GROWTH AND YIELD OF BLACKGRAM AS AFFECTED BY WEEDING FREQUENCY UNDER MIKANIA VINE APPLICATION

MUSARRAT NITOL MURSANA

DEPARTMENT OF AGRONOMY

SHER-E-BANGLA AGRICULTURAL UNIVERSITY

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By

MUSARRAT NITOL MURSANA

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Approved by:

(Prof. Dr. Md. Jafar Ullah) **Supervisor**	**(Prof. Dr. H. M. M. Tariq Hossain)** **Co-supervisor**

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

DEPARTMENT OF AGRONOMY
Sher-e-Bangla Agricultural University
Sher-e-Bangla Nagar, Dhaka-1207
PABX: 9110351 & 9144270-79

CERTIFICATE

This is to certify that the thesis entitled " ***GROWTH AND YIELD OF BLACKGRAM AS AFFECTED BY WEEDING FREQUENCY UNDER MIKANIA VINE APPLICATION****" submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of* ***MASTER OF SCIENCE (MS)*** *in* ***AGRONOMY,*** *embodies the results of a piece of bona fide research work carried out by* ***MUSARRAT NITOL MURSANA,*** *Registration. No.* **09-03665** *under my supervision and guidance. No part of this thesis has been submitted for any other degree or diploma.*

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

Dated:
Dhaka, Bangladesh

(Prof. Dr. Md. Jafar Ullah)

Supervisor

DEDICATED TO

MY

BELOVED PARENTS

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ABSTRACT

An experiment was carried out at the Agronomy field laboratory, Sher-e-Bangla Agricultural University, Dhaka during the period from August to December, 2014 to find out the growth and yield of blackgram as affected by weeding frequency under mikania vine application. The experiment comprised two factors viz. (i) four weeding frequency (W_0= No weeding, Control), W_1= Before critical period (3 DAS), W_2= At critical period (6 DAS) and W_3= After critical period (9 DAS) and (ii) four mikania vine application (M_0= No Mikania vine, Control), M_1= Mikania vine 2% of soil weight, M_2 = Mikania vine 4% of soil weight and M_3 = Mikania vine 6% of soil weight). The results revealed that interaction of W_0M_0 gave the greatest number (469.0) of weeds plot^{-1} and (81.99 g) weed dry weight plot^{-1}. The highest seed yield (1.43 t ha^{-1}) was recorded form W_1M_3 and the minimum (0.81 t ha^{-1}) was recorded from the interaction of W_0M_0. The maximum yield as shown by the W_1M_3 might be attributed to higher pods plant^{-1} (19.00), seed pod^{-1} (6.82) and 1000-seeds weight (47.67 g) which were also shown by this combination.

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LIST OF ACRONYMS

%	= Percent
^0C	= Degree Celsius
AEZ	= Agro-Ecological Zone
BARI	= Bangladesh Agricultural Research Institute
BAU	= Bangladesh Agricultural University
BBS	= Bangladesh Bureau of Statistics
Co	= Cobalt
CV%	= Percentage of coefficient of variance
cv.	= Cultivar
DAE	= Department of Agricultural Extension
DAS	= Days after sowing
et al.	=And others
FAO	= Food and Agriculture Organization
g	= gram(s)
ha^{-1}	= Per hectare
HI	= Harvest Index
kg	= Kilogram
LSD	= Least Significant Difference
Max	= Maximum
mg	= milligram
Min	= Minimum
MoP	= Muriate of Potash
N	= Nitrogen
No.	= Number
NPK	= Nitrogen, Phosphorus and Potassium
NS	= Not significant
SAU	= Sher-e-Bangla Agricultural University
SRDI	= Soil Resources and Development Institute
TSP	= Triple Super Phosphate
Wt.	= Weight

CHAPTER 1

INTRODUCTION

Among the pulse crops, blackgram (*Vigna mungo*.) is one of the main edible pulse crops of Bangladesh. It ranks fourth among the pulses with an area of about 32002 ha (BBS, 2013). As an excellent source of plant protein it is cultivated extensively in the tropics and subtropics. It has good digestibility and flavor. Blackgram grain contains 59% carbohydrates, 24% protein, 10% moisture, 4% mineral and 3% vitamins (Khan, 1981; Kaul, 1982). The green plants can also be used as animal feed and its residues have manual value. The crop is potentially useful in improving cropping pattern. The yield of blackgram is very poor as compared to many other legume crops (Wahhab and Bhandari, 1981). It can also fix atmospheric nitrogen through the symbiotic relationship between the host blackgram roots and soil bacteria and thus improves soil fertility.

Though the agro ecological conditions of Bangladesh are favorable for blackgram cultivation, its area under cultivation and total production are low in this country (BBS, 2008). In Bangladesh, the average yield of blackgram is 0.70 t ha^{-1} (BBS, 2013), which is much lower than those of India and other countries of the world. There are many reasons of such lower yield of blackgram.

Weed is one of the most important factors responsible for low yield of blackgram. The decrease in blackgram productivity due to weed competition is 45.6% (Pandey and Mishra, 2003). Blackgram is very competitive against weed and therefore, weed control is essential for blackgram production. Dry weight of weed increased as the duration of weed competition increased in crop (Islam *et al.,* 1989). Weeds compete with main crop for space, nutrients, water and light. It is also recognized that a low weed population can be beneficial to the crop as it provides food and habitat for a range of beneficial organisms (Bueren *et al.*, 2002). Weed crop competition commences with germination of the crop and continues till its maturity. Several growth stages of blackgram such as emergence, flowering and pod setting are greatly hampered by weed. Weed infestation of these stages causes low pod setting and ultimately yield reduces. Weeds above critical population thresholds can significantly reduce crop yield and quality. Weed problem is becoming more and more acute. Weeds have been reported to harbor the viruses and act as a primary source of inoculums, which causes high incidence of virus-like symptoms. However, the aim of weed management should be to maintain weed population at a manageable level. Timely control of weeds is essential for high yield in blackgram. Significantly more seed yields by weeding have been reported by (Hossain *et al*., 1990; Kumar and Kiron, 1990; Musa *et al*., 1996). Thus, proper weed management at the right time is the main concern for maximum yield of blackgram.

Use of natural or organic source of herbicides has also been found to control weeds through utilizing the allelopathic potentials (Anon, 2014). These natural herbicides do not have any negative effect on environment and human health, and also is less costly. If such type of allelopathic herbicides could be innovated these would help to reduce the cost of laborer for weed control in crop field along with helping environmental sustainability.

Mikania (*Mikania micrantha*), a climbing weed, known as 'refusi lata' or 'Germani lata' in Bangladesh (Anon., 2013a) contains allelopathic compounds and has allelopathic effect on weeds in crop fields (Weng, 1964). Extracts from *M. micrantha* was found to slow the germination and growth of a variety of weed species (Anon. 2013b, Ismail and Suat, 1994) which has been attributed to at least three sesquiterpenoids identified in mikania (Shao *et al* ., 2005). Ismail and Mah (1993) reported that plant height of some weeds reduced with increasing amounts of debris originated either from leaf or root of Mikania. Li and Jin (2010) found that extracts of *M. micrantha* inhibited the seed germination and seedling growth of *C. lacryma-jobi* which they attributed to the regulation of the anti-oxidase activity, such as POD (peroxidase) and CAT (catalase) in the cells resulting in injury after oxidization of the cell membranes with the increase of MDA (malondialdehyde) content. However mikania application in soil has also beneficial effects through exerting effects on weeds and pathogens, and also adding organic matter to soil thereby benefiting the standing crops (Saha, 1986; Zhang *et al*., 2002; Dey *et al*., 2012).

Any plant material when well decomposed and added to soil act as an organic fertilizer those supply essential elements to crop plants or improve soil physical properties after its proper decomposition. But when added before decomposition, they release some organic acids which may be harmful to both crop and weed plants. It is normally desirable that these allelochemicals are not or limitedly harmful to crop plants but is quite harmful to weed plants. If such happens, these allelochemicals can be used as selective organic herbicides. So, before using the natural herbicides it is essential to find out which weeds are sensitive to the application of these natural herbicides, to identify which crop(s) are resistant to them and to evaluate and examine crop-weed interaction due to application of these testing materials in crop fields.

Though blackgram is cultivated in many parts of our country, very little research work has been done regarding the effect of different weeding frequency and allelopathic effect of mikania vine on weeds in growth and yield contributing characters of blackgram. Considering the above facts the present work was conducted to evaluate the effect of different weeding frequency and allelopathic effect of mikania vine on blackgram production with the following objectives:-

- To determine the suitable time of weeding for the optimum growth and yield of blackgram.
- To observe the allelopathic effect of mikania vine in blackgram cultivation.
- To study the interaction effect of different weeding frequency and allelopathic effect of mikania vine in blackgram for achieving maximum yield.

CHAPTER 2

REVIEW OF LITERATURE

An attempt was made in this section to collect and study relevant information available in the country and abroad regarding the effect of different weeding frequency under mikania vine application on the growth and yield of blackgram and other crops to gather knowledge helpful in conducting the present research work and subsequently writing up the result and discussion.

2.1 Effect of weed management

Shweta and Malik (2015) made a field study during *kharif* season at Crop Research Station, GBPUA and T, Pantnagar. Five weed management treatments comprised W_1-weedy, W_2- Hand weeding at 20 DAS, W_3-Hand weeding (HW) 40 DAS, W_4-Alachlor @ 2.0 kg ha^{-1} (PE) and W_5- Alachlor @1.5 kg ha^{-1} (PE) and hand weeding at 40 DAS; and three seed rates S_1- normal seed rate, S_2-30 % higher seed rate than normal and S_3-50% higher seed rate than normal. *Echinochloa colonum* was dominant under weedy condition. The highest weed density (288.7 m^{-2}) and total weed dry matter production (159.2 g m^{-2}) at 30 DAS were recorded in weedy plots, whereas, the lowest total weed density (48.3 m^{-2}) and total weed biomass (11.3 g m^{-2}) were recorded under HW20 DAS followed by alachlor @ 2.0 kg ha^{-1} and alachlor @1.5 kg ha^{-1} + HW 40 DAS. Lower weed density (92.6 m^{-2}) and total weed biomass (62.8 g m^{-2}) associated with 50 per cent higher seed rate.

Rao *et al.* (2015) conducted a field experiment during *kharif* (rainy) season at Regional Agricultural Research Station, Lam, Guntur, India to study the effect of integrated weed management practices on growth and yield of pigeonpea. The weed free treatment significantly decreased the weed density, dry weight of weeds and also increased in weed control efficiency compared with weedy check. Integration of one hand weeding per intercultivation at 50 DAS with pendimethalin (PE) @ 0.75 kg *a.i.* ha^{-1}, PE proved effective in reducing total weed density and dry weights of weeds and also increased in weed control efficiency compared with weedy check. The maximum values of growth parameters, yield components and grain yield (2647 kg ha^{-1}) were recorded under weed free situation.

Kumar *et al.* (2015) set a field experiment to refining the weed management practices to increase the yield of blackgram (*Vigna mungo* L.). Growth and yield attributes were affected significantly due to different weed management practices. However, weed density and weed dry weight were decreased significantly with increasing number of hand weeding (20 and 40 DAS). Hand weeding at 20 and 40 DAS proved its superiority over other methods of weed control in respect of all the growth characters and yield attributes as well as grain and straw yield of blackgram crop followed by oxyfloufen @ 100 g *a.i*. ha^{-1} as pre-emergence + one hand weeding at 40 DAS.

A field experiment was conducted by Bhowmick *et al.* (2015) to evolve an integrated weed management (IWM) practice in blackgram. *Cynodon dactylon*, *Dactyloctenium aegyptium*, *Cyperus rotundus, Cleome viscosa* and *Physalis minima* were the dominant weeds. Pre-emergence application of pendimethalin either at lower dosage (0.75 kg ha^{-1}) along with one hand weeding at 40 days after sowing or at higher dosage (1.0 kg ha^{-1}) without any integration with hand weeding proved to record higher seed yield (1.09 and 1.03 t ha^{-1}, respectively. In addition, use of 30% higher seed rate than the normal rate of 22.0 kg ha^{-1} was found to effectively suppress the weeds and further enhance the yield level. Season-long weed competition caused an average yield reduction of 26.4% as compared to IWM in blackgram.

Das *et al.* (2014) conducted a field experiment to study the integrated weed management in blackgram (*Vigna mungo* L.) and its effect on soil microflora under sandy loam soil of West Bengal. Treatments comprised of T_1 -Pendimethalin @ 1.5 lit ha^{-1}, T_2 -Fluchloralin @ 1.5 lit ha^{-1}, T_3 -Pendimethalin @ 1.5 lit ha^{-1} + hand weeding at 25 DAS, T_4 -Fluchloralin @ 1.5 lit ha^{-1} + hand weeding at 25 DAS, T_5 -Two hand weeding at 15 and 25 DAS and T_6 -Weedy check. Result showed that T_5 recorded lowest weed population (84.1 no m^{-2} and 55.5 no m^{-2}) and dry weight (13.23 and 10.57 g m^{-2}) which was significantly superior over rest of the treatments. Though weed control efficiency (85.53%) and seed yield (1.441 t ha^{-1}), stover yield (3.419 t ha^{-1}) were highest under treatment T_5 but net return per rupee investment (2.2) was highest under T_3 as compared to other weed control treatments.

Pramanik *et al.* (2014) conducted an experiment to study the effect of bio fertilizer and weeding on the growth characters and yield of summer mungbean. Experimental treatments comprised of (a) five levels of biofertilizer: 0, 1, 2, 3, 4 kg ha^{-1} and (b) four levels of weeding: no weeding, one weeding, two weeding, and three weeding. The results indicate that the three times weeding produced highest plant height (41.69 cm) and dry weight plant^{-1} (18.09 g) at 60 DAS and seed yield (1.96 t ha^{-1}) was attained significantly at maximum level from the application of 2 kg ha^{-1} biofertilizer. Application of 2 kg biofertilizer ha^{-1} with three times weeding was proved to be the best possible combination.

Akter *et al.* (2013) conducted an experiment to assess the effect of weeding on growth, yield and yield contributing characters of mungbean *(Vigna radiata* L.). The trial comprised seven treatments namely, T_1=no weeding, T_2=one-stage weeding (Emergence Flowering), T_3=one-stage weeding (Flowering-Pod setting), T_4=one-stage weeding (Pod setting- Maturity), T_5=two-stage weeding (Emergence-Flowering and Flowering-Pod setting), T_6=two-stage weeding (Flowering-Pod setting and Pod setting-Maturity) and T_7=three-stage weeding (Emergence-Flowering and Flowering-Pod setting and Pod setting-Maturity). The growth parameters such as relative growth rate (0.075 g g^{-1} day^{-1}) and net assimilation rate (0.075 g m^{-2} day^{-1}) showed the best performance with T_2 at one-stage weeding condition (Emergence-Flowering). Three-stage weeding ensured the highest plant height (58.62 cm) as well as the highest number of branches (4.45) and leaves (10.34) plant^{-1}. Dry weight plant^{-1} (12.38 g) was highest from three stage weeding and the lowest from no weeding treatment. The highest number of pods (22.03) plant^{-1}, the longest pod (5.95 cm), the highest number of seeds (17.07) pod^{-1} and the highest seed yield (1.38 t ha^{-1}) were obtained from three-stage weeding (Emergence-Flowering and Flowering-Pod setting and Pod setting-Maturity) in mungbean. On the other hand, the lowest seed yield was obtained under no weeding condition. The highest seed yield resulted in higher biological yield (4.70 t ha^{-1}) and the highest harvest index (37.15%) in three-stage weeding and the lowest from no weeding.

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.

An experiment was carried out by Asaduzzaman *et al.* (2010) to evaluate the impact of weeding and plant spacing on the growth and yield performance of blackgram. The differential weeding and plant spacing did not show remarkable differences in dry matter production at early stages of crop growth. Two weeding at 25 and 40 DAS significantly increased the number of pods plnat^{-1}, number of seeds pod^{-1}, seed weight and seed yield. Two weeding at 25 and 40 DAS contributed 56.18% and 25.23% higher seed yield compared to no weeding and single weeding, respectively. Two weeding at 25 and 40 DAS and 30 x 10 cm spacing performed the best giving the highest seed yield of 1.58 t ha^{-1}.

Awan *et al*.(2009) conducted an experiment on mungbean in Pakistan and pod length was recorded maximum in plots where treatments were *terphali* (9.9 cm) and hand weeding (9.7 cm); while in plots with 45cm row spacing + tractor and 60 cm + tractor, pod length was 9.2 cm and 9.6 cm, respectively compared to control (9.0 cm).

A field study was carried out by Vivek *et al.* (2008) to determine the critical period of crop-weed competition in blackgram (*Phaseolus mungo*). *Trianthema portulacastrum*, *Digera arvensis*, *Echinochloa crusgalli*, *Parthenium hysterophorus*, *Phyllanthus niruri* and *Cynodon dactylon* were the most predominating weeds. Grain yield loss increased with the increase in the duration of competition and maximum loss (67%) occurred due to full season competition. Significantly higher grain yield (12.42 q ha^{-1}) and yield attributing characters were obtained in plots remaining weed free upto harvest. The critical period of weed competition was between 30 to 45 DAS during which the crop should be kept free of weeds to prevent the potential loss in blackgram grain yield.

Kumar *et al*. (2005) conducted a study to evaluate the benefits of the resource conservation technologies in mungbean during kharif 2004 in Haryana, India. Among the weed control treatments, the maximum reduction in dry weight of weeds was recorded in treatment with hand weeding at 20 and 40 DAS.

Anwar *et al.* (2004) investigated the feasibility of sorghum extract as natural weed control in comparison with hand weeding and herbicide. Sorghum extract reduced the weed number and weed weight. It also increased fresh and dry weight of crops.

Malik *et al.* (2003) conducted an experiment to determine the effect of varying levels of weeding (0, 1 and 2 weeding) on the yield and quality of blackgram. They observed that number of flowers plant^{-1} and pods plant^{-1} was found to be significantly higher by two times of weeding.

In a study it was observed that among some herbicides, tank mixture of fenoxaprop-pethyl @ 50 g ha^{-1} + chlorimuron-ethyl @ 4.0 g ha^{-1} (PoE) consistenly increased all the yield attributes *viz*. pods $plant^{-1}$, pod length and grains pod^{-1} and was statistically at par to 2-HW. The results are in conformity with the findings of Dungarwal *et al*. (2003).

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 said by Bueren *et al.* (2002).

Batish *et al.* (2002) studied to explore the effect of parthenin a sesquiterpene lactone from *Parthenium hysterophorus* on two weed species viz. *Amaranthus viridis* and *Chenopodium murale*. The study concluded that phytotoxicity of Parthenin could be useful as a natural herbicide for future weed management programs.

Khaliq *et al*. (2002) investigated the efficacy of different weed management strategies in mungbean and stated that hoeing treatments resulted in reduced weed dry weight by 79% compared to control and maximum plant height while conducting a field trial.

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

Kalita *et al.* (1995) reported that the times of weeding (2 or 3 times) on blackgram resulted 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}.

Ahmed *et al.* (1993) found that one hand weeding at 10 or 20 DAE produced higher yield than unweeded plots in blackgram during early *kharif*. Although some information on the effect of weeding on yield and yield attributes are available, the effect of crop density and delay in weed removal of blackgram (duration of weed competition) on its yield and yield attributes, leaf area index (LAI), light interception, are not yet available for blackgram in agro-ecological conditions of Bangladesh.

Ahmed (1992) observed highest grain yield of mungbean when weeded at 10 DAS.

Bryson (1990) observed that critical period of weed competition is the minimum 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.

Islam *et al.* (1989) found that every crop has a stage during its life cycle when it is particularly sensitive to weed competition.

Hamid (1988) conducted a field experiment to investigate the effect of weeding on the growth and yield performance of mungbean. He found that the plant height, dry matter production plant^{-1} and yield of mungbean were found to be increased with more weeding.

Pongkao and Inthong (1988) reported that proper weeding on blackgram was found to be superior giving 23 % higher biological yield over the control.

Kumar and Kairon (1988) found that weed biomass increased yield decreased with delay in weeding of blackgram. However, delay in weeding did not affect the number of seeds pod^{-1}. The higher percent yield reduction was recorded when the blackgram plants were exposed to longer weed competition. Dry matter was maximum under weed free condition followed by weed removal at 30 DAS.

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}.

Singh *et al.* (1988) stated that higher yield of mungbean was obtained from the weeded plants compared to unweeded control.

Patel *et al.* (1984) studied the effect of weeding on the growth and seed yield of mungbean during summer season. They observed that two times of weeding significantly increased the 1000 seed weight of mungbean compared to control treatment.

Yadav *et al.* (1983) found that removal of weeds at 10, 20 or 30 days after sowing, produced higher yield of mungbean than weedy check.

While studying the competition, I observed that soybean seeds pod^{-1} and pods plant^{-1} were reduced due to long duration of wild oat competition (Rathmen and Miller, 1981).

Madrid and Manimtim (1977) stated that yield loss due to uncontrolled weed growth in blackgram range from 27 to 100%.

Enyi (1973) reported that weeding up to 8 weeks after sowing is required for optimum yield of blackgram.

2.2 Effect of mikania vine application

An experiment was conducted by Ullah *et al.* (2014b) to evaluate the allelopathic effect of mikania on *Fymbristylis miliacea.* Soil from the wheat field was collected, dried in sun and mixed with mikania fresh plants at 6 different rates (control, 2%, 4%, 6%, 8% and 10%; all of sundried soil by weight) and allowed weed seeds to germinate and grow within the soil in earthen pots. Results revealed that mikania (M) application showed significantly lower population of *Fybristylis* weed plant at 30 to 60 days after setting (DAS). Treatments 4-10% in comparison to control showed significantly lower number of *Fymbristylis miliacea* (46-76.50 pot^{-1} than the control (60.50-136.33 pot^{-1}) reducing the *Fymbristylis miliacea* population by 34-44% due to mikania application. But higher plant heights (up to 38.50cm) were obtained with these treatments than control (up to 31cm). In contrast to the population, *Fymbristylis* dry weight increased due to mikania application after 30 DAS. The highest above ground biomass of 5.33 g pot^{-1} was obtained with 10% mikania at 60 DAS while the lowest of 5.04-5.37 g pot^{-1} with control. Mikania application also showed increased ranges of per plant biomass (0.097-0.120 g plant^{-1}) at 60 DAS than control (0.045 g plant^{-1}).

Ullah *et al.* (2014b) carried an experiment out to evaluate the allelopathic effect of mikania on purple and yellow nut sedges. Soil from the wheat field was collected, sun dried and mixed with mikania fresh plants at 6 different rates (Control, 2%, 4%, 6%, 8% and 10%) all of sundried soil by weight) and allowed the weed seeds to germinate and grow within the soil in earthen pots. Mikania application had greater effect at 30 to 60 days after setting (DAS) than at 90 DAS. Treatments 4-10% in comparison to control showed significantly lower number of sedges (37.67-42.5 pot^{-1}) than the control (48-69 pot^{-1}) reducing the sedge population by 22-36% due to mikania application. Total number of weeds pot^{-1} increased from 30 DAS (117-156 pot^{-1}) to 60 DAS (151-271 pot^{-1}) and thereafter decreased at 90 DAS (66-141 pot^{-1}) showing significantly highest values with control. Relative percentage by number of sedges gradually decreased from

30 (37 %) to 90 DAS (2.94%). Sedge control efficiency with mikania application on plant number basis was significantly increased up to 38% with 6% rate which was significantly higher than control.

Sahu and Devkota (2013) carried a study out to evaluate the allelopathic effects of aqueous extract of leaves of *Mikania micrantha* were studied on seed germination and seedling growth of *Oryza sativa* L. and *Raphanus sativus* L. Seed germination and seedling growth were inhibited by concentrated aqueous extract of *M. micrantha*. *R. sativus* was more sensitive to inhibitory effects of leaf aqueous extract of *M. micrantha*. The extract has strong inhibitory effects on root elongation of seedling than shoot elongation.

Kavitha *et al.* (2012) conducted a field experiment to investigate the allelopathic influence of *Vitex negundo* L. against germination, growth and biochemical constituents changes of two pulses namely, greengram (*Vigna radiata* L.) and blackgram (*Vigna mungo* L.). Various concentrations of (2.5, 5, 10, 15, 20 25%) aqueous leaf extracts were prepared from matured leaves of *V. negundo* and germination studies were conducted. The lower concentrations (2.5 and 5%) of leaf extracts stimulated the seed germination, growth and biochemical constituents (Chl., amino acid, protein and total sugar) of blackgram and greengram. In higher concentrations an inhibitory effect was observed in all the parameters studied in two pulses and the inhibitory effects were more prominent in greengram than blackgram seedlings.

Shao *et al.* (2005) conducted an experiment on potential allelochemicals from an invasive weed *Mikania micrantha*. They found phytotoxicity-directed extraction and fractionation of the aerial parts of *Mikania micrantha*. led to the isolation and identification of three sesquiterpenoids: dihydromikanolide, deoxymikanolide, and 2, 3-epoxy-1-hydroxy-4, 9-germacradiene-12, 8:15, 6-diolide. These sesquiterpenoids inhibited both germination and seedling growth of tested species with deoxymikanolide possessing the strongest phytotoxicity. In a bioassay against lettuce (*Lectuca sativa* L.), deoxymikanolide reduced radicle elongation at low concentration (IC_{50} = 47 µg ml^{-1}); dihydromikanolide showed a weaker effect (IC_{50} = 96 µg ml^{-1}), and 2, 3-epoxy-1-hydroxy-4,9-germacradiene-12,8:15,6-diolide exhibited the least effect (IC_{50} = 242 µg ml^{-1}). Deoxymikanolide caused yellowish lesions at the root tips of lettuce at a concentration of 50 µg ml^{-1}, and 250 µg ml^{-1} solution killed lettuce seedlings. A bioassay against the monocot ryegrass (*Lolium multiforum*) revealed similar results on radicle elongation, which implied that the growth inhibition by these compounds was not selective.

Zhang *et al.* (2002) conduct an experiment on allelopathic potential of volatile oil from *Mikania micrantha*. The volatile oil of the weed species had significant biological activities on plants and their pathogens, particularly *Pyricularia grisea*. The results showed that the seedling growth of 6 plant species decreased obviously when exposed to increasing concentration (200, 400, 800, 1600 mg l^{-1}) of the volatile oil. The fresh weight of all test plants decreased, and the emergence of all test plants delayed for 1-2 days under soil treatment (2500 g m^{-2}). The inhibitory effect of volatile oil of M. micrantha at its medium concentration was the most strong on *Pyricularia grisea*; secondary on *Fusarium oxysporum*; but weak on *Phytophthora nicotianae*. The inhibitory rate was 53.38%, 28.66% and 18.69% for the three plant pathogens, respectively.

A field study was conducted by Ismail and Suat (1994) to determine the allelopathic potential of *Mikania mierantha.* on the germination and growth of three weed species, *Asystasia gangetica* (L.) T. Anders., *Chrysopogon aciculatus* (Ritz.) Trin and *Paspalum conjugatum*. Germination and fresh weight of all three weeds decreased progressively when exposed to increasing concentrations of aqueous leaf or root extract of *Mikania.* The phytotoxic effect of root extract on the radical elongation of the test species was greater than that of leaf extract. The dry weight and rate of emergence of the bioassay species used were affected when *Mikania* debris (leaf or root) were placed on soil surfaces or incorporated into the soil. *P. conjugatum* emergence was strongly affected when *Mikania* (root or leaf) was incorporated into the soil. Soil collected from the field where *Mikania* had been growing had no effect on the final germination of the three weed species. However, dry weights of *A. gangetica* and *P. conjugatum* were significantly reduced when grown in the *Mikania-infested* soil.

Ismail and Miah (1993) investigated to determine the effects of *Mikania micrantha* on germination and growth of weed species. The plant height of the test species decreased with increasing amounts of debris when either leaf or root debris of Mikania was present on the soil surface or incorporated into the soil. In general, incorporated debris caused greater reduction in height and seedling fresh weight than debris placed on the soil surface. Paspalum was more sensitive to either root or leaf of Mikania when incorporated into soil than on the soil surface. Leachate of Mikania leaf caused a significant reduction in radicle length and fresh weight of the seedlings of the test species. However, only Paspalum seeds showed significant decrease in germination when exposed to leaf leachate. Full-strength extract of either leaf or root caused a significant decrease in both germination and fresh weight of the test species. At the highest concentration, root extract of Mikania caused a marked reduction of radical elongation of Paspalum.

Weng (1964) carried out a study to evidence for the presence of growth inhibitory substances in *Mikania cordata* (Burm. f.) B.L. Robinson. Laboratory and pot culture tests have shown that *Mikania cordata* contains substances which can depress growth of *Hevea brasiliensis*, tomato and *Pueraria phaseoloides*, and also strongly inhibit in vitro growth of the fungus *Fomes lignosus* and depress nitrification in the soil. In the field the harmful effect of *M. cordata* on other plants appears likely to be the combined result of a direct toxicity and of indirect effects via the soil micro flora. Essential oils separated by steam distillation showed inhibitory activity, and chromatographic examination of petroleum ether extracts suggests that the growth inhibitory substances include phenolic and flavonoid constituents, either or both of which may be responsible for the observed effects.

2.3 Interaction effect of weed management and mikania vine application

Field experiments were carried out by Ibrahim Usman (2013**)** in 2010 and 2011 cropping seasons at the Institute for Agricultural Research, Ahmadu Bello University, Zaria-Nigeria to evaluate the effect of pre emergence herbicides on growth and yield parameters of cowpea. There was significant yield increase due to Application of pendimenthaline at 3.5 L ha^{-1} + Hand weeding of cowpea at 6 WAS (weeks after sowing).

Asheesh and Elamathi (2007) conducted an experiment to evaluate the effect of plant spacing (25 cm x 10 cm, 30 cm x 10 cm, 25 cm x l5 cm and 30 cm x 15 cm) and number of weeding (control, one weeding, two weeding and three weeding) on the yield attributes, yield and economics of mungbean with recommended fertilizer dose during the *kharif* season of 2005. The maximum plant height, number of leaves, number of branches plant^{-1}, dry weight plant^{-1}, pod number, grain number pod^{-1}, grain yield, economic yield and stover yield were obtained under the spacing 30 cm x 10 cm with three weeding.

Chattha *et al*. (2007) conducted a field study at National Agricultural Research Centre (NARC), Islamabad and observed that all the weed control methods significantly affected plant height of mungbean. Among different weed control methods, WC_6 (chemical-weeding at 2-3 leaf stage of weeds + hand weeding at 50 DAS) that was similar to that of WC_5 caused a pronounced affect on plant height of mungbean that showed about 5% and 3%, respectively higher plant height as compared to WC_1 (weedy check) treatment. On an average, treatment WC_6 caused about 31% increase in plant biomass of mungbean as compared to weedy check treatment. There was a significant increase (50%) in grain yield of mungbean due to chemical weeding at 2-3 leaf stage of weeds + hand weeding at 50 DAS.

Raman (2006) and Chand *et al*. (2004) also observed similar findings of significant reduction in weed count, weed biomass and highest value of weed control efficiency under two hand weeding at 20 and 40 DAS over herbicides.

Mansoor *et al*. (2004) conducted an experiment in Pakistan during 2003 to investigate the efficacy of various weed management strategies in mungbean (cv. NIAB MUNG 98). Water extracts of sorghum, eucalyptus (*Eucalyptus camaldulensis*) and acacia (*Acacia nilotica*) were used in comparison with hand weeding and a pre-emergence herbicide (Pendimethalin, Stomp 330 EC). The water extract of acacia recorded the highest yield and almost all the yield components followed by the two hand weeding + pre-emergence herbicide treatment.

Srinivas *et al.* (2002) studied the effect of weeding (4 levels; no weeding, weeding at 15, 25, 35 and 45 DAS) and seed rate (4 levels 35, 45, 55 and 65 kg ha^{-1}) on the growth and yield components of mungbean. They observed that number of leaves plant^{-1}, dry weight, pod length, 1000 seed weight and grain yield was increased by the seed rate of 45 kg ha^{-1} with 4 times of weeding.

CHAPTER 3

MATERIALS AND METHODS

The experiment was conducted at the Agronomy field of Sher-e-Bangla Agricultural University, Dhaka to study the growth and yield of blackgram as affected by weeding frequency under mikania vine application. Materials used and methodologies followed in the present investigation have been described in this chapter.

3.1 Description of the experimental site

3.1.1 Site and soil

Geographically the experimental field was located at 23° 77' N latitude and 90° 33' E longitudes at an altitude of 9 m above the mean sea level. The soil belonged to the Agro-ecological Zone-Modhupur Tract (AEZ-28). The land topography was medium high and soil texture was silty clay with pH 6.1. The morphological, physical and chemical characteristics of the experimental soil have been presented in Appendix-I.

3.1.2 Climate and weather

The climate of the locality is subtropical which is characterized by high temperature and heavy rainfall during *Kharif* season (April-September) and scanty rainfall during Rabi season (October-March) associated with moderately low temperature. The prevailing weather conditions during the study period have been presented in Appendix-II.

3.2 Plant materials

BARI Mash-3 was used as planting material. BARI Mash-3 was released and developed by BARI in 1996. Plant height of the cultivar ranges from 35 to 37 cm. Average yield of this cultivar is about 1.5-1.6 t ha^{-1}. The seeds of BARI Mash-3 for the experiment were collected from BARI, Joydepur Gazipur. The seeds were drum-shaped and blackish and free from mixture of other seeds, weed seeds and extraneous materials.

3.3 Treatments under investigation

There were two factors in the experiment namely weeding frequency and mikania vine application as mentioned below:

A. Factor-1: weeding frequency (4):

a) W_0= No weeding (Control)
b) W_1= Before critical period
c) W_2= At critical period
d) W_3= After critical period

B. Factor-2: Mikania vine application (4):

a) M_0= No Mikania vine (Control)
b) M_1= Mikania vine 2% of soil weight
c) M_2 = Mikania vine 4% of soil weight
d) M_3 = Mikania vine 6% of soil weight

Treatment combination: Sixteen treatment combinations

W_0M_0	W_1M_0	W_2M_0	W_3M_0
W_0M_1	W_1M_1	W_2M_1	W_3M_1
W_0M_2	W_1M_2	W_2M_2	W_3M_2
W_0M_3	W_1M_3	W_2M_3	W_3M_3

3.4 Experimental design and layout

The experiment was laid out in a 2 factors Randomized Completely Block Design (RCBD) having 3 replications. There are 16 treatment combinations and 48 unit plots. The unit plot size was 0.3 m^2 (0.60 m × 0.50 m).

3.5 Land and mikania preparation

The experimental land was opened with a spade on 14th August 2014. Land preparation was completed on 20th August 2014 and was ready for sowing seeds. Soil from the experimental field was collected and sun dried so that fresh mikania plant could be added in right proportion by weight. Mikania fresh plants were harvested, chopped to 2 cm pieces and mixed with the soil at 4 varying rates (0, 2, 4, 6 by weight). Each plots were then filled with mikania mixed soil. Plots with 0 % mikania filled with soil without mikania application.

3.6 Fertilizer application

The fertilizers were applied as basal dose at final land preparation where N, K_2O, P_2O_5, Ca and S were applied @ 20 kg ha^{-1}, 33 kg ha^{-1}, 48 kg ha^{-1}, 3.3 kg ha^{-1} and 1.8 kg ha^{-1}, respectively in all plots. All fertilizers were applied by broadcasting and mixed thoroughly with soil (Afzal *et al*., 2003). The mikania vine was collected and chopped properly then mixed with soil as per treatment during final land preparation.

3.7 Sowing of seeds

Seeds were sown at the rate of 35 kg ha^{-1} in the furrow on 20^{th} August 2014 and the furrows were covered with the soils soon after seeding. Row to row distance was 30 cm and in rows seed to seed distance 10 cm was maintained.

3.8 Intercultural operations

3.8.1 Thinning

Thinning was done to maintain 10 cm plant to plant distance after 10 days of germination.

3.8.2 Weed control

Weed control was done as per experimental treatments.

3.8.3 Application of irrigation water

Irrigation water was added to each plot, first irrigation was done as pre sowing and other two were given 2-3 days before weeding.

3.8.4 Plant protection measures

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

3.9 Harvesting and sampling

The crop was harvested plot wise when about 80% of the pods became mature. Samples were collected from different places of each plot leaving undisturbed very small in the center. The harvested crops were tied into bundles and carried to the threshing floor. The crop bundles were sun dried by spreading those on the threshing floor. The seeds were separated, cleaned and dried in the sun for 3 to 5 consecutive days for achieving safe moisture of seed.

3.10 Threshing

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

3.11 Drying, cleaning and weighing

The seeds thus collected were dried in the sun for reducing the moisture in the seeds to a constant level. The dried seeds and straw were cleaned and weighed.

3.12 Recording of data

The data were recorded on the following parameters

a. Number of weed 0.3m^{-2}
b. Weed dry weight 0.3m^{-2} (g)
c. Plant height (cm)
d. Number of leaves $plant^{-1}$ (cm^2)
e. Number of branches $plant^{-1}$
f. Number of pods $plant^{-1}$
g. Pod length (cm)
h. Number of seeds pod^{-1}
i. 1000 seed weight (g)
j. Seed yield (t ha^{-1})
k. Stover yield (t ha^{-1})
l. Biological yield (t ha^{-1})
m. Harvest index (%)

3.13 Procedure of recording data

i. Plant height (cm)

The height of the selected plant was measured from the ground level to the tip of the plant at 20, 40, 60 and 80 DAS with a centimeter scale.

ii. Number of leaves plant^{-1} (cm^2)

Number of leaves plant^{-1} was counted from each selected plant sample and then averaged at 20, 40, 60 and 80 DAS.

iii. Number of branches plant^{-1}

The number of branches plant^{-1} was counted from five randomly sampled plants. It was done by counting total number of branches of all sampled plants then the average data were recorded.

iv. Number of pod plant^{-1} (no.)

Number of pod plant^{-1} was counted from the 10 selected plant sample and then the average pod number was calculated.

v. Pod length (cm)

Length of pod was measured by meter scale from 20 pods of plants and then the average seed number was calculated.

vi. Number of seed pod^{-1} (no.)

Number of seed pod^{-1} was counted from 20 selected pods of plants and then the average seed number was calculated.

vii. Weight of 1000 seed (g)

1000 seeds were counted, which were taken from the seeds sample of each plot separately, then weighed in an electrical balance and data were recorded.

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

Seed yield was recorded on the basis of total harvested seeds plot^{-1} and was expressed in terms of yield (t ha^{-1}). Seed yield was adjusted to 12% moisture content.

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

After separation of seeds from plant, the straw and shell harvested area was sun dried and the weight was recorded and then converted into t ha^{-1}.

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

The summation of seed yield and above ground stover yield was the biological yield. Biological yield = seed yield + Stover yield.

xi. Harvest index (%)

Harvest index was calculated on dry basis with the help of following formula.

Harvest index (HI %) = $\frac{\text{Seed yield}}{\text{Biological yield}} \times 100$

Here, Biological yield = Seed yield + stover yield

xii. Weed plot^{-1} (No.)

The data on weed infestation as well as density was collected from each treated plot at the time of harvest.

xiii. Weed dry weight (g)

Fresh weeds from each plot were collected at each time of weeding and washed by tap water. Weeds were oven dried for 72 hours at 70°C temperature and then weighed by an eclectic balance.

3.14 Data analysis technique

The collected data were compiled and analyzed statistically using the analysis of variance (ANOVA) technique with the help of a computer package program MSTAT-C and the mean differences were adjusted by Least Significance Difference (LSD) test at 5% level of significance (Gomez & Gomez, 1984).

CHAPTER 4

RESULTS AND DISCUSSION

The experiment was conducted to determine the effect of weeding frequency and mikania vine chopping on the growth and yield of blackgram. Data on different yield contributing characters and yield were recorded to find out the appropriate level of weeding and mikania vine chopping on blackgram. The results of the experiment have been presented and discussed in this chapter.

4.1 Number of weed plot^{-1}

4.1.1 Effect of weeding frequency on the number of weed plot^{-1}

Significant variation was observed in number of weeds plot^{-1} of blackgram when different levels of weeding were applied (Figure 1). The highest number of weeds plot^{-1} (430.60) was recorded in W_0 while the lowest number of weeds plot^{-1} (181.80) was recorded in the W_1. The results agreed with the findings of Rao *et al.* (2015), Kumar *et al.* (2015), Das *et al.* (2014) and Akter *et al.* (2013) who stated that weeding decrease the number of weeds.

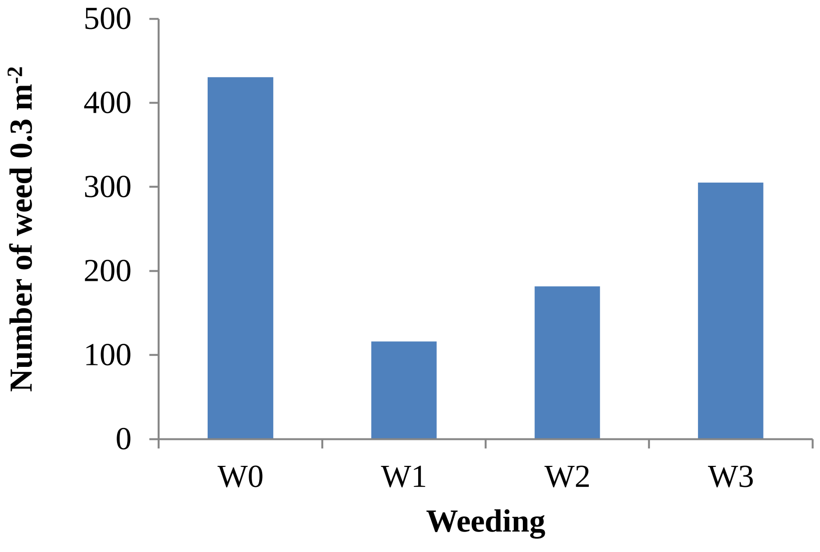


Figure 1. Effect of weeding frequency on number of weed plot^{-1} of blackgram (LSD $_{(0.05)}$ = 24.56)

Note: W_0: No weeding (Control), W_1: Weeding before critical stage, W_2: Weeding at critical stage and W_3: Weeding after critical stage

4.1.2 Effect of mikania vine chopping on the number of weeds plot^{-1}

Different doses of mikania vine chopping showed significant variations in respect of number of weeds plot^{-1} (Figure 2). Among the different doses of mikania vine chopping, M_0 showed the highest number of weeds plot^{-1} (299.10). On the contrary, the lowest number of weeds plot^{-1} (214.70) was observed with M_3. The results agreed with the findings of Ullah *et al.* (2014a).

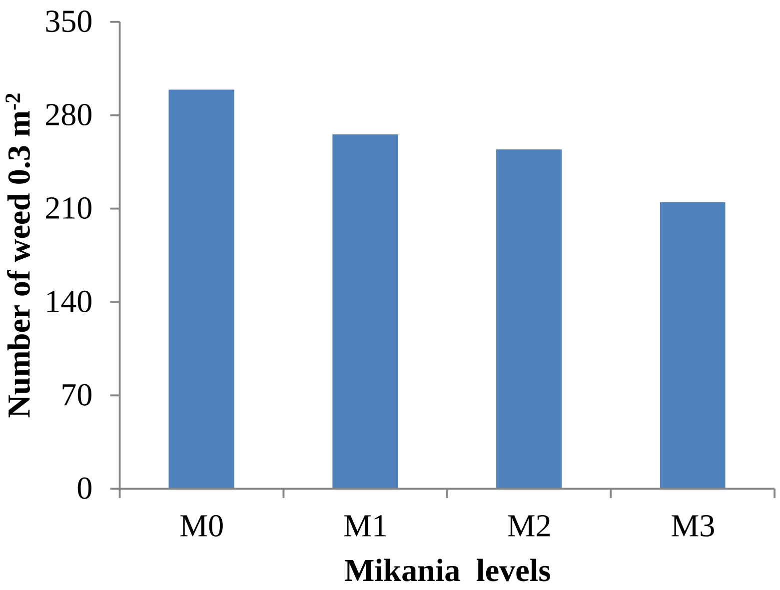


Figure 2. Effect of mikania vine on number of weed plot^{-1} of blackgram (LSD $_{(0.05)}$ = 24.56)

Note: M_0: No mikania vine chopping (Control), M_1: Mikania vine chopping 2% of soil weight, M_2: Mikania vine chopping 4% of soil weight and M_3: Mikania vine chopping 6% of soil weight

4.1.3 Combined effect of weeding frequency and mikania vine chopping on number of weeds plot^{-1}

The Combined effect of weeding frequency and different doses of mikania vine chopping on number of weeds plot^{-1} of blackgram was significant (Table 1). The highest number of weeds plot^{-1} (469.00) was recorded with the treatment combination of W_0M_0 which were statistically similar with W_0M_1. On the other hand, the lowest number of weeds plot^{-1} (61.67) was found in W_1M_3.

4.2 Dry weight of weeds (g)

4.2.1 Effect of weeding frequency on dry weight of weeds

Significant variation was observed dry weight of weeds when different levels of weeding were applied (Figure 3). The maximum dry weight of weeds (77.20) was recorded in W_0 while the minimum dry weight of weeds (32.86) was recorded in W_1. The results agreed with the findings of Rao *et al.* (2015), Kumar *et al.* (2015), Das *et al.* (2014), Pramanik *et al.* (2014), Akter *et al.* (2013) and Mahla *et al.* (1999).

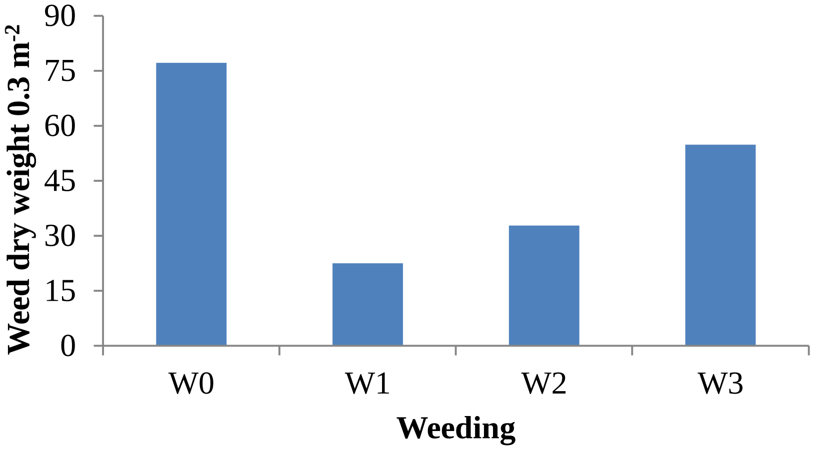


Figure 3. Effect of weeding frequency on weed dry weight plot^{-1} of blackgram (LSD $_{(0.05)}$ = 4.24)

Note: W_0: No weeding (Control), W_1: Weeding before critical stage, W_2: Weeding at critical stage and W_3: Weeding after critical stage

4.2.2 Effect of mikania vine chopping on dry weight of weeds

Different doses of mikania vine chopping showed significant variations in respect of dry weight of weeds (Figure 4). Among the different doses of mikania vine chopping, M_0 showed the maximum dry weight of weeds (55.05). On the contrary, the minimum dry weight of weeds (37.96) was observed with M_3. The results agreed with the findings of Ismail and Suat (1994).

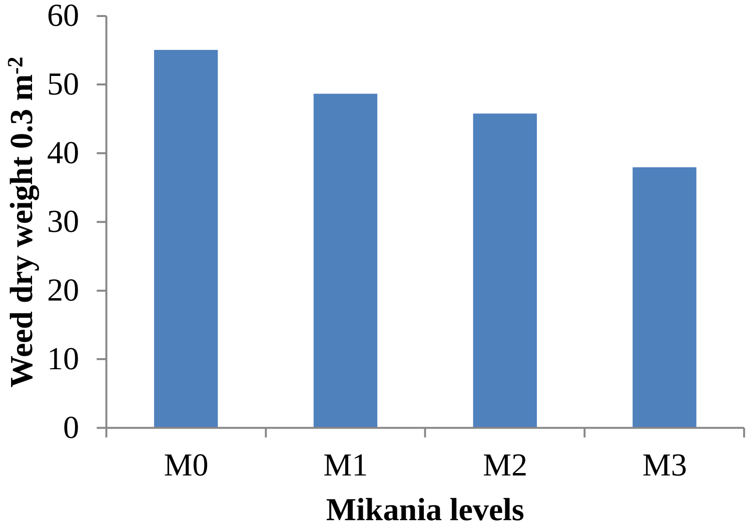


Figure 4. Effect of mikania vine on weed dry weight plot^{-1} of blackgram (LSD $_{(0.05)}$ = 4.24)

Note: M_0: No mikania vine chopping (Control), M_1: Mikania vine chopping 2% of soil weight, M_2: Mikania vine chopping 4% of soil weight and M_3: Mikania vine chopping 6% of soil weight

4.2.3 Combined effect of weeding frequency and mikania vine chopping on dry weight of weeds

The Combined effect of weeding frequency and different doses of mikania vine chopping in respect of dry weight of weeds was significant (Table 1). The maximum dry weight of weeds (81.99) was recorded with the treatment combination of W_0M_0 which were statistically similar with W_0M_1 and W_0M_2. On the other hand, the minimum dry weight of weeds (13.13) was found in W_1M_3.

Table 1. Interaction effect of weeding frequency and mikania vine on number of weed plot^{-1} and weed dry weight plot^{-1} of blackgram

Treatment combination	Number of weed plot^{-1} (No.)	Weed dry weight plot^{-1} (g)
W_0M_0	469.0 a	81.99 a
W_0M_1	430.0 ab	77.96 ab
W_0M_2	416.7 bc	77.40 ab
W_0M_3	406.7 bc	71.45 bc
W_1M_0	146.0 hi	31.77 gh
W_1M_1	129.7 i	23.17 i
W_1M_2	126.3 i	22.17 i
W_1M_3	61.67 j	13.13 j
W_2M_0	208.3 fg	38.07 fg
W_2M_1	184.0 gh	34.24 g
W_2M_2	185.0 gh	35.65 fg
W_2M_3	150.0 hi	23.49 hi
W_3M_0	373.0 c	68.37 c
W_3M_1	318.7 d	59.31 d
W_3M_2	289.3 de	47.86 e
W_3M_3	240.3 ef	43.77 ef
LSD (0.05)	**49.12**	**8.49**
CV (%)	**11.4**	**10.86**

W_0: No weeding (Control),
W_1: Weeding before critical stage,
W_2: Weeding at critical stage and
W_3: Weeding after critical stage

M_0: No mikania vine chopping (Control),
M_1: Mikania vine chopping 2% of soil weight,
M_2: Mikania vine chopping 4% of soil weight and
M_3: Mikania vine chopping 6% of soil weight

4.3 Plant height (cm)

4.3.1 Effect of weeding frequency on the plant height

Significant variation was observed on the plant height of blackgram due to the different levels of weeding frequency (Figure 5). The highest plant height (27.12, 58.04, 83.26 and 95.90 cm at 20, 40, 60 and 80 DAS, respectively) was obtained from W_1 which was statistically similar with W_2. W_1 was also statistically similar with W_3 at 40 DAS. The lowest plant height (20.88, 48.65, 72.08 and 81.01 cm at 20, 40, 60 and 80 DAS, respectively) was obtained from W_0. The results agreed with the findings of Pramanik *et al.* (2014), Akter *et al.* (2013) and Mahla *et al.* (1999) who state that weeding increase the plant height of blackgram.

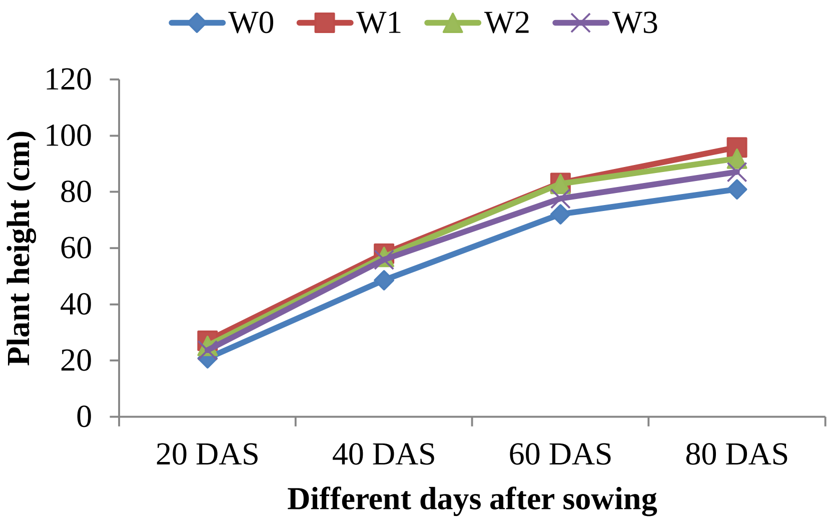


Figure 5. Effect of weeding frequency on plant height of blackgram at different days after sowing (LSD $_{(0.05)}$ = 1.99, 3.88, 5.30 and 5.65 at 20, 40, 60 and 80 DAS, respectively)

Note: W_0: No weeding (Control), W_1: Weeding before critical stage, W_2: Weeding at critical stage and W_3: Weeding after critical stage

4.3.2 Effect of mikania vine chopping on the plant height

Significant variation was observed on the plant height of blackgram when the field was treated with different doses of mikania vine chopping (Figure 6). Among the different doses of mikania vine chopping, M_3 showed the highest plant height (25.87, 59.02, 83.79 and 93.18 cm at 20, 40, 60 and 80 DAS, respectively) which was followed by M_2; at 80 DAS also similar with M_1. On the other hand, the lowest plant height (22.77, 51.32, 74.34 and 84.74 cm at 20, 40, 60 and 80 DAS, respectively) was observed in M_0 which was statistically similar with M_1; at 20 DAS also similar with M_2. The results agreed with the findings of Ullah *et al.* (2014a).

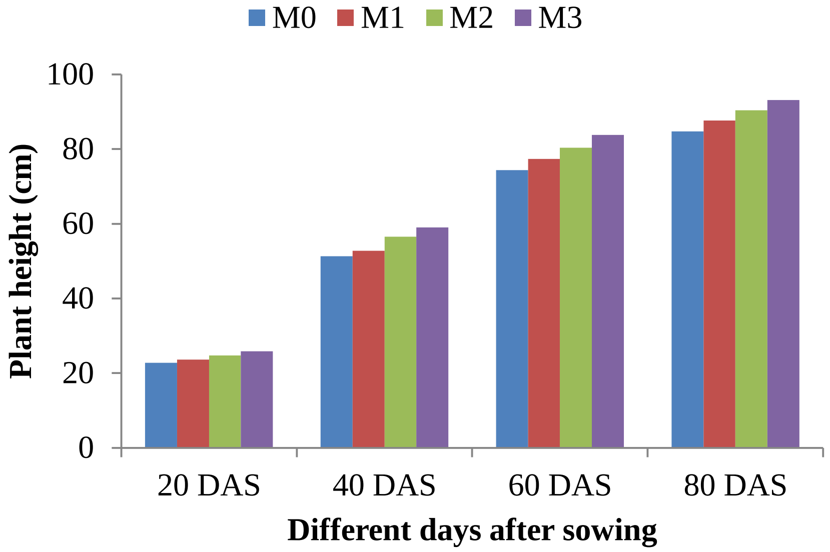


Figure 6. Effect of mikania vine on plant height of blackgram at different days after sowing (LSD $_{(0.05)}$ = 1.99, 3.88, 5.30 and 5.65 at 20, 40, 60 and 80 DAS, respectively)

Note: M_0: No mikania vine chopping (Control), M_1: Mikania vine chopping 2% of soil weight, M_2: Mikania vine chopping 4% of soil weight and M_3: Mikania vine chopping 6% of soil weight

4.3.3 Combined effect of weeding frequency and mikania vine chopping on the plant height

Combined application of weeding frequency and different doses of mikania vine chopping had significant effect on the plant height of blackgram (Table 2). The highest plant height (28.31, 61.91, 88.71 and 99.60 cm at 20, 40, 60 and 80 DAS, respectively) was observed in the treatment combination of W_1M_3 which was statistically similar with W_1M_0, W_1M_1, W_1M_2, W_2M_0, W_2M_1, W_2M_2, W_2M_3 and W_3M_3 at 20 DAS; all other combinations except W_0M_0, W_0M_1, W_0M_2, W_3M_0 and W_3M_1 at 40 DAS; all other combinations except W_0M_0, W_0M_1, W_0M_2, W_0M_3, W_3M_0 and W_3M_1 at 60 and 80 DAS. On the other hand, the lowest plant height (19.11, 43.46, 67.87 and 77.95 cm at 20, 40, 60 and 80 DAS, respectively) was recorded with W_0M_0 treatment which was statistically similar with W_0M_1, W_0M_2, W_0M_3 and W_3M_0 at 20 DAS; W_0M_1 and W_0M_2 at 40 DAS; W_0M_1, W_0M_2, W_0M_3, W_2M_0, W_3M_0, W_3M_1 and W_3M_2 at 60 DAS; W_0M_1, W_0M_2, W_0M_3, W_2M_0, W_3M_0 and W_3M_1 at 80 DAS. The results agreed with the findings of Khan *et al*. (2011).

Table 2. Combined effect of different levels of weeding frequency and mikania vine chopping on plant height of blackgram

Treatment combination	Plant height (cm) at different days after sowing (DAS)			
	20	40	60	80
W_0M_0	19.11 g	43.46 e	67.87 e	77.95 e
W_0M_1	19.97 fg	44.11 de	70.33 de	79.64 de
W_0M_2	21.61 e-g	51.63 cd	73.25 c-e	80.71 de
W_0M_3	22.85 c-g	55.40 a-c	76.87 b-e	85.73 b-e
W_1M_0	25.80 a-c	55.21 a-c	78.63 a-d	90.91 a-d
W_1M_1	26.65 a-c	56.50 a-c	80.49 a-d	95.16 ab
W_1M_2	27.74 ab	58.55 a-c	85.23 ab	97.94 a
W_1M_3	28.31 a	61.91 a	88.71 a	99.60 a
W_2M_0	24.51 a-e	54.63 a-c	78.12 a-e	88.80 a-e
W_2M_1	24.61 a-e	56.50 a-c	81.19 a-c	90.73 a-d
W_2M_2	25.31 a-e	57.46 a-c	85.00 ab	93.06 ab
W_2M_3	26.71 a-c	59.32 a-c	87.43 ab	95.17 ab
W_3M_0	21.67 d-g	51.98 bc	72.73 c-e	81.31 c-e
W_3M_1	23.47 c-f	53.83 bc	77.47 b-e	85.00 b-e
W_3M_2	24.21 b-e	58.54 abc	78.17 a-e	89.99 a-d
W_3M_3	25.60 a-d	59.47 ab	82.15 a-c	92.22 a-c
$LSD_{(0.05)}$	**3.98**	**7.75**	**10.60**	**11.29**
CV (%)	**9.83**	**8.46**	**8.05**	**7.61**

W_0: No weeding (Control),
W_1: Weeding before critical stage,
W_2: Weeding at critical stage and
W_3: Weeding after critical stage

M_0: No mikania vine chopping (Control),
M_1: Mikania vine chopping 2% of soil weight,
M_2: Mikania vine chopping 4% of soil weight and
M_3: Mikania vine chopping 6% of soil weight

4.4 Number of leaf plant^{-1}

4.4.1 Effect of weeding frequency on number of leaf plant^{-1}

Significant variation was observed on the number of leaves plant^{-1} of blackgram due to different level of weeding (Figure 7). Number of leaf plant^{-1} rapidly increased from 20 DAS to 60 DAS then there was a slow decrease up to 80 DAS. The maximum number of leaf plant^{-1} (6.08, 13.75 and 22.58 at 20, 40 and 80 DAS, respectively) was obtained from W_1; (25.67 at 60 DAS) was obtained from W_2 which was statistically similar with W_1. The minimum number of leaf plant^{-1} (4.42 at 20 DAS) was obtained from W_3 which was statistically similar with W_2; (10.38, 20.75 and 12.88 at 40, 60 and 80 DAS, respectively) was obtained from W_1 which was statistically similar with W_3 at only 60 DAS. The results agreed with the findings of Akter *et al.* (2013) who state that weeding increase the number of leaves of blackgram.

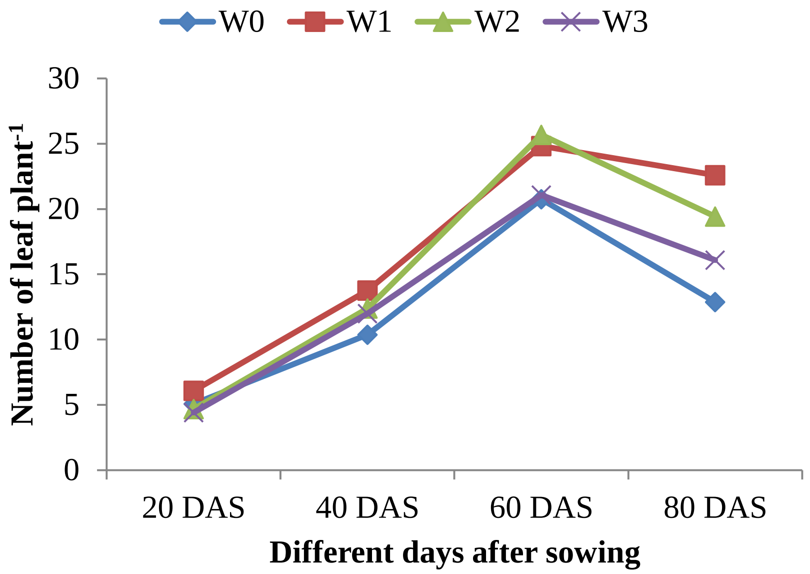


Figure 7. Effect of weeding frequency on number of leaf plant^{-1} of blackgram at different days after sowing (LSD $_{(0.05)}$ = 0.55, 0.97, 1.28 and 1.50 at 20, 40, 60 and 80 DAS, respectively)

Note: W_0: No weeding (Control), W_1: Weeding before critical stage, W_2: Weeding at critical stage and W_3: Weeding after critical stage

4.4.2 Effect of mikania vine chopping on number of leaf plant^{-1}

Significant variation was observed on number of leaf plant^{-1} of blackgram due to the application of mikania vine chopping (Figure 8). Number of leaf plant^{-1} rapidly increased from 20 DAS to 60 DAS thereafter a slower rate of decrease in number of leavf plant^{-1} was recorded up to 80 DAS. Among the different doses of mikania vine chopping, M_3 showed the maximum leaves plant^{-1} (5.67, 13.50, 25.92 and 20.46 at 20, 40, 60 and 80 DAS, respectively) which was statistically similar with M_2 at 20 and 40 DAS. On the other hand, the minimum number of leaf plant^{-1} (4.42, 10.25, 20.50 and 14.96 at 20, 40, 60 and 80 DAS, respectively) was observed in M_0 which was statistically similar with M_1 at 20 DAS.

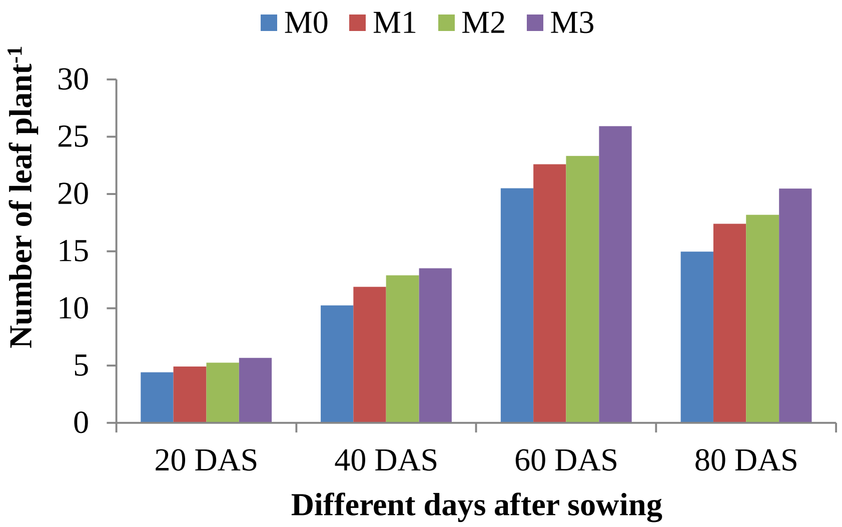


Figure 8. Effect of mikania vine on number of leaf plant^{-1} of blackgram at different days after sowing (LSD $_{(0.05)}$ = 0.55, 0.97, 1.28 and 1.50 at 20, 40, 60 and 80 DAS, respectively)

Note: M_0: No mikania vine chopping (Control), M_1: Mikania vine chopping 2% of soil weight, M_2: Mikania vine chopping 4% of soil weight and M_3: Mikania vine chopping 6% of soil weight

4.4.3 Combined effect of weeding frequency and mikania vine chopping on number of leaf plant^{-1}

Combined application of weeding frequency and different doses of mikania vine chopping had significant effect on the number of leaf plant^{-1} of blackgram (Table 3). The maximum number of leaf plant^{-1} (7.00, 16.00 and 25.00 at 20, 40 and 80 DAS, respectively) was observed in the treatment combination of W_1M_3 which was statistically similar with W_0M_3, W_1M_1 and W_1M_2 at 20 DAS; W_2M_3 at 40 DAS; W_1M_2 and W_2M_3 at 80 DAS; (29.00 at 60 DAS) was observed in W_2M_3 which was statistically similar with W_1M_3 and W_2M_2. On the other hand, the minimum number of leaf plant^{-1} (3.33 at 20 DAS) was recorded with W_3M_0 which was statistically similar with W_0M_0, W_2M_1, W_2M_3 and W_3M_1; (8.50 at 40 DAS) was recorded with W_0M_0 which was statistically similar with W_0M_3 and W_2M_0; (17.67 at 60 DAS) was recorded with W_3M_0 which was statistically similar with W_0M_0 and W_0M_1; (9.50 at 80 DAS) was recorded with W_0M_0.

Table 3. Combined effect of different levels of weeding frequency and Mikania vine chopping on number of leaf plant^{-1} of blackgram at different days after sowing

Treatment combination	Different days after sowing (DAS)			
	20	40	60	80
W_0M_0	4.33 cd	8.50 h	19.33 hi	9.500 j
W_0M_1	4.67 c	11.50 e-g	20.00 g-i	12.50 i
W_0M_2	5.33 bc	11.50 e-g	21.67 e-h	14.00 g-i
W_0M_3	6.00 ab	10.00 gh	22.00 d-g	15.50 f-h
W_1M_0	4.67 c	12.00 d-f	22.67 c-f	20.33 cd
W_1M_1	6.33 ab	13.00 b-e	24.67 bc	22.00 bc
W_1M_2	6.33 ab	14.00 bc	23.67 c-e	23.00 a-c
W_1M_3	7.00 a	16.00 a	28.33 a	25.00 a
W_2M_0	5.33 bc	10.00 gh	22.33 c-g	17.00 ef
W_2M_1	4.33 cd	11.50 e-g	24.33 cd	19.00 de
W_2M_2	4.67 c	13.50 b-d	27.00 ab	18.33 d-f
W_2M_3	4.33 cd	14.50 ab	29.00 a	23.33 ab
W_3M_0	3.33 d	10.50 fg	17.67 i	13.00 hi
W_3M_1	4.33 cd	11.50 e-g	21.33 e-h	16.00 fg
W_3M_2	4.67 c	12.50 c-e	21.00 f-h	17.33 ef
W_3M_3	5.33 bc	13.50 b-d	24.33 cd	18.00 d-f
$LSD_{(0.05)}$	**1.10**	**1.95**	**2.57**	**3.00**
CV (%)	**12.98**	**9.63**	**6.67**	**10.13**

W_0: No weeding (Control),
W_1: Weeding before critical stage,
W_2: Weeding at critical stage and
W_3: Weeding after critical stage

M_0: No mikania vine chopping (Control),
M_1: Mikania vine chopping 2% of soil weight,
M_2: Mikania vine chopping 4% of soil weight and
M_3: Mikania vine chopping 6% of soil weight

4.5 Number branch plant^{-1}

4.5.1 Effect of weeding frequency on the number of branch plant^{-1}

Significant variation was observed in the number of branch plant^{-1} of blackgram when different levels of weeding frequency were applied (Figure 9). The highest number of branch plant^{-1} (2.60, 4.88 and 5.71 at 40, 60 and 80 DAS, respectively) was recorded in W_1 while the lowest number of branch plant^{-1} (1.37, 3.16 and 3.76 at 40, 60 and 80 DAS, respectively) was recorded in W_0. The results agreed with the findings of Akter *et al.* (2013) and Mahla *et al.* (1999) who state that weeding increase the number of branches of blackgram.

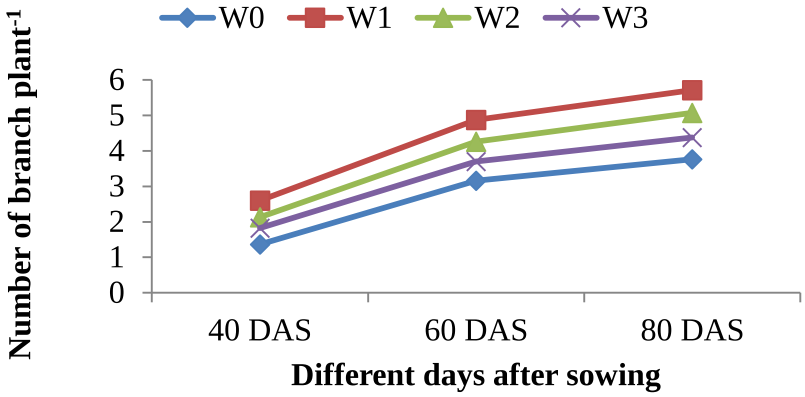


Figure 9. Effect of weeding frequency on number of branch plant^{-1} of blackgram at different days after sowing (LSD $_{(0.05)}$ = 0.17, 0.23 and 0.37 at 40, 60 and 80 DAS, respectively)

Note: W_0: No weeding (Control), W_1: Weeding before critical stage, W_2: Weeding at critical stage and W_3: Weeding after critical stage

4.5.2 Effect of mikania vine chopping on the number of branch plant^{-1}

Significant variation was observed in the number of branch plant^{-1} of blackgram when different doses of mikania vine chopping were applied (Figure 10). The highest number of branch plant^{-1} (2.26, 4.57 and 5.56 at 40, 60 and 80 DAS, respectively) was recorded in M_3 while the lowest number of branch plant^{-1} (1.72, 3.55 and 4.04 at 40, 60 and 80 DAS, respectively) was recorded in M_0.

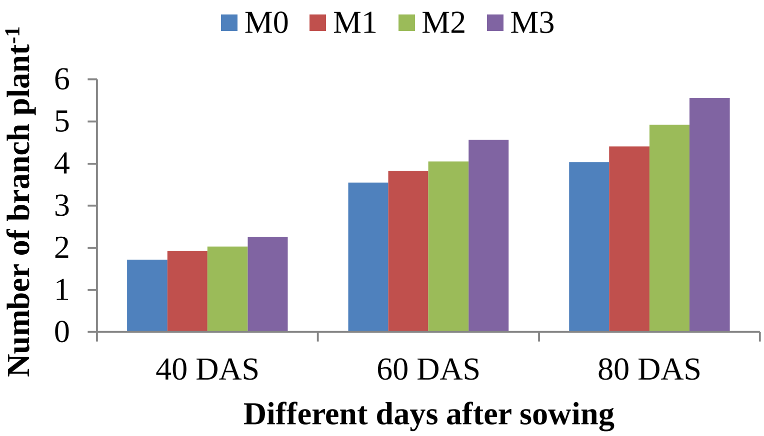


Figure 10. Effect of mikania vine on number of branch plant^{-1} of blackgram at different days after sowing (LSD $_{(0.05)}$ = 0.17, 0.23 and 0.37 at 20, 40, 60 and 80 DAS, respectively)

Note: M_0: No mikania vine chopping (Control), M_1: Mikania vine chopping 2% of soil weight, M_2: Mikania vine chopping 4% of soil weight and M_3: Mikania vine chopping 6% of soil weight

4.5.3 Combined effect of weeding frequency and mikania vine chopping on the number of branch plant^{-1}

The Combined effect of different doses of weeding frequency and mikania vine chopping on the number of branch plant^{-1} of blackgram was significant (Table 4). The highest number of branch plant^{-1} (2.90, 5.80 and 6.87 at 40, 60 and 80 DAS, respectively) was recorded with the treatment combination of W_1M_3 which was statistically similar with W_1M_2 at 40 DAS. On the other hand, the lowest number of branch plant^{-1} (1.03, 2.67 and 3.25 at 40, 60 and 80 DAS, respectively) was found in W_0M_0 which was statistically similar with W_0M_1 at 40 DAS; which was statistically similar with W_0M_1, W_0M_2, W_3M_0 and W_3M_1 at 80 DAS.

Table 4. Combined effect of different levels of weeding frequency and Mikania vine chopping on number of branch plant^{-1} of blackgram at different days after sowing

Treatment combination	Different days after sowing (DAS)		
	40	**60**	**80**
W_0M_0	1.03 j	2.67 g	3.25 h
W_0M_1	1.33 ij	3.20 f	3.59 gh
W_0M_2	1.40 hi	3.30 f	3.88 f-h
W_0M_3	1.70 gh	3.48 ef	4.33 ef
W_1M_0	2.23 c-e	4.23 cd	4.88 de
W_1M_1	2.50 bc	4.63 bc	5.30 b-d
W_1M_2	2.77 ab	4.85 b	5.80 bc
W_1M_3	2.90 a	5.80 a	6.87 a
W_2M_0	1.90 e-g	3.93 de	4.29 e-g
W_2M_1	2.07 ef	3.98 d	4.88 de
W_2M_2	2.14 d-f	4.22 cd	5.20 b-d
W_2M_3	2.43 b-d	4.90 b	5.92 b
W_3M_0	1.70 gh	3.36 f	3.73 f-h
W_3M_1	1.80 fg	3.52 ef	3.87 f-h
W_3M_2	1.82 fg	3.84 de	4.80 de
W_3M_3	2.00 efg	4.08 d	5.13 cd
$LSD_{(0.05)}$	**0.35**	**0.45**	**0.73**
CV (%)	**10.53**	**6.82**	**9.27**

W_0: No weeding (Control),
W_1: Weeding before critical stage,
W_2: Weeding at critical stage and
W_3: Weeding after critical stage

M_0: No mikania vine chopping (Control),
M_1: Mikania vine chopping 2% of soil weight,
M_2: Mikania vine chopping 4% of soil weight and
M_3: Mikania vine chopping 6% of soil weight

4.6 Number pod plant^{-1}

4.6.1 Effect of weeding frequency on the number of pod plant^{-1}

Significant variation was observed in number of pod plant^{-1} of blackgram when different levels of weeding frequency were applied (Figure 11). The highest number of pod plant^{-1} (17.25) was recorded in W_1 while the lowest number of pod plant^{-1} (12.34) was recorded in the W_0. The results agreed with the findings of Akter *et al.* (2013) and Malik *et al.* (2003) who state that weeding frequency increase the number of pod plant^{-1} of blackgram.

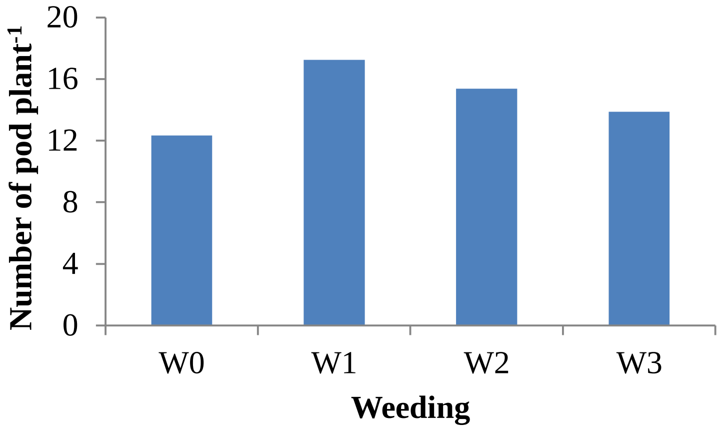


Figure 11. Effect of weeding frequency on number of pod plant^{-1} of (LSD $_{(0.05)}$ = 1.19)

Note: W_0: No weeding (Control), W_1: Weeding before critical stage, W_2: Weeding at critical stage and W_3: Weeding after critical stage

4.6.2 Effect of mikania vine chopping on the number of pod plant^{-1}

Different doses of mikania vine chopping showed significant variations in respect of number of pod plant^{-1} (Figure 12). Among the different doses of mikania vine chopping, M_3 showed the highest number of pod plant^{-1} (16.03) which was statistically similar with M_2. On the contrary, the lowest number of pod plant^{-1} (13.65) was observed with M_0 which was statistically similar with M_1.

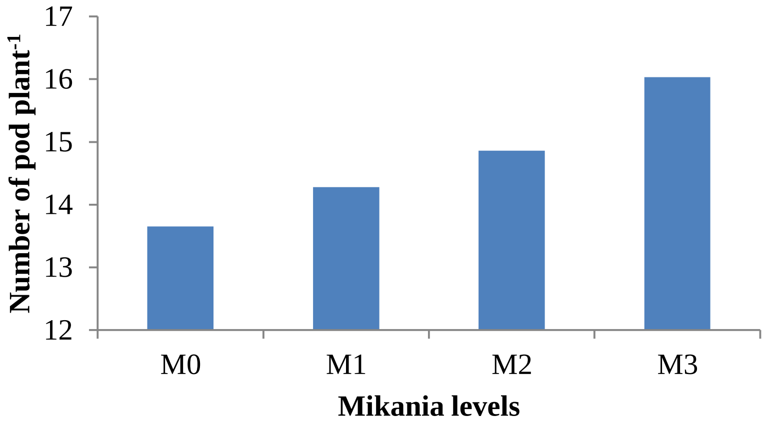


Figure 12. Effect of mikania vine on number of pod plant^{-1} of blackgram (LSD $_{(0.05)}$ = 1.19)

Note: M_0: No mikania vine chopping (Control), M_1: Mikania vine chopping 2% of soil weight, M_2: Mikania vine chopping 4% of soil weight and M_3: Mikania vine chopping 6% of soil weight

4.6.3 Combined effect of weeding frequency and mikania vine chopping on the number of pod plant^{-1}

The Combined effect of weeding frequency and different doses of mikania vine chopping on number of pod plant^{-1} of blackgram was significant (Table 5). The highest number of pod plant^{-1} (19.00) was recorded with the treatment combination of W_1M_3 which were statistically similar with W_1M_1 and W_1M_2. On the other hand, the lowest number of pod plant^{-1} (11.52) was found in W_0M_0 which were statistically similar with W_0M_1, W_0M_2, W_0M_3, W_3M_0, W_3M_1 and W_3M_2. The results agreed with the findings of Madukwe *et al*. (2012).

4.7 Pod length (cm)

4.7.1 Effect of weeding frequency on pod length

The pod length as affected by different levels of weeding frequency showed statistically significant variation (Figure 13). The highest pod length (4.51 cm) was observed in W_1 whereas the lowest pod length (4.11 cm) was recorded in the W_0. The results agreed with the findings of Akter *et al.* (2013) and Awan *et al*. (2009).

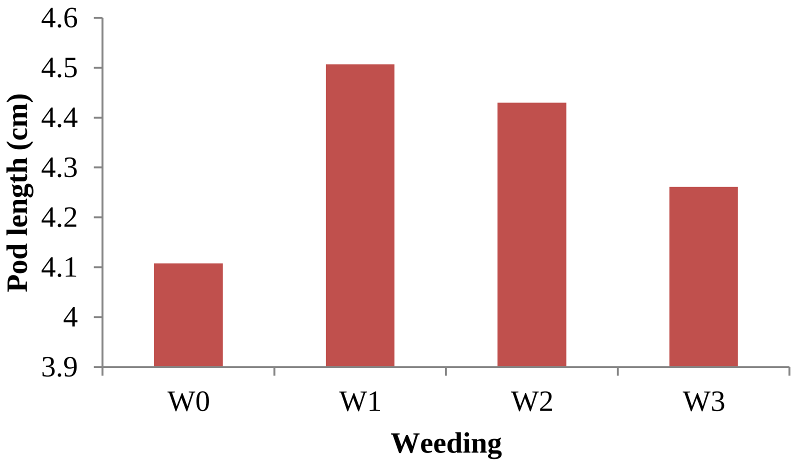


Figure 13. Effect of weeding frequency on pod length of blackgram (LSD $_{(0.05)}$ = 0.25)

Note: W_0: No weeding (Control), W_1: Weeding before critical stage, W_2: Weeding at critical stage and W_3: Weeding after critical stage

4.7.2 Effect of mikania vine chopping on pod length of blackgram

Significant variations were observed due to the application of mikania vine chopping at different doses on the pod length of blackgram (Figure 14). Among the different mikania vine chopping doses, M_3 showed the highest pod length (4.55 cm), which was statistically similar with M_2. The lowest pod length (4.12 cm) was recorded in the M_0 which was statistically similar with M_1.

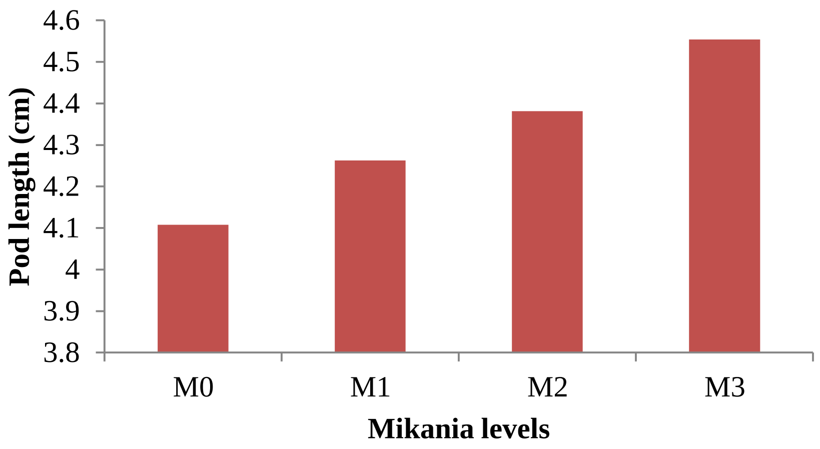


Figure 14. Effect of mikania vine on pod length of blackgram (LSD $_{(0.05)}$ = 0.25)

Note: M_0: No mikania vine chopping (Control), M_1: Mikania vine chopping 2% of soil weight, M_2: Mikania vine chopping 4% of soil weight and M_3: Mikania vine chopping 6% of soil weight

4.7.3 Combined effect of weeding frequency and mikania vine chopping on pod length

Combined effect of weeding frequency and different doses of mikania vine chopping on pod length showed a statistically significant variation (Table 5). The highest pod length (4.75 cm) was recorded in the treatment combination of W_1M_3 which was statistically similar with all other combinations except W_0M_0, W_0M_1, W_0M_2, W_2M_0, W_3M_0 and W_3M_1. On the other hand, the lowest pod length (3.92 cm) was found in W_0M_0 which was statistically similar with all other combinations except W_1M_1, W_1M_2, W_1M_3, W_2M_2, W_2M_3 and W_3M_3.

4.8 Number of seed pod^{-1} (No.)

4.8.1 Effect of weeding frequency on the number of seed pod^{-1}

Significant variation was observed in number of seed pod^{-1} of blackgram when different levels of weeding frequency were applied (Figure 15). The highest number of seed pod^{-1} (6.43) was recorded in W_1 which was statistically similar with W_2. The lowest number of seed pod^{-1} (5.11) was recorded in the W_0. The results agreed with the findings of Akter *et al.* (2013) and Kumar and Kairon (1988).

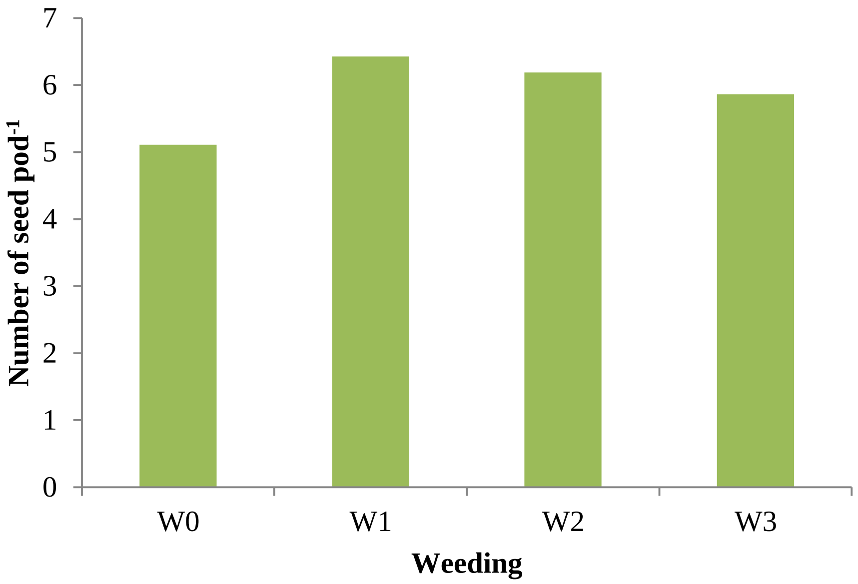


Figure 15. Effect of weeding frequency on number of seed pod^{-1} of blackgram (LSD $_{(0.05)}$ = 0.35)

Note: W_0: No weeding (Control), W_1: Weeding before critical stage, W_2: Weeding at critical stage and W_3: Weeding after critical stage

4.8.2 Effect of mikania vine chopping on the number of seed pod^{-1}

Different doses of mikania vine chopping showed significant variations in respect of number of seed pod^{-1} (Figure 16). Among the different doses of mikania vine chopping, M_3 showed the highest number of seed pod^{-1} (6.28) which was statistically similar with M_2. On the contrary, the lowest number of seed pod^{-1} (5.44) was observed with M_0.

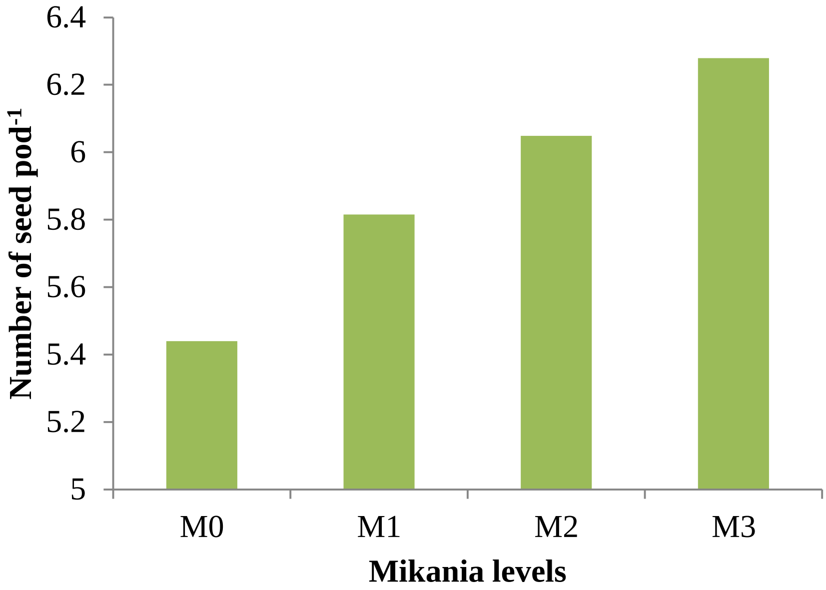


Figure 16. Effect of mikania vine on number of seed pod^{-1} of blackgram (LSD $_{(0.05)}$ = 0.35)

Note: M_0: No mikania vine chopping (Control), M_1: Mikania vine chopping 2% of soil weight, M_2: Mikania vine chopping 4% of soil weight and M_3: Mikania vine chopping 6% of soil weight

4.8.3 Combined effect of weeding frequency and mikania vine chopping on the number of seed pod^{-1}

The Combined effect of weeding frequency and different doses of mikania vine chopping on number of seed pod^{-1} of blackgram was significant (Table 5). The highest number of seed pod^{-1} (6.82) was recorded with the treatment combination of W_1M_3 which was statistically similar with W_1M_1, W_1M_2, W_2M_1, W_2M_2, W_2M_3 and W_3M_3. On the other hand, the lowest number of seed pod^{-1} (4.63) was found in W_0M_0 which was statistically similar with W_0M_1 and W_0M_2.

4.9 Weight of 1000 seed (g)

4.9.1 Effect of weeding frequency on weight of 1000-seed

Significant variation was observed in weight of 1000 seed of blackgram when different levels of weeding frequency were applied (Figure 17). The highest weight of 1000 seed (44.23 g) was recorded in W_1 and the lowest was recorded (35.29 g) in the W_0 which was statistically similar with W_3. The results agreed with the findings of Akter *et al.* (2013).

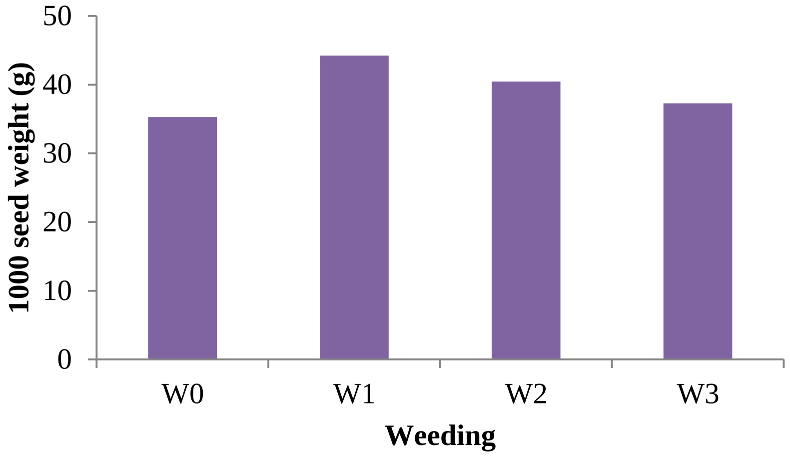


Figure 17. Effect of weeding on 1000 seed weight of blackgram (LSD $_{(0.05)}$ = 3.02)

Note: W_0: No weeding (Control), W_1: Weeding before critical stage, W_2: Weeding at critical stage and W_3: Weeding after critical stage

4.9.2 Effect of mikania vine chopping on weight of 1000 seed

Different doses of mikania vine chopping showed significant variations in respect of the weight of 1000 seed (Figure 18). Among the different doses of mikania vine chopping, M_3 showed the highest weight of 1000 seed (42.01 g) which was statistically similar with M_2. On the contrary, the lowest weight of 1000 seed (36.92 g) was observed with M_1.

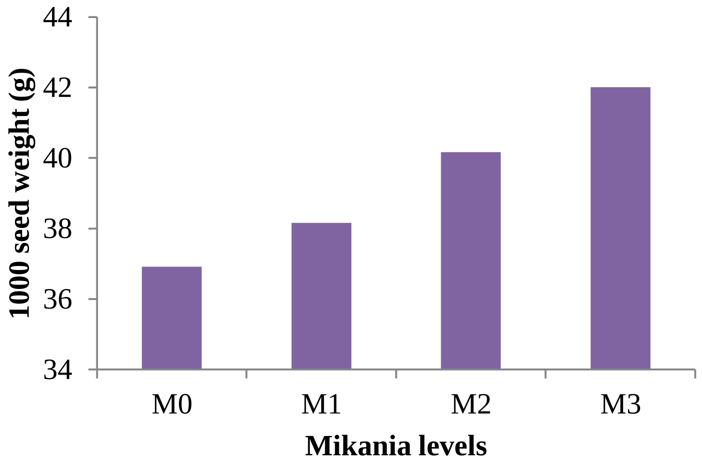


Figure 18. Effect of mikania vine on plant height of blackgram (LSD $_{(0.05)}$ = 3.02)

Note: M_0: No mikania vine chopping (Control), M_1: Mikania vine chopping 2% of soil weight, M_2: Mikania vine chopping 4% of soil weight and M_3: Mikania vine chopping 6% of soil weight

4.9.3 Combined effect of weeding frequency and mikania vine chopping on weight of 1000 seed

The Combined effect of weeding frequency and different doses of mikania vine chopping on the weight of 1000 seed of blackgram was significant (Table 5). The highest weight of 1000 seed (47.67 g) was recorded with the treatment combination of W_1M_3 which was statistically similar with W_1M_1, W_1M_2, W_2M_2 and W_2M_3. On the other hand, the lowest weight of 1000 seed (32.67 g) was found in W_0M_0 which was statistically similar with W_0M_1, W_0M_2, W_0M_3, W_2M_0, W_2M_1, W_3M_0, W_3M_1 and W_3M_2. The results agreed with the findings of Madukwe *et al*. (2012).

Table 5. Interaction effect of weeding frequency and mikania vine on number of pod plant^{-1}, pod length, number of seed pod^{-1} and 1000 seed weight of blackgram

Treatment combination	Pod plant^{-1} (No.)	Pod length (cm)	Seed pod^{-1} (No.)	1000 seed weight (g)
W_0M_0	11.52 g	3.92 e	4.63 f	32.67 g
W_0M_1	11.95 g	4.04 c-e	5.00 ef	34.67 fg
W_0M_2	12.44 fg	4.17 b-e	5.33 d-f	35.89 e-g
W_0M_3	13.44 d-g	4.31 a-e	5.47 de	37.95 c-g
W_1M_0	15.77 b-d	4.31 a-e	6.00 b-d	41.33 b-e
W_1M_1	16.75 a-c	4.43 a-d	6.29 a-c	43.59 a-c
W_1M_2	17.50 ab	4.54 a-c	6.60 ab	44.33 ab
W_1M_3	19.00 a	4.75 a	6.82 a	47.67 a
W_2M_0	14.42 c-f	4.21 b-e	5.71 cd	37.17 d-g
W_2M_1	14.90 c-e	4.38 a-e	6.20 a-c	38.67 b-g
W_2M_2	15.65 b-d	4.51 a-c	6.33 a-c	42.79 a-d
W_2M_3	16.50 bc	4.63 ab	6.50 ab	43.15 a-d
W_3M_0	12.90 e-g	4.00 de	5.42 de	36.53 e-g
W_3M_1	13.53 d-g	4.21 b-e	5.77 cd	35.72 e-g
W_3M_2	13.87 d-g	4.31 a-e	5.93 b-d	37.67 c-g
W_3M_3	15.18 b-e	4.53 a-c	6.33 a-c	39.27 b-f
LSD (0.05)	**2.39**	**0.51**	**0.70**	**6.04**
CV (%)	**9.73**	**7.01**	**7.16**	**9.21**

W_0: No weeding (Control),
W_1: Weeding before critical stage,
W_2: Weeding at critical stage and
W_3: Weeding after critical stage

M_0: No mikania vine chopping (Control),
M_1: Mikania vine chopping 2% of soil weight,
M_2: Mikania vine chopping 4% of soil weight and
M_3: Mikania vine chopping 6% of soil weight

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

4.10.1 Effect of weeding frequency on the seed yield

Significant variation was observed on the seed yield of blackgram when different levels of weeding frequency were applied (Figure 19). The highest seed yield of blackgram (1.29 t ha^{-1}) was recorded in W_1. The lowest seed yield of blackgram (0.93 t ha^{-1}) was recorded in the W_0. W_1 produced 38.71% higher seed than W_0. W_1 produced the highest yield due to maximum production of crop characters like plant height, branches plant^{-1}, leaves plant^{-1}, pods plant^{-1} and seeds pod^{-1}. The results agreed with the findings of Kumar *et al.* (2015), Das *et al.* (2014), Pramanik *et al.* (2014), Akter *et al.* (2013) and Mahla *et al.* (1999) who state that weeding frequency increase the seed yield of blackgram by increasing the crop growth characters.

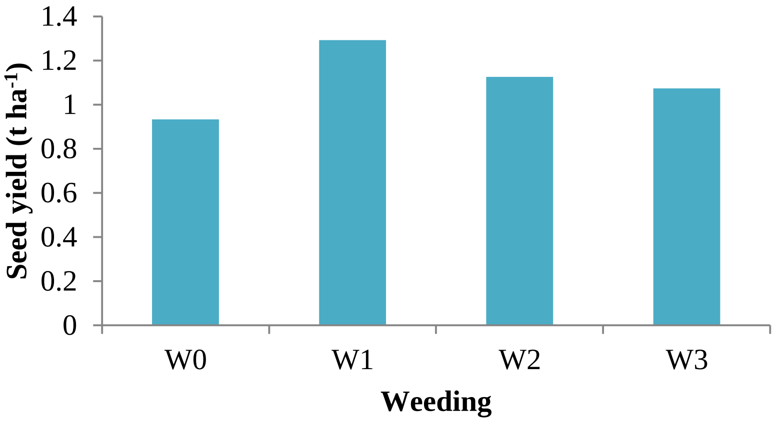


Figure 19. Effect of weeding frequency on seed yield of blackgram (LSD $_{(0.05)}$ = 0.07)

Note: W_0: No weeding (Control), W_1: Weeding before critical stage, W_2: Weeding at critical stage and W_3: Weeding after critical stage

4.10.2 Effect of mikania vine chopping on the seed yield

Different doses of mikania vine chopping showed significant effect of seed yield of blackgram (Figure 20). Among the different doses of mikania vine chopping, M_3 showed the highest seed yield of blackgram (1.20 t ha^{-1}). On the contrary, the lowest seed yield of blackgram (1.01 t ha^{-1}) was observed with M_0. M_3 produced 1.88% higher seed than M_0.

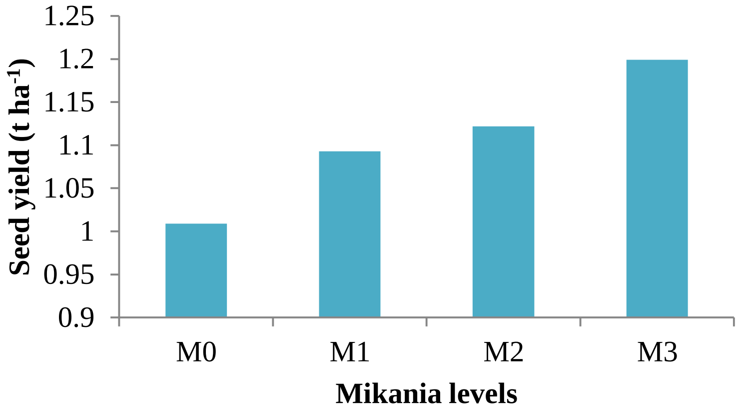


Figure 20. Effect of mikania vine on seed yield of blackgram (LSD $_{(0.05)}$ = 0.07)

Note: M_0: No mikania vine chopping (Control), M_1: Mikania vine chopping 2% of soil weight, M_2: Mikania vine chopping 4% of soil weight and M_3: Mikania vine chopping 6% of soil weight

4.10.3 Combined effect of weeding frequency and mikania vine chopping on seed yield

The Combined effect of weeding frequency and different doses of mikania vine chopping on the seed yield of blackgram was significant (Table 6). The highest seed yield of blackgram (1.43 t ha^{-1}) was recorded with the treatment combination of W_1M_3 which was statistically similar with W_1M_2, W_2M_2 and W_2M_3. On the other hand, the lowest seed yield of blackgram (0.81 t ha^{-1}) was found in W_0M_0 which was statistically similar with W_0M_1. The results agreed with the findings of Madukwe *et al*. (2012).

4.11 Stover yield (t ha^{-1})

4.11.1 Effect of weeding frequency on the stover yield

Significant variation was observed on the stover yield of blackgram when different levels of weeding frequency were applied (Figure 21). The highest stover yield of blackgram (2.03 t ha^{-1}) was recorded in W_1 whereas the lowest stover yield (1.71 t ha^{-1}) was recorded in the W_0. The results agreed with the findings of Das *et al.* (2014), Akter *et al.* (2013) and Mahla *et al.* (1999).

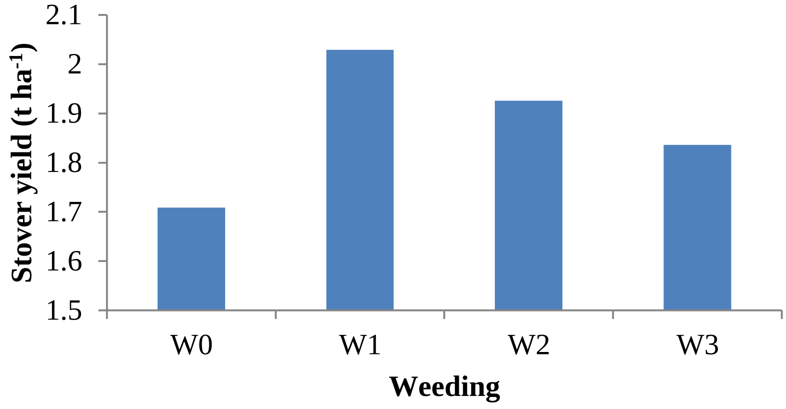


Figure 21. Effect of weeding frequency on stover yield of blackgram (LSD $_{(0.05)}$ = 0.10)

Note: W_0: No weeding (Control), W_1: Weeding before critical stage, W_2: Weeding at critical stage and W_3: Weeding after critical stage

4.11.2 Effect of mikania vine chopping on the stover yield

Different doses of mikania vine chopping showed significant variations in respect of stover yield of blackgram (Figure 22). Among the different doses of mikania vine chopping, M_3 showed the highest stover yield (2.05 t ha^{-1}). On the contrary, the lowest stover yield (1.68 t ha^{-1}) was observed with M_0.

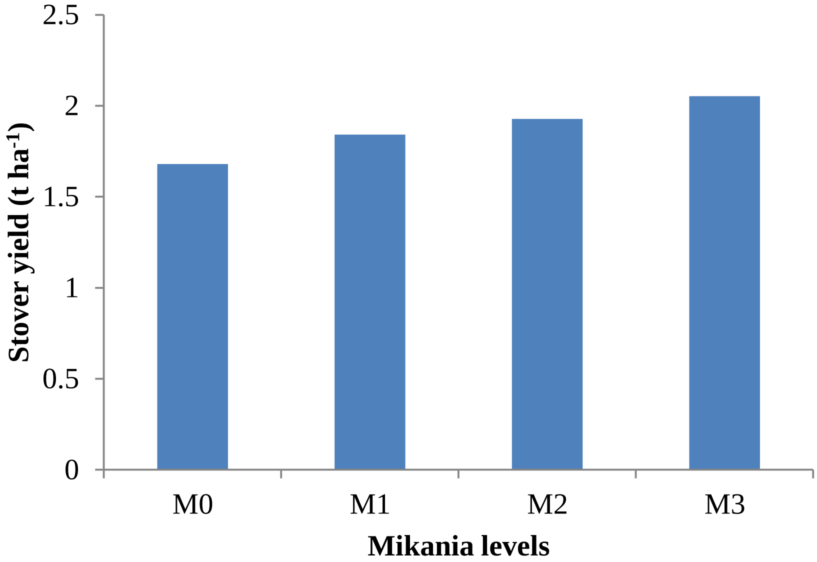


Figure 22. Effect of mikania vine on stover yield of blackgram (LSD $_{(0.05)}$ = 0.10)

Note: M_0: No mikania vine chopping (Control), M_1: Mikania vine chopping 2% of soil weight, M_2: Mikania vine chopping 4% of soil weight and M_3: Mikania vine chopping 6% of soil weight

4.11.3 Combined effect of weeding frequency and mikania vine chopping on stover yield

The Combined effect of weeding frequency and different doses of mikania vine chopping on the stover yield was significant (Table 6). The highest stover yield (2.22 t ha^{-1}) was recorded with the treatment combination of W_1M_3 which were statistically similar with W_1M_1, W_1M_2 and W_2M_3. On the other hand, the lowest stover yield (1.46 t ha^{-1}) was found in W_0M_0 treatment combination which was statistically similar with W_0M_1 and W_3M_0.

4.12 Biological yield

4.12.1 Effect of weeding frequency on the biological yield

Significant variation was observed on the biological yield of blackgram when different levels of weeding frequency were applied (Figure 23). The highest biological yield of blackgram (3.32 t ha^{-1}) was recorded in W_1 whereas the lowest biological yield (2.64 t ha^{-1}) was recorded in the W_0. The results agreed with the findings of Akter *et al.* (2013).

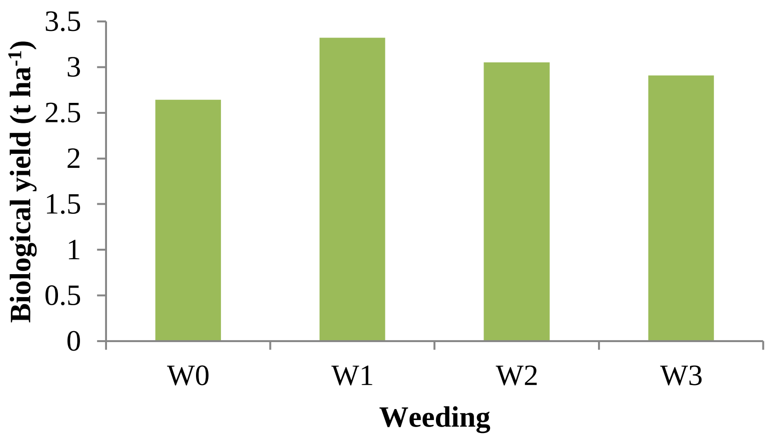


Figure 23. Effect of weeding frequency on biological yield of blackgram (LSD $_{(0.05)}$ = 0.12)

Note: W_0: No weeding (Control), W_1: Weeding before critical stage, W_2: Weeding at critical stage and W_3: Weeding after critical stage

4.12.2 Effect of mikania vine chopping on the biological yield

Different doses of mikania vine chopping showed significant variations in respect of biological yield of blackgram (Figure 24). Among the different doses of mikania vine chopping, M_3 showed the highest biological yield (3.25 t ha^{-1}). On the contrary, the lowest biological yield (2.69 t ha^{-1}) was observed with M_0.

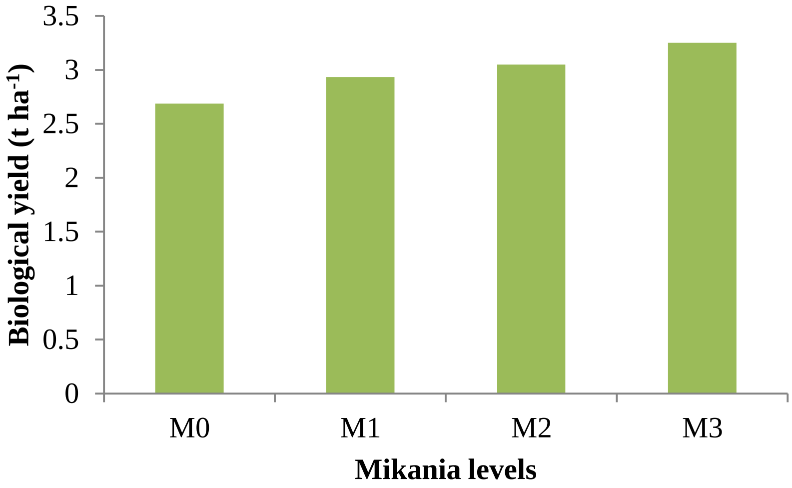


Figure 24. Effect of mikania vine on biological yield of blackgram (LSD $_{(0.05)}$ = 0.12)

Note: M_0: No mikania vine chopping (Control), M_1: Mikania vine chopping 2% of soil weight, M_2: Mikania vine chopping 4% of soil weight and M_3: Mikania vine chopping 6% of soil weight

4.12.3 Combined effect of weeding frequency and mikania vine chopping on biological yield

The Combined effect of weeding frequency and different doses of mikania vine chopping on the biological yield was significant (Table 6). The highest biological yield (3.65 t ha^{-1}) was recorded with the treatment combination of W_1M_3. On the other hand, the lowest biological yield (2.27 t ha^{-1}) was found in W_0M_0 treatment combination.

4.13 Harvest index

4.13.1 Effect of weeding frequency on the harvest index

Significant variation was observed on the harvest index of blackgram when different levels of weeding frequency were applied (Figure 25). The highest harvest index of blackgram (38.86%) was recorded in W_1 which was statistically similar with W_3, whereas the lowest harvest index of blackgram (35.42%) was recorded in W_0 which was statistically similar with W_2 and W_3. The results agreed with the findings of Akter *et al.* (2013).

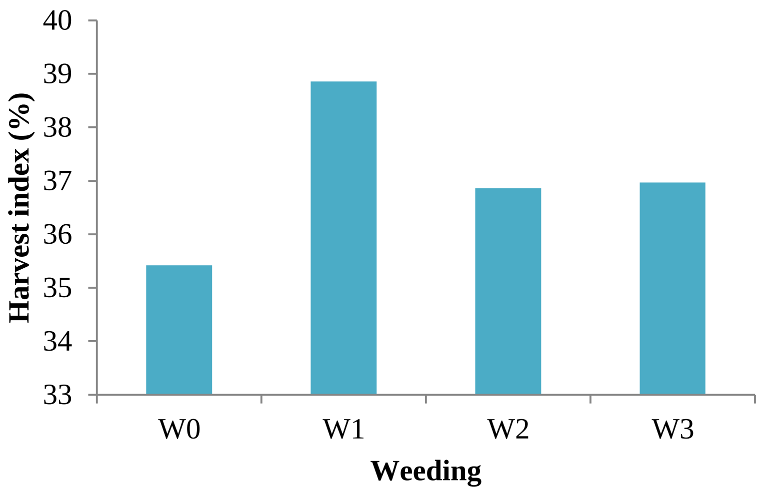


Figure 25. Effect of weeding on harvest index of blackgram (LSD $_{(0.05)}$ = 1.89)

Note: W_0: No weeding (Control), W_1: Weeding before critical stage, W_2: Weeding at critical stage and W_3: Weeding after critical stage

4.13.2 Effect of mikania vine chopping on the harvest index

Different doses of mikania vine chopping showed non-significant variations in respect of harvest index of blackgram (Figure 26). Among the different doses of mikania vine chopping, M_0 showed the highest harvest index (37.44%) and the lowest was observed (36.70%) with M_2 treatment.

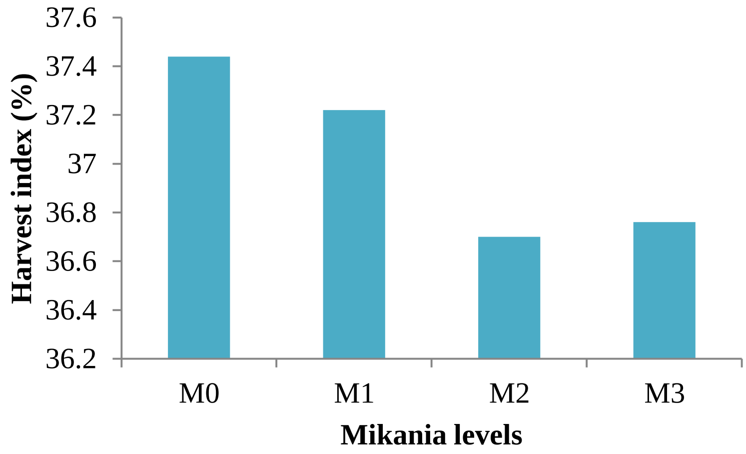


Figure 26. Effect of mikania vine on harvest index of blackgram (LSD $_{(0.05)}$ = NS)

Note: M_0: No mikania vine chopping (Control), M_1: Mikania vine chopping 2% of soil weight, M_2: Mikania vine chopping 4% of soil weight and M_3: Mikania vine chopping 6% of soil weight

4.13.3 Combined effect of weeding frequency and mikania vine chopping on harvest index

The Combined effect of weeding frequency and different doses of mikania vine chopping on the harvest index was significant (Table 6). The highest harvest index (39.27%) was recorded with the treatment combination of W_1M_3 which was statistically similar with all other combinations except W_0M_2 and W_0M_3. On the other hand, the lowest harvest index (34.66%) was recorded with the treatment combination of W_0M_2 which was statistically similar with all other combinations except W_1M_0, W_1M_1, W_1M_2 and W_1M_3.

Table 6. Interaction effect of weeding frequency and mikania vine on seed yield, stover yield, biological yield and harvest index (%) of blackgram

Treatment combination	Seed yield ($t\ ha^{-1}$)	Stover yield ($t\ ha^{-1}$)	Biological yield ($t\ ha^{-1}$)	Harvest index (%)
W_0M_0	0.81 h	1.46 f	2.27 i	35.83 a-c
W_0M_1	0.92 gh	1.65 ef	2.57 h	36.12 a-c
W_0M_2	0.96 fg	1.82 c-e	2.78 f-h	34.66 c
W_0M_3	1.03 e-g	1.91 b-d	2.94 d-f	35.10 bc
W_1M_0	1.15 c-e	1.82 c-e	2.97 d-f	38.69 ab
W_1M_1	1.28 bc	2.03 ab	3.32 bc	38.68 ab
W_1M_2	1.30 ab	2.05 ab	3.35 b	38.80 ab
W_1M_3	1.43 a	2.22 a	3.65 a	39.27 a
W_2M_0	1.05 e-g	1.79 de	2.84 e-g	36.93 a-c
W_2M_1	1.10 df	1.90 b-d	3.00 d-f	36.58 a-c
W_2M_2	1.15 c-e	1.92 b-d	3.07 c-e	37.36 a-c
W_2M_3	1.20 b-d	2.08 ab	3.29 bc	36.58 a-c
W_3M_0	1.02 e-g	1.65 ef	2.67 gh	38.31 a-c
W_3M_1	1.07 d-f	1.78 de	2.84 e-g	37.49 a-c
W_3M_2	1.08 d-f	1.92 b-d	2.99 d-f	35.97 a-c
W_3M_3	1.13 de	2.00 bc	3.13 b-d	36.10 a-c
LSD (0.05)	**0.14**	**0.20**	**0.25**	**3.78**
CV (%)	**7.44**	**6.41**	**5.01**	**6.13**

W_0: No weeding (Control),
W_1: Weeding before critical stage,
W_2: Weeding at critical stage and
W_3: Weeding after critical stage

M_0: No mikania vine chopping (Control),
M_1: Mikania vine chopping 2% of soil weight,
M_2: Mikania vine chopping 4% of soil weight and
M_3: Mikania vine chopping 6% of soil weight

CHAPTER V

SUMMARY AND CONCLUSION

The experiment was conducted at the Agronomy field of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during August to December, 2014 to study the effect of weeding frequency under mikania vine chopping on the growth and yield of blackgram. The experimental field belongs to the Agro-ecological zone (AEZ) of "The Modhupur Tract", AEZ-28. The soil of the experimental field belongs to the General soil type, Deep Red Brown Terrace Soils under Tejgaon soil series. The experiment consisted of two factors. Factor A: Weeding frequency (4 levels); W_0: No weeding (Control), W_1: Weeding before critical stage, W_2: Weeding at critical stage and W_3: Weeding after critical stage, and factor B: Mikania vine chopping (4 levels); M_0: No mikania vine chopping (Control), M_1: Mikania vine chopping 2% of soil weight, M_2: Mikania vine chopping 4% of soil weight and M_3: Mikania vine chopping 6% of soil weight. The variety, BARI mash-3 was used in this experiment as the test crop. There were 16 treatment combinations. The total numbers of unit plots were 48. The size of unit plot was 0.3 m^2 (0.60 m × 0.50 m). N, K_2O, P_2O_5, Ca and S were applied during the final land preparation at the rate of 20 kg ha^{-1}, 33 kg ha^{-1}, 48 kg ha^{-1}, 3.3 kg ha^{-1} and 1.8 kg ha^{-1}, respectively following BARI recommendation. Data on different yield contributing characters & yield were recorded to find out the optimum levels of weeding and mikania vine chopping for higher yield of blackgram.

Different growth and yield parameters were significantly influenced by different levels of weeding. The highest plant height (27.12, 58.04, 83.26 and 95.90 cm at 20, 40, 60 and 80 DAS, respectively) was obtained from W_1, while the lowest plant height (20.88, 48.65, 72.08 and 81.01 cm at 20, 40, 60 and 80 DAS, respectively) was obtained from W_0 treatment. The maximum leaves $plant^{-1}$ (6.08, 13.75 and 22.58 at 20, 40 and 80 DAS, respectively) was obtained from W_1; (25.67 at 60 DAS) was obtained from W_2. The minimum leaves $plant^{-1}$ (4.42 at 20 DAS) was obtained from W_3; (10.38, 20.75 and 12.88 at 40, 60 and 80 DAS, respectively) was obtained from W_1. The highest number of branches $plant^{-1}$ (2.60, 4.88 and 5.71 at 40, 60 and 80 DAS, respectively) was recorded in W_1 while the lowest number of branches $plant^{-1}$ (1.37, 3.16 and 3.76 at 40, 60 and 80 DAS, respectively) was recorded in W_0. The highest number of weeds 0.3 m^{-2} (430.60) and maximum dry weight of weeds 0.3 m^{-2} (77.20) was recorded in W_0 while the lowest number of weeds 0.3 m^{-2} (181.80) and minimum dry weight of weeds 0.3 m^{-2} (32.86) was recorded in W_2. The highest number of pods $plant^{-1}$ (17.25), pod length (4.51 cm), number of seeds pod^{-1} (6.43), weight of 1000 seed (44.23 g), seed yield (1.29 t ha^{-1}), stover yield (2.03 t ha^{-1}), biological yield (3.32 t ha^{-1}) and harvest index of blackgram (38.86%) was recorded in W_1. The lowest number of pods $plant^{-1}$ (12.34), pod length (4.11 cm), number of seeds pod^{-1} (5.11), weight of 1000 seed (35.29 g), seed yield (0.93 t ha^{-1}), stover yield (1.71 t ha^{-1}), biological yield (2.64 t ha^{-1}) and harvest index of blackgram (35.42%) was recorded in the W_0.

Different growth and yield parameters were significantly influenced by different levels of mikania vine chopping. The highest plant height (25.87, 59.02, 83.79 and 93.18 cm at 20, 40, 60 and 80 DAS, respectively) was observed in M_3, while the lowest plant height (22.77, 51.32, 74.34 and 84.74 cm at 20, 40, 60 and 80 DAS, respectively) was observed in the M_0 treatment. M_3 showed the maximum leaves $plant^{-1}$ (5.67, 13.50, 25.92 and 20.46 at 20, 40, 60 and 80 DAS, respectively) whereas the minimum leaves $plant^{-1}$ (4.42, 10.25, 20.50 and 14.96 at 20, 40, 60 and 80 DAS, respectively) was observed in M_0. The highest number of branches $plant^{-1}$ (2.26, 4.57 and 5.56 at 40, 60 and 80 DAS, respectively) was recorded in M_3 while the lowest number of branches $plant^{-1}$ (1.72, 3.55 and 4.04 at 40, 60 and 80 DAS, respectively) was recorded in M_0. M_0 showed the highest number of weeds 0.3 m^{-2} (299.10) and maximum dry weight of weeds 0.3 m^{-2} (55.05) whereas, the lowest number of weeds 0.3 m^{-2} (214.70) and minimum dry weight of weeds 0.3 m^{-2} (37.96) was observed with M_3. The highest number of pods $plant^{-1}$ (16.03), pod length (4.55 cm), number of seeds pod^{-1} (6.28), weight of 1000 seed (42.01 g), seed yield (1.20 t ha^{-1}), stover yield (2.05 t ha^{-1}), biological yield (3.25 t ha^{-1}) and harvest index of blackgram (37.44%) was recorded in M_3. The lowest number of pods $plant^{-1}$ (13.65), pod length (4.12 cm), number of seeds pod^{-1} (5.44), weight of 1000 seed (36.92 g), seed yield (1.01 t ha^{-1}), stover yield (1.68 t ha^{-1}), biological yield (2.69 t ha^{-1}) and harvest index of blackgram (36.70%) was recorded in the M_0.

Seed yield of blackgram responded significantly to the combined effect of weeding frequency and mikania vine chopping. The highest and lowest seed yield (1.41 t ha^{-1} and 0.80 t ha^{-1}) was recorded in N_2R_2 and W0M0 treatment combinations, respectively. The highest and lowest stover yield (2.24 t ha^{-1} and 1.41 t ha^{-1}) was recorded in N_2R_2 and

W0M0 treatment combinations, respectively.

The highest plant height (28.31, 61.91, 88.71 and 99.60 cm at 20, 40, 60 and 80 DAS, respectively) was observed in the treatment combination of W_1M_3 and the lowest plant height (19.11, 43.46, 67.87 and 77.95 cm at 20, 40, 60 and 80 DAS, respectively) was recorded with W_0M_0. The maximum leaves plant^{-1} (7.00, 16.00 and 25.00 at 20, 40 and 80 DAS, respectively) was observed in the treatment combination of W_1M_3; (29.00 at 60 DAS) was observed in W_2M_3. The minimum leaves plant^{-1} (3.33 at 20 DAS) was recorded with W_3M_0; (8.50 at 40 DAS) was recorded with W_0M_0; (17.67 at 60 DAS) was recorded with W_3M_0; (9.50 at 80 DAS) was recorded with W_0M_0. The highest number of branches plant^{-1} (2.90, 5.80 and 6.87 at 40, 60 and 80 DAS, respectively) was recorded with the treatment combination of W_1M_3 and the lowest number of branches plant^{-1} (1.03, 2.67 and 3.25 at 40, 60 and 80 DAS, respectively) was found in W_0M_0. The highest number of weeds 0.3 m^{-2} (469.00) and maximum dry weight of weeds 0.3 m^{-2} (81.99) was recorded with the treatment combination of W_0M_0 whereas, the lowest number of weeds 0.3 m^{-2} (61.67) and minimum dry weight of weeds 0.3 m^{-2} (13.13) was found in W_1M_3. The highest number of pods plant^{-1} (19.00), pod length (4.75 cm), number of seeds pod^{-1} (6.82), weight of 1000 seed (47.67 g), seed yield (1.43 t ha^{-1}), stover yield (2.22 t ha^{-1}), biological yield (3.65 t ha^{-1}) and harvest index of blackgram (39.27%) was recorded with the treatment combination of W_1M_3. The lowest number of pods plant^{-1} (11.52), pod length (3.92 cm), number of seeds pod^{-1} (4.63), weight of 1000 seed (32.67 g), seed yield (0.81 t ha^{-1}), stover yield (1.46 t ha^{-1}), biological yield (2.27 t ha^{-1}) and harvest index of blackgram (34.66%) was found in W_0M_0.

The results in this study indicated that the plants performed better in respect of seed yield in W_1M_3 treatment than the control treatment (W_0M_0) showed the least performance. It can be therefore, concluded from the above study that the treatment combination (Weeding before critical stage and Mikania vine chopping 6% of soil weight) was found to the most suitable combination for the highest yield of blackgram in Deep Red Brown Terrace Soils of Bangladesh.

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

1. The individual and combined effects of weeding frequency and Mikania vine chopping on yield and yield attributes of blackgram were found positive and significant.

2. Weeding before critical stage and Mikania vine chopping 6% of soil weight was the most suitable combination for higher yield of blackgram in Deep Red Brown Terrace Soils of Bangladesh.

This experiment was an individual one conducted in this soil type. For proper fertilizer recommendation, further regional trials should be conducted.

However, to reach a specific conclusion and recommendation, more research work on blackgram should be done in different Agro-ecological zones of Bangladesh.

REFERENCES

Afzal, M. A., Bakar, M. A., Luna, N. K., Rahman, M. M., Hamid, A., Haque, M. M. and Shanmungasudaram, S. (2003). Registration of 'Barimungs' Mungbean. *Crop Sci*. **43**: 930-931.

Ahmad, A., Shamdane, G. and Maniruzzaman, A. F. M. (1993). Effect of time of weeding and plants density on the growth and yield of blackgram. *Bangladesh J. Agric. Res.* p. 162.

Ahmed, A. (1992). Effect of time of weeding and plant density on the growth and yield of mungbean. *Bangladesh J. Agric. Res.* **16**(2): 19-22.

Akter, R., Samad, M. A., Zaman, F. and Islam, M. S. (2013). Effect of weeding on the growth, yield and yield contributing characters of mungbean (*Vigna radiata* L.). *J. Bangladesh Agril. Univ.* **11**(1): 53–60.

Anonymous. (2013a). Bangladesh: Mikania. Published by Metabolism. http: //metabolomics. jp/ wiki/Bangladesh:Mikania.

Anonymous. (2013b). Mikania Vine. Fact Sheet Index. Queensland Government. http://keyserver.lucidcentral.org/weeds/data/03030800-0b07-490a-8d04 0605030c0f01/media/Html /Mikania_micrantha.htm.

Anonymous. (2014). Protecting and restoring our natural heritage- A practical guide-Common herbicides used to control weeds. Department of Conservation. New Zealands Central and Local Govt. Services Publications. http://www. doc. govt. nz/publications/

Anwar, S., Shah, W. A., Bakht, J. and Jabeen, U. (2004). Comparison of sorghum extracts, chemical and hand weeding management in wheat Crop. *J. Agron.* **3**(1): 59-67.

Asaduzzaman, M., Sultana, S., Roy, T. S. and Masum S. M. (2010). Weeding and plant spacing effects on the growth and yield of blackgram. *Bangladesh Res. Publ. J.* **4**(1): 62-68.

Asheesh, K. and Elamathi, S. (2007). Effect of plant spacing and weeding on yield attributes, yield and economics of mungbean (*Vigna radiata*). *India J. Agric. Sci.* **3**(1): 179-180.

Awan, F. K., Zahid, M. A. and Yaqoob, M. (2009). Weed management in mungbean (*Vigna radiata* L.) using different methods and row spacing. *Pakistan J. Weed Sci. Res.* **15**(4): 269-274.

Batish, D. R., Singh, H. P., Saxena, D. B. and Kohli, R. K. (2002). Weed suppressing ability of parthenin-a sesquiterpene lactone from *Parthenium hysterophorus*. Proceeding of a conference, 13-15 August, 2002. New Zealand Plant Protection Society. Rotoura, New Zealand: 218-221.

BBS (Bangladesh Bureau of Statistics). (2008). Statistical Yearbook of Bangladesh. Stat. Div., Minis. Plan. Govt. People's Repub. Bangladesh, Dhaka.

BBS (Bangladesh Bureau of Statistics). (2013). Statistical Yearbook of Bangladesh. Stat. Div., Minis. Plan. Govt. People's Repub. Bangladesh, Dhaka.

Bhowmick, M. K., Duary, B. and Biswas, P. K. (2015). Integrated weed management in blackgram. *Indian J. Weed Sci.* **47**(1): 34–37.

Bryson, C. T. (1990). Interference and critical times of removel of Himp Sesbenia (Sesbania exaltata) in cotton (Gossypium hersutum). *Weed Tech.* **4**: 833-837.

Bueren, E. T. L., Struik, P. C. and Jacobsen, E. (2002). Ecological concepts in organic farming and their consequences for an organic crop ideotype. *J. Life Sci.* **50**: 1-26.

Bueren, E. T. L., Struik, P.C. and Jacobsen, E. (2002). Ecological concepts in organic farming and their consequences for an organiccrop ideotype. *J. Life Sci.* **50**: 1-26.

Chand, R., Singh, N. P. and Singh, V. K. (2004). Effect of weed control treatments on weed and grain yield of late sown urdbean (*Vigna mungo* L.) during kharif season. *Ind. J. Weed Sci*. **36**: 127-128.

Chattha, M. R., Jamil, M. and Mahmood, T. Z. (2007). Yield and Yield Components of Mungbean as Affected by Various Weed Control Methods under Rain-fed Conditions of Pakistan. *Int. J. Agri. Biol.* **9**(1):114-119.

Das, R., Patra, B. C., Mandal, M. K. and Pathak, A. (2014). Integrated weed management in blackgram (*Vigna mungo* L.) and its effect on soil microflora under sandy loam soil of West Bengal. *The Bios.* **9** (4): 1593-1596.

Dey, P., Chandra, S., Chatterjee, P. and Bhattacharya, S. (2012). Assessment of allelopathic property of *Mikania scandens* root. *Curr. Biotech. Pharm.* **6**(3): 322-327.

Dungarwal, H. S., Chaplot, P. C. and Nagda, B. L. (2003). Chemical weed control in mungbean (*Phaseolus radiatus* L.). *Ind. J. Weed Sci*. **35**: 283-284.

Enyi, B. A. C. (1973). Analysis and effect of weed competition on growth and yield attribute in sorgham (Sorghum vulgar), cowpea (*Vigna unguiculata*) and blackgram (*Vigna mungo*). *J. A gric. Sci.* **81**: 449-463.

Gomez, K. A. and Gomez, A. A. (1984). Statistical Procedures for Agricultural Research. 2nd edn. John Wiley and Sons, New York. pp. 207-215.

Hamid, A. (1988). Growth and yield performance of mungbean (*Vigna radiata*) at a wide range of population densites. Abst. of Annual pes. Rev. IPSA. p.3.

Hossain, M. A., Karim, M. F. and Maniruzzaman, A. F. M. (1990). Response of summer mungbean to levels of field management. *Appl. Agric. Res.* **5**: 289-92.

Ibrahim Usman (2013). Effect of pre emergence herbicides on weed control and performance of cowpea in samar. *J. Agric. Sci.* **8**(2): 46-49.

Islam, M. A., Mamun A. A., Bhuiyan, M. S. U. and Hossain, S. M. A. (1989). Weed biomass and grain yield in wheat as affected by seed rate and duration of weed competition . *Bangladesh J. A gric.* **14**: 213-224.

Islam, M. A., Mamun, A. A., Bhuiyan, M. S. U. and Hossain, S. M. A. (1989). Weed biomass and grain yield in wheat as affected by seed rate and duration of weed competition. *Bangladesh J. Agril. Sci*. **14**: 213-224.

Ismail, B. S. and Mah, L. S. (1993). Effects of *Mikania micrantha* . on germination and growth of weed species. *Plant Soil.* **157**: 107-113.

Ismail, B. S. and Suat, M. L. (1994). Evidence for allelopathic activity of *Mikania* *micrantha* . on three weed species. *Pertanika J. Sci. Technol.* **2**(1): 73-83.

Kalita, P., Dey, S. C. and Chandra, K. (1995). Influence of different levels of weeding on the performance of dry matter accumulation and yield of blackgram (Vigna mungo). *Indian J. P1. Physio.* **38**(3): 197-202.

Kaul, A. (1982). Pulses in Bangladesh. BARC (Bangladesh Agricultural Research Council), Farmgate, Dhaka. p. 27.

Kavitha, D., Prabhakaran, J. and Arumugam, K. (2012). Allelopathic influence of *Vitex negundo* L. on germination and growth of greengram (*Vigna radiata* (L.) R. Wilczek) and blackgram (*Vigna mungo* (L.) Hepper). *Intl. J. Ayurved. Herbal. Medic.* 2(1): 163-170.

Khaliq, A., Aslam, Z. and Cheema, Z. A. (2002). Efficacy of weed management strategies in mungbean (*Vigna radiate* L.). *Intl. J. Agric. Biol.* **4**: 237-239.

Khan, M. A. A. (1981). The effect of CO2 environment on the pattern of growth and development in rice and mustard. Ph.D. Dissertation. Royal Vet. And Agril Univ. Copenhagen. p.104.

Khan, R. U., Rashid, A. and Khan, M. S. (2011). Impact of various rates of pendi methalin herbicide on weed control, seed yield and economic returns in mungbean under rainfed conditions. *J. Agric. Res.* **49**(4): 132-135.

Kumar, A., Malik, Y. P. and Yadav, A. (2005). Effect of sowing methods and weed control treatments on nutrient content and their uptake by mungbean and associated weeds. *Haryana J. Agron.* **21**(2): 191-193.

Kumar, D., Qureshi, A. and Nath, P. (2015). Refining the weed management practices to increase the yield of urd bean (*Vigna mungo* L.) in north-western India. *Intl. J. App. Sci. Agri.* **1**(7): 123-129.

Kumar, S. and Kairon, M. S. (1988). Effect of time of weed removal on yield of blackgram (Vigna mungo). *Indian J. Agric. Sci.* **58**: 859-860.

Kumar, S. and Kiron, M. S. (1990). Studies on crop weed competition in summer mungbean. *Legume Res.* **13**:110-120.

Li, J. and Jin, Z. (2010). Potential allelopathic effects of *Mikania micrantha* on the seed germination and seedling growth of *Coix lacryma-jobi*. http://onlinelibrary.wiley.com.

Madrid, M. T. and Manimtim, M. B. (1977). Duration of weed control and weed competition and the effect on yield. Blackgram phaseolus aureas. *Philippine Agric.* **100**: 216-220.

Madukwe, D. K., Ogbuehi, H. C. and Onuh, M. O. (2012). Effects of Weed Control Methods on the Growth and Yield of Cowpea (*Vigna unguiculata* (L.) Walp) under Rain-Fed Conditions of Owerri. *American-Eurasian J. Agric. Environ. Sci.* **12**(11): 1426-1430.

Mahla, C. P. S., Dadheech, R. C. and Kulhari, R. K. (1999). Effect of weeding on growth and yield of blackgram (Vigna mungo). Department of Agronomy, Rajasthan Agricultural University. *India. Crop Res. Hisar.* **18**(1): 163-165.

Malik, M. A., Saleem, M. F., Asghar, A. and Ijaz, M. (2003). Effect of weeding on growth, yield and quality of blackgram (Vigna mungo). *Pakisthan J. Agril. Sci.* **40**(3/4): l33-136.

Mansoor, M., Ahmad, H. K., Khan, H. and Yaqoob, M. (2004). Development of economical weed management strategies for mungbean (*Vigna radiata* L.). *Pakistan J. Weed Sci. Res*. **10**: 15-16.

Mirjha, P. R., Prasad, S. K., Singh, M. K., Baghel, P. and Paikra, R. H. (2013). Productivity and economics of mungbean as influenced by chemical weed Control. *Ann. Agric. Res. New Series.* **34**(2): 185-188.

Musa, M., Chawdhury, G. A., Khalid, A. H., Shahzad, M. A. and Cheema, N. M. (1996). Weed competition studies in mungbean. Absts. 5th. Pakistan Weeds Sci. Conf. March, 3-5.

Pandey, J. and Mishra, B. N. (2003). Effect of weed management practices in a rice mustard-mungbean cropping system on weeds and yield of crops. *Annals Agric. Res.* **24**: 737-742.

Pascua, A. C. (1988). Duration of weed control weed competition of mungbean yield.

Philipines. *Philipines J. Crop Sci.* **3**:11-14.

Patel, R. G., Palel, M. P., Palel, H. C. and Palel, R. B. (1984). Effect of graded levels of weeding and yield performance on growth, yield and economics of summer mungbean. *Indian J. A gran.* **29**(3): 42-44.

Pongkao, S. and Inthong, W. (1988). Effect of weeding at different days of sowing on yield of blackgram. In. Proceeding of the 3rd seminar on blackgram research. Chainat Field Crop Association Research Center, Chainat (Thailand). Pp. 52-67.

Pramanik, J. K., Chowdhury, A. K. M. S. H. and Uddin, F. M. J. (2014). Effect of bio fertilizer and weeding on the growth characters and seed yield of summer mungbean. *J. Environ. Sci. Natural Resources.* **7**(1): 87–92.

Raman, R. (2006). Impact of weed management practices on growth and yield of urdbean (*Vigna mungo* L.). *Crop Res.* **32**: 24-26.

Rao, P. V., Reddy, A. S. and Rao, Y. K. (2015). Effect of integrated weed management practices on growth and yield of pigeonpea (*Cajanus cajan* L.). *Intl. J. Plant. Animal. Environ. Sci.* **5**(3): 124-127.

Rathmen, D. P. and. Miller, S. D. (1981). Wild oat (Avena fatua) Competition in soyabean (Glycine max). *Weed Sci.* **29**: 410-414.

Saha, A. K. (1986). Rice yield improvement on dry abandoned *terracesinmid* hills of Mizoram by green manuring. *Indian J. Agril. Sci.* **56**(3): 210-212.

Sahu, A. and Devkota, A. (2013). Allelopathic effects of aqueous extract of leaves of *Mikania micrantha* . on seed germination and seedling growth of *Oryza sativa* L. and *Raphanus sativus* L. *Sci. World.* **11**(11): 90-93.

Shao, H., Peng, S., Wei, X., Zhang, D. and Zhang, C. (2005). Potential allelochemicals from an invasive weed *Mikania micrantha* . *J. Chem. Eco.* **31**(7): 1657-1668.

Shweta and Malik, M. (2015). Influence of integrated weed management on growth and yield of black gram (*Vigna mungo* L.). *Agri. Sustain. Develop.* **3**(1): 27-31.

Singh, R. P., Singh, P. P., Vyas, A. M., Sharma, D. K. and Gal, H. B. (1988). Effect of weed management on grain yield of soyabean. *Indian J. Pulses Res.* **l**: 124-127.

Srinivas, M., Shaik, M., Mohammad, S. (2002). Performance of soyabean and response functions as infliuienced by different seed rate levels. *Crop Res. Hisar.* **24**(3): 458-462.

Ullah, M. J., Rahman, J. Yeasmin, M., Fatima, K. and Quamruzzaman, M. (2014a). Allelopathic effect of mikania (*Mikania micrantha*) in kharif season to control *Fymbristylis miliacea* weeds. *J. Expt. Biosci.* **5**(2): 79-86.

Ullah, M. J., Rahman, J. Yeasmin, M., Fatima, K. and Quamruzzaman, M. (2014b). Suitability of using mikania (*Mikania micrantha*) in kharif season to control nutsedge weeds. *J. Expt. Biosci.* **5**(1): 77-86.

Vivek, N. S., Rana, R. S. and Tomar, S. S. (2008). Effect of weed interference on weeds and productivity of blackgram (*Phaseolus mungo*). *Indian J. Weed Sci.* **40** (1 & 2): 65-67.

Wahhab and Bhandari. (1981). Effect of Fertilizer application on rainfed blackgram (Phaseolus mungo), lentil (*Lens culinaris*) in fermers field .Indian *J. Agric. Sci*. **59**: 709-712.

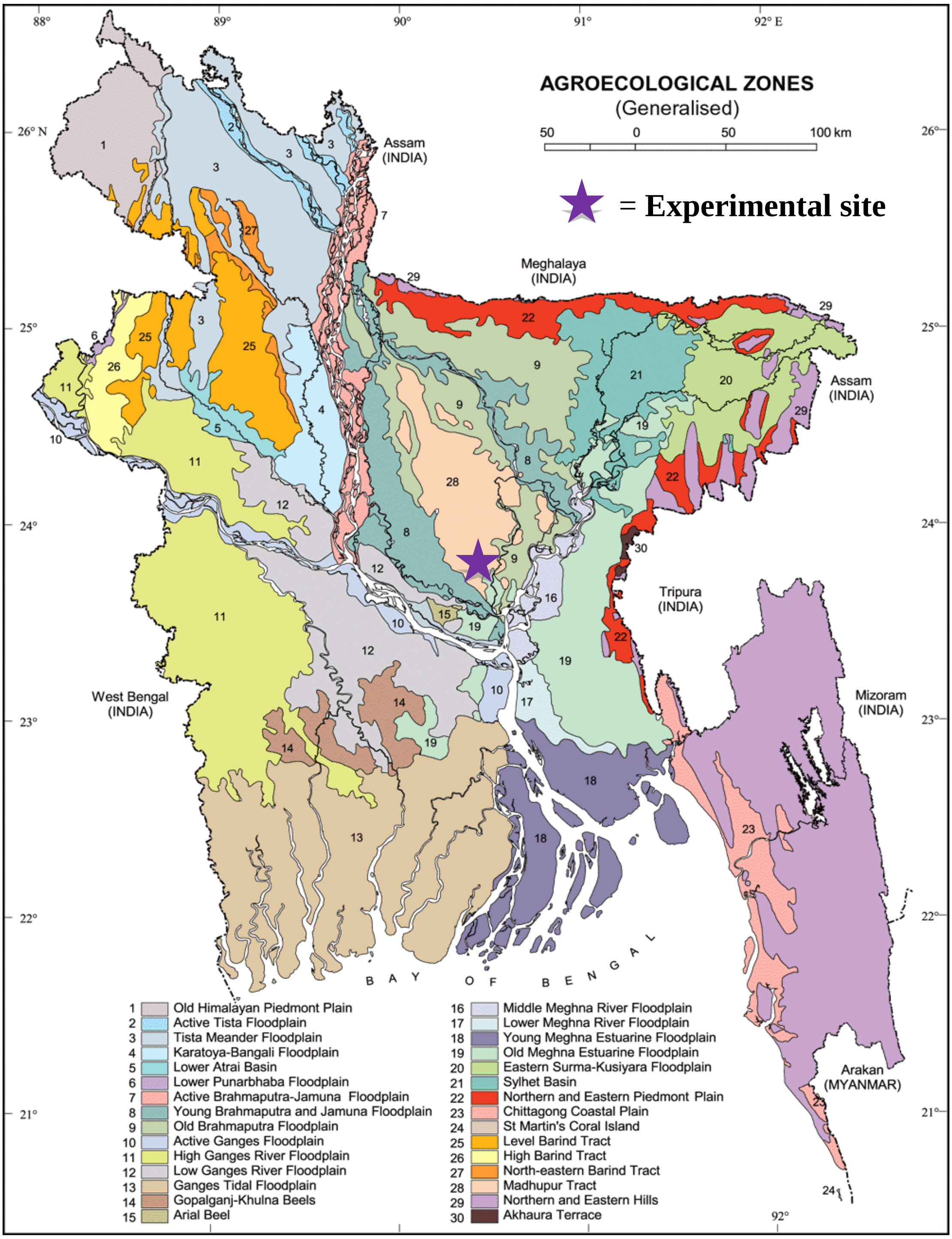
Weng, W. P. (1964). Evidence for the presence of growth inhibitory substances in *Mikania cordata* (Burm.f.) B. L. Robinson. *J. Rubber Res. Inst. Malaya.* **18**(5): 231-242.

Yadav, S. K., Bhan, V. M. and Singhs, S. P. (1983). Crop weed competition studies in mungbean (*Vigna radiata*). *Exp. Agric.* **19**: 337-340.

Zhang, M., Ling, B., Kong, C., Zhao, H., Pang, X. (2002). Allelopathic potential of volatile oil from *Mikania micrantha*. *Ying Yong Sheng Tai Xue Bao*. **13**(10):1300-1302.

APPENDICES

Appendix I. Experimental location on the map of Agro-ecological Zones of Bangladesh



Appendix II. Characteristics of soil of experimental field

A. Morphological characteristics of the experimental field

Morphological features	Characteristics
Location	Sher-e-Bangla Agricultural University Research Farm, Dhaka
AEZ	AEZ-28, Modhupur Tract
General Soil Type	Deep Red Brown Terrace Soil
Land type	High land
Soil series	Tejgaon
Topography	Fairly leveled

B. The initial physical and chemical characteristics of soil of the experimental site (0 - 15 cm depth)

Physical characteristics	
Constituents	**Percent**
Sand	26
Silt	45
Clay	29
Textural class	Silty clay
Chemical characteristics	
Soil characters	**Value**
pH	6.1
Organic carbon (%)	0.45
Organic matter (%)	0.78
Total weeding (%)	0.03
Available P (ppm)	20.54
Exchangeable K (me/100 g soil)	0.10

Appendix III. Monthly meteorological information during the period from August to December, 2014

Year	Month	Air temperature (^0C)		Relative humidity (%)	Total rainfall (mm)
		Maximum	Minimum		
2014	August	31.02	15.27	74.41	158
	September	31.46	14.82	73.20	161
	October	30.18	14.85	67.82	137
	November	28.10	11.83	58.18	47
	December	25.00	9.46	69.53	0

Source: Meteorological Centre, Agargaon, Dhaka (Climate Division)

Appendix IV. Layout for experimental field.

Total number of unit plots: 12 × 3 = 36
Unit plot size: 0.5 m×0.6 m = 0.3 m^2
The main plot and unit plots were separated by 1m and 0.5m, respectively.

Replication 1	W_0M_0	W_1M_3	W_2M_2	W_3M_1
	W_0M_1	W_1M_2	W_2M_0	W_3M_3
	W_0M_2	W_1M_1	W_2M_3	W_3M_0
	W_0M_3	W_1M_0	W_2M_1	W_3M_2
Replication 2	W_2M_0	W_0M_3	W_3M_2	W_1M_1
	W_2M_1	W_0M_2	W_3M_0	W_1M_3
	W_2M_2	W_0M_1	W_3M_3	W_1M_0
	W_2M_3	W_0M_0	W_3M_1	W_1M_2
Replication 3	W_3M_0	W_2M_3	W_1M_2	W_0M_1
	W_3M_1	W_2M_2	W_1M_0	W_0M_3
	W_3M_2	W_2M_1	W_1M_3	W_0M_0
	W_3M_3	W_2M_0	W_1M_1	W_0M_2

Appendix V. Analysis of variance of the data on number of weeds 0.3 m^{-2} and weed dry weight 0.3 m^{-2} (g) of blackgram as influenced by combined effect of weeding frequency and mikania vine application

Source of variation	df	Mean square values	
		Number of weeds 0.3 m^{-2}	Weed dry weight 0.3 g m^{-2}
Replication	2	1012.02	39.30
Weeding (A)	3	232055.17*	7082.40*
Mikania vine (B)	3	14543.50*	602.95*
Mikania vine (B)	9	937.30*	42.29*
Error	30	867.80	25.91

*Significant at 5% level of significance

^{NS} Non significant

Appendix VI. Analysis of variance of the data on plant height (cm) of blackgram as influenced by combined effect of weeding frequency and mikania vine application

Source of variation	df	Mean square of plant height (cm) at different days after sowing (DAS)			
		20	40	60	80
Replication	2	9.93	33.96	299.54	331.63
Weeding (A)	3	83.71*	217.44*	333.76*	494.70*
Mikania vine (B)	3	21.41*	148.94*	197.33*	157.97*
Mikania vine (B)	9	0.62*	9.84*	1.97*	4.81*
Error	30	5.69	21.60	40.40	45.87

*Significant at 5% level of significance

^{NS} Non significant

Appendix VII. Analysis of variance of the data on number of leaf plant^{-1} of blackgram as influenced by combined effect of weeding frequency and mikania vine application

Source of variation	df	Mean square of number of leaf plant^{-1} at different days after sowing (DAS)			
		20	40	60	80
Replication	2	0.188	0.063	15.083	8.130
Weeding (A)	3	6.465*	23.125*	76.722*	210.727*
Mikania vine (B)	3	3.354*	24.125*	60.056*	61.769*
Mikania vine (B)	9	1.336*	2.667*	3.778*	2.204*
Error	30	0.432	1.363	2.372	3.230

*Significant at 5% level of significance

^{NS} Non significant

Appendix VIII. Analysis of variance of the data on number of branch plant^{-1} of blackgram as influenced by combined effect of weeding frequency and mikania vine application

Source of variation	df	Mean square of number of branch plant^{-1} at different days after sowing (DAS)		
		40	60	80
Replication	2	0.03	0.06	0.59
Weeding (A)	3	3.23*	6.52*	8.55*
Mikania vine (B)	3	0.61*	2.22*	5.24*
Mikania vine (B)	9	0.02*	0.13*	0.13*
Error	30	0.04	0.07	0.19

*Significant at 5% level of significance

^{NS} Non significant

Appendix IX. Analysis of variance of the data on pod plant^{-1} (No.), pod length (cm), seed pod^{-1} (No.) and 1000 seed weight (g) of blackgram as influenced by combined effect of weeding frequency and mikania vine application

Source of variation	df	Mean square values			
		Pod plant^{-1} (No.)	Pod length (cm)	Seed pod^{-1} (No.)	1000 seed weight (g)
Replication	2	4.62	0.17	0.29	27.94
Weeding (A)	3	52.95*	0.38*	3.95*	182.76*
Mikania vine (B)	3	12.32*	0.43*	1.54*	60.12*
Mikania vine (B)	9	0.20*	0.003*	0.01*	3.00*
Error	30	2.05	0.09	0.18	13.10

*Significant at 5% level of significance

^{NS} Non significant

Appendix X. Analysis of variance of the data on Seed yield (t ha^{-1}), stover yield (t ha^{-1}), biological yield (t ha^{-1}), and harvest index (%) of blackgram as influenced by combined effect of weeding frequency and mikania vine application

Source of variation	df	Mean square values			
		Seed yield (t ha^{-1})	Stover yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
Replication	2	0.02	0.01	0.04	4.59
Weeding (A)	3	0.26*	0.22*	0.96*	23.84*
Mikania vine (B)	3	0.07*	0.30*	0.66*	1.54^{NS}
Mikania vine (B)	9	0.003*	0.01*	0.01*	1.42*
Error	30	0.01	0.01	0.02	5.15

*Significant at 5% level of significance

^{NS} Non significant