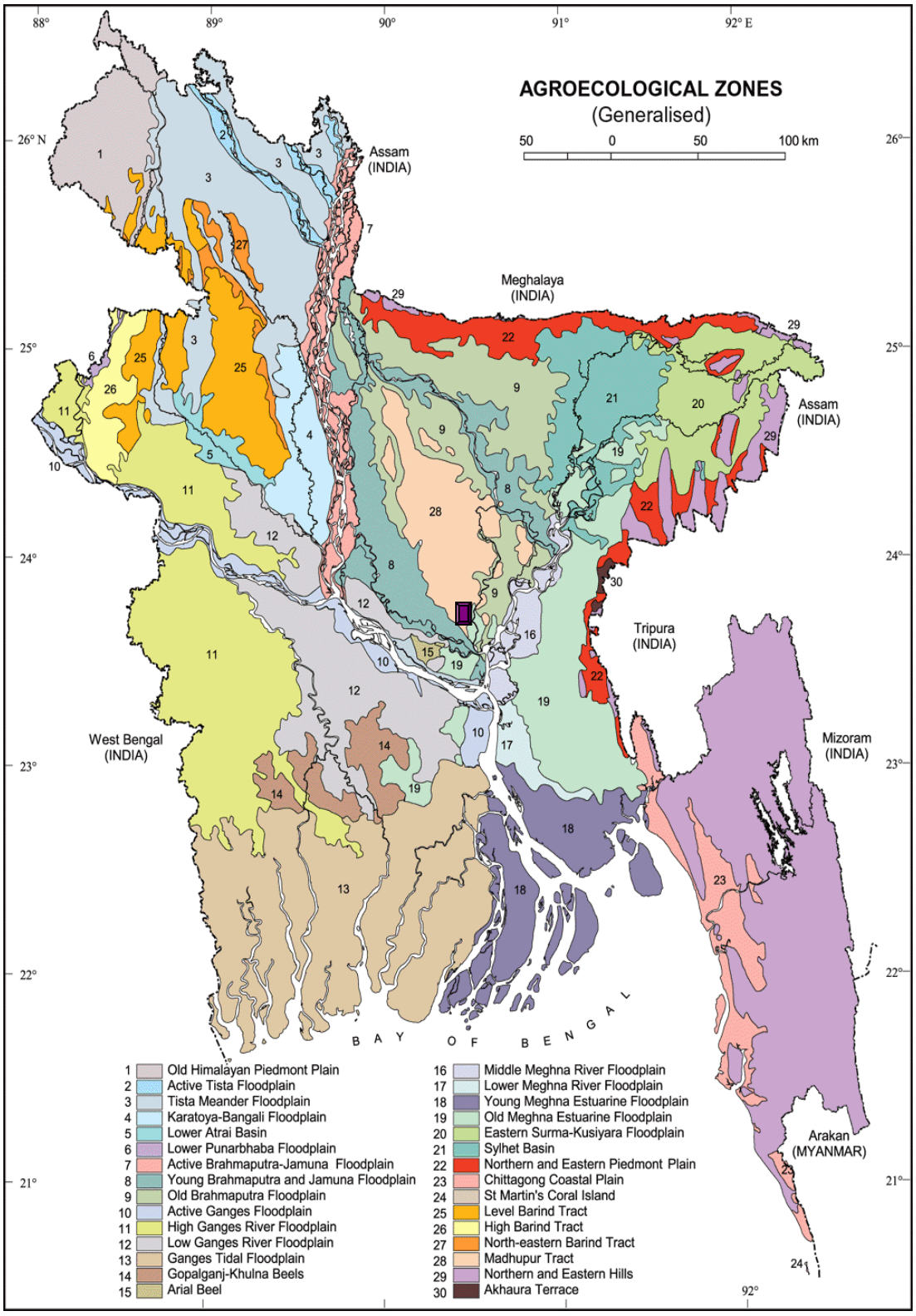
Appendices

APPENDICES

Appendix I. The Map of the experimental site



Appendix II. Characteristics of soil of experimental field

A. Morphological characteristics of the experimental field

Morphological features	Characteristics
Location	Agronomy field , SAU, Dhaka
AEZ	Madhupur Tract (28)
General Soil Type	Shallow red brown terrace soil
Land type	High land
Soil series	Tejgaon
Topography	Fairly leveled

B. Physical and chemical properties of the initial soil

Characteristics	Value
% Sand	27
% Silt	43
% clay	30
Textural class	silty-clay
pH	5.6
Organic matter (%)	0.78
Total N (%)	0.03
Available P (ppm)	20.00
Exchangeable K (me/100 g soil)	0.10
Available S (ppm)	45

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

Appendix III. Monthly average of air temperature, relative humidity and total rainfall of the experimental site during the period from December, 2013 to March, 2014

Month	*Air temperature (^{o}C)		*Relative humidity (%)	*Rainfall (mm) (total)
	Maximum	Minimum		
November, 2013	25.8	16.0	78	00
December, 2013	22.4	13.5	74	00
January, 2014	25.2	12.8	69	00
February, 2014	27.3	16.9	66	39
March, 2014	31.7	19.2	57	23

* Monthly average,

* Source: Bangladesh Meteorological Department (Climate & weather division) Agargoan, Dhaka - 1212

Appendix IV. Analysis of variance of the data on weed population in soybean at different days after sowing (DAS) as influenced by different variety and weed control methods

Source of variation	Degrees of freedom	Mean square			
		Weed population (No.)			
		30 DAS	45 DAS	60 DAS	75 DAS
Replication	2	0.361	0.528	0.028	0.028
Variety (A)	2	1.194	2.861	2.111	1.361
Error	4	2.444	1.194	1.944	0.986
Methods of weed control (B)	3	352.991**	546.704**	219.778**	97.370**
Interaction (A × B)	6	10.269**	8.787**	19.777*	2.065*
Error	18	1.676	1.565	3.306	0.667

** Significant at 0.01 level of probability; * Significant at 0.05 level of probability

Appendix V. Analysis of variance of the data on plant height of soybean at different days after sowing (DAS) as influenced by different variety and weed control methods

Source of variation	Degrees of freedom	Mean square				
		Plant height (cm) at				
		30 DAS	45 DAS	60 DAS	75 DAS	Harvest
Replication	2	0.441	1.417	0.617	11.453	6.764
Variety (A)	2	6.263*	92.973**	204.629**	124.728**	309.54**
Error	4	0.644	2.275	4.682	2.284	6.420
Methods of weed control (B)	3	22.627**	178.527**	639.517**	541.692**	486.061**
Interaction (A × B)	6	2.092*	5.377*	13.018*	18.522*	18.833*
Error	18	0.772	3.593	6.215	7.297	7.777

** Significant at 0.01 level of probability; * Significant at 0.05 level of probability

Appendix VI. Analysis of variance of the data on number of leaves plant^{-1} of soybean at different days after sowing (DAS) as influenced by different variety and weed control methods

Source of variation	Degrees of freedom	Mean square				
		Number of leaves plant^{-1} at				
		30 DAS	45DAS	60 DAS	75 DAS	Harvest
Replication	2	0.093	0.389	0.693	0.114	0.159
Variety (A)	2	1.605*	13.521*	18.823**	15.514**	16.636**
Error	4	0.146	1.759	1.255	0.716	0.969
Methods of weed control (B)	3	3.722**	19.184**	41.339**	50.917**	53.515**
Interaction (A × B)	6	2.093**	2.547**	2.071**	5.048**	4.348**
Error	18	0.096	0.565	0.479	1.283	0.870

** Significant at 0.01 level of probability; * Significant at 0.05 level of probability

Appendix VII. Analysis of variance of the data on dry matter content plant^{-1} of soybean at different days after sowing (DAS) as influenced by different variety and weed control methods

Source of variation	Degrees of freedom	Mean square				
		Dry matter content plant^{-1} (g) at				
		30 DAS	45 DAS	60 DAS	75 DAS	Harvest
Replication	2	0.006	0.216	0.077	0.704	0.138
Variety (A)	2	1.614**	4.879**	13.575**	29.221**	45.387**
Error	4	0.063	0.226	0.045	0.653	0.477
Methods of weed control (B)	3	0.632**	11.427**	29.099**	54.676**	69.981**
Interaction (A × B)	6	0.052*	0.349*	1.558**	2.490*	0.663*
Error	18	0.018	0.130	0.098	0.510	0.283

** Significant at 0.01 level of probability; * Significant at 0.05 level of probability

Appendix VIII. Analysis of variance of the data on days to harvest, pod length, number of pods plant^{-1} and number of seeds pod^{-1} of soybean at different days after sowing (DAS) as influenced by different variety and weed control methods

Source of variation	Degrees of freedom	Mean square			
		Days to harvest (days)	Pod length (cm)	Pods plant^{-1} (No.)	Seeds pod^{-1} (No.)
Replication	2	0.333	0.018	6.326	0.002
Variety (A)	2	43.750*	1.143**	188.083**	0.665*
Error	4	3.958	0.074	12.777	0.072
Methods of weed control (B)	3	27.361**	1.143**	429.602**	0.756**
Interaction (A × B)	6	19.417*	0.131*	32.040*	0.043*
Error	18	8.565	0.042	11.283	0.015

** Significant at 0.01 level of probability; * Significant at 0.05 level of probability

Appendix IX. Analysis of variance of the data on weight of 100 seeds, seed, stover and biological yield and harvest index of soybean of soybean at different days after sowing (DAS) as influenced by different variety and weed control methods

Source of variation	Degrees of freedom	Mean square				
		Weight of 100 seeds (g)	Seed yield (t ha^{-1})	Stover yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
Replication	2	0.012	0.014	0.018	0.060	0.946
Variety (A)	2	2.076*	0.729**	0.503*	2.438**	17.975
Error	4	0.187	0.021	0.048	0.097	6.729
Methods of weed control (B)	3	2.334**	0.644**	0.250**	1.680**	40.465**
Interaction (A × B)	6	0.336*	0.021*	0.021*	0.078**	0.595*
Error	18	0.123	0.008	0.008	0.022	1.610

** Significant at 0.01 level of probability; * Significant at 0.05 level of probability

Appendix X. Field view of the experimental plot