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Yield performance of mungbean (*Vigna radiata* L.) under the application of different herbicides

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Abstract

The study was aim to find out the suitable herbicides and their performance on controlling weeds in mungbean field. Three varieties (V_1 = BARI Mung-5, V_2 = BARI Mung-6, V_3= BARI Mung-4) and four herbicides (T_1 = Whipsuper, T_2 = Panida 33 EC, T_3 = Paraxon, T_4 = Topstar 40 WP) were used in this experiment with a Randomized Complete Block Design (RCBD) design using three replications. The results indicated that both the varieties and herbicides and also their interactions significantly affected all observed parameters. The highest number of pods plant^{-1} (23.44), number of seeds pod^{-1} (15.41), 1000-seed weight (54.54 g), pod yield (2827.63 kg ha^{-1}), seed yield (1893 kg ha^{-1}) and harvest index (24.98%) were found from the combine effect of BARI Mung-6 with Topstar 40 WP. From the results it was concluded that herbicide Topstar 40 WP showed the best performance by maximum reduction of weed population in BARI Mung-6 and further this experiment may be carry out in different locations of Bangladesh in different season.

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Introduction

Mungbean (*Vigna radiata* L. Wilczek) belongs to the family Fabaceae (Lambridges and Godwin, 2006). It is an important grain legume and is extensively grown in tropical and subtropical countries of the world (Asante *et al.,* 2002). After chickpea, mungbean is called as poor people diet owing to its protein nature and is meeting the major protein demand of the people (Shafique *et al.,* 2009). It has an edge over other pulses (Ghafoor *et al.,* 2003). It has the ability to fix nitrogen to the soil because of its root nodules (Hoorman *et al.,* 2009).

Although many hectares are dedicated to its production, the per capita consumption of pulse in Bangladesh is only 12 gm day^{-1} which is much lower than the recommended daily consumption of 80 gm day^{-1} (FAO, 2011). Mungbean is vulnerable to weed competition because of its short stature, slow establishment, and limited vegetative growth. Seed yield of mungbean was maximum (2108 kg ha^{-1}) in the weed free treatment and decreased by 29.5%, 23.5% and 45.8% with 160 plants m^{-2} of *Trianthema portulacastrum*, *Echinochloa colonum* and *Cyperus rotundus*, respectively (Punia *et al.*, 2004). According to Raman and Krishnamoorthy (2005) presence of weeds reduced the seed yield of mungbean by 35%. Besides causing crop losses, weeds creating competition for nutrients, space, water etc. reduce the crop yield and the quality of produce hence; reduce the market value of the turnout (Arif *et al.*, 2006).

There are different weed control methods like manual, mechanical and chemical (herbicide) etc. However, manual and mechanical weeding are laborious, time consuming and costly. Today, some herbicides are available in the market which is good to control weeds in crop fields. Herbicides inhibit weed growth for a considerable period after their application (Gupta, 2003). Use of herbicides has provided producers with simple efficacious weed control and has lead to improved crop yields (Heap, 2014; Walsh and Powles, 2007). According to Cheema *et al.* (2001) an inhibition of 44, 28 and 44% in total weed dry weight was noticed by three sorgaab sprays, one hand-weeding and pendimethalin treatment, respectively.

Although the vast majority of mungbean production is under rain-fed conditions, there is a little-published information on weed control with herbicides. Considering the above-mentioned facts herbicides have been selected. Therefore, the present study was undertaken to evaluate the performance of different herbicides on yield attributes of mungbean varieties and to find out the suitable herbicides for controlling weeds in mungbean field.

Materials and methods

Experimental site

The experiment was conducted at Agronomy farm of Sher-e-Bangla Agricultural University Dhaka-1207, Bangladesh during the period of March to June, 2018 and it was located in 24.09° N latitude and 90.26° E longitudes. The area belongs to the Agro-ecological Zone (no. 28): (Madhupur Tract).

Climate and soil

The climate of the experimental site is sub-tropical, wet and humid. The soil of experimental area was silty clay in texture. Soil pH was 6.7 and has organic carbon 0.45%.

Experimental treatments

Mungbean varieties were used in the experiment. The experiment consisted of two factors: factor A: three mungbean varieties; (V_1 = BARI Mung-5, V_2 = BARI Mung-6 and V_3= BARI Mung-4) and factor B: four herbicides; [T_1= Whipsuper (Fenoxaprop-p-ethyl) @ 1.5 ml L^{-1}, T_2 = Panida 33 EC (Pendimethalion) @ 2.0 ml L^{-1}, T_3 = Paraxon (27.6% WV paraquat dichloride salt) @ 2.0 ml L^{-1} and T_4 = Topstar 40 WP (40% oxadiargyl) @ 1.0 g L^{-1}]. The experiment was laid out in a factorial RCBD design with three replications. There were 12 treatment combinations.

The total numbers of unit plots were 36. The size of unit plot was 3.50 m × 1.50 m. The distances between plot to plot and replication to replication were 0.75 m and 1.0 m, respectively.

Crop husbandry

The experimental land was prepared and weeds, stubbles and crop residues were removed. The recommended chemical fertilizer dose was 50, 100, 55 and 1 kg ha^{-1} of Urea, TSP, MoP, BA (boric acid) and 10 t ha^{-1} cowdung, respectively (BARI, 2013).

All the fertilizers and manure along with half of urea were applied at final land preparation and rest of the urea was applied at 25 DAS followed by light irrigation. Healthy seeds of mungbean @ 40 g $plot^{-1}$ were sown by hand as uniformly as possible in furrows with 15 cm hill to hill distance and 30 row to row distance at about 3 cm depth. Gap filling, weeding, application of irrigation water and plant protection measures were taken properly when needed.

Herbicides application

The herbicides (Whipsuper, Panida 33 EC, Paraxon and Topstar) were applied at twenty five days after emergence of mungbean seedlings by the using of knapsack sprayer. The herbicides were prepared (with a given concentrations) prior to spray to avoid the loss.

Data collection

Ten plants were selected randomly from each plot. Data on the following parameters were recorded during the period of experiment such as:- dry weight of weed (g), number of pods $plant^{-1}$, number of seeds pod^{-1}, weight of 1000-seed (g), pod yield (kg ha^{-1}), seed yield (kg ha^{-1}) and harvest index (%). Total dry matter weight of plant (g) was recorded at different DAS by uprooting five random plant samples carefully. The plant samples were oven dried at 72 °C temperature.

$$\text{Dry matter content of plant (\%)} = \frac{\text{Weight of oven dried plant}}{\text{Fresh weight of plant}} \times 100$$

The weeds were collected at 40 days after sowing from 1 m^{-2} area of each plot and oven dried to estimate weed growth.

Statistical analysis

All the collected data were analyzed following the analysis of variance (ANOVA) technique using a statistical computer software Statistix 10 and the means were adjusted by DMRT (Duncan's Multiple Range Test) test at 5% level of significance (Duncan, 1955).

Results and discussion

Number of pods $plant^{-1}$

Mungbean varieties produced positively significant values on number of pods $plant^{-1}$ at harvest (Figure 1). The maximum number of pods was found in V_2 (BARI Mung-6) and minimum number of pods was recorded in V_3 (BARI Mung-4). The values of pods number in BARI Mung-4 and BARI Mung-6 was 4.35 and 19.60 at 60 DAS and at harvest times, respectively.

This might be due to less competition among the plants and weeds in BARI Mung-6 treatment. Probably, BARI Mung-6 variety had allelopathic effect to control weeds. The finding is close conformity of finding Lertmongkol *et al.* (2011).

Table 1. Lists of some weeds found in experimental field.

Sl. No.	Common name	English name	Scientific name
1	Hatishur	Indian helitrope	*Heliotropiun indicum*
2	Mutha	Purple nutsedge	*Cyperus rotundus*
3	Holdemutha	Yellow nutsedge	*Cyperus esculentus*
4	Chotoshema	Jungle rice	*Echinochloa colonum*
5	Dhurba	Bermuda grass	*Cynodon dactylon*
6	Malancha	Alligator weed	*Alternanthera philoxeroides*
7	Helencha	Marsk herb	*Enhydra fluctuans*
8	Bon pat	Wild jute	*Corchorus acutangulus*

Application of herbicides showed significant effects on number of pods in mungbean at harvest (Figure 1). The maximum number of pods plant^{-1} (20.45) was recorded in T_4 (Topstar 40 WP) while minimum number of pods plant^{-1} (43.64) was found in T_1 (Whipsuper). This might be due to less competition among weeds and mungbean plants. Because less number of weeds and weeds dry weight was recorded in Topstar 40 WP and highest number of weeds and weeds dry weight was found in Whipsuper. Our finding agreed with the finding of Soltani *et al.* (2013); Khaliq *et al.* (2012); Khan *et al.* (2011).

Table 2. Combine effect of varieties and herbicide on yield contributing characters and weed dry weight.

Treatments	No. of pods plant^{-1}	No. of seeds pod^{-1}	1000-seed weight (g)	Pods yield (kg ha^{-1})	Seeds yield (kg ha^{-1})	Harvest index (%)	Weed dry weight (g)
BARI Mung-5 x Whipsuper	15.18 e	12.63	44.66e	1203.43 gh	765.27 cd	8.08 b	8.08 b
Panida 33 EC	15.88 de	12.79	45.06 e	1352.51 e-h	857.04 b-d	6.20 d	6.20 d
Paraxon	17.24 c-e	13.04	46.43 d	1673.91 b-d	1046.92 bc	4.15 f	4.15 f
Topstar 40 WP	19.92 bc	13.99	53.95 a	1895.41 b	1136.39 b	3.03 g	3.03 g
BARI Mung-6 x Whipsuper	16.54 de	13.03	46.32 d	1317.81 f-h	757.37 cd	5.20 e	5.20 e
Panida 33 EC	17.54 c-e	13.33	50.75 c	1540.94 c-f	924.72 b-d	4.20 f	4.20 f
Paraxon	20.91 ab	13.72	52.52 b	1655.14 b-e	907.63 b-d	3.12 g	3.12 g
Topstar 40 WP	23.44 a	15.41	54.54 a	2827.63 a	1982.99 a	1.03 i	1.03 i
BARI Mung-4 x Whipsuper	09.84 f	12.36	40.75 f	1065.77 h	685.62 d	10.33 a	10.33 a
Panida 33 EC	10.97 f	12.73	41.40 f	1341.11 e-h	867.44 b-d	7.21 c	7.21 c
Paraxon	15.24 e	1301	44.85 e	1420.61 d-g	863.49 b-d	5.17 e	5.17 e
Topstar 40 WP	18.62 b-d	13.66	53.69 a	1788.51 bc	1107.17 b	2.11 h	2.11 h
SE (±)	0.585	NS	1.861	61.162	59.267	0.098	0.098
CV (%)	5.64	3.43	4.12	6.71	10.77	2.23	2.23

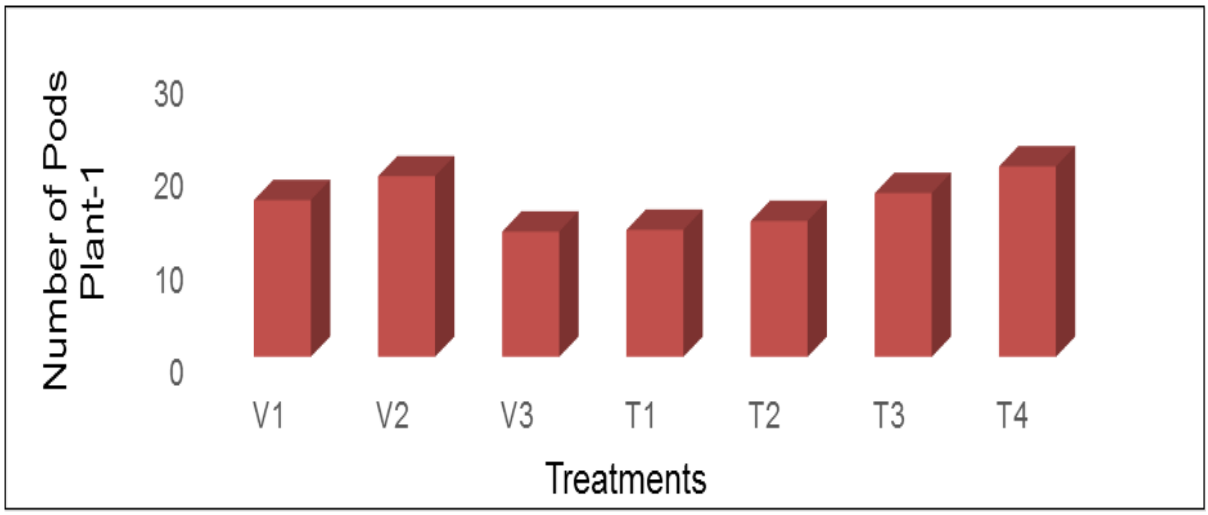
In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability.

The combination effect of mungbean varieties and herbicides showed significant effect on number of pods plant^{-1} at harvest (Table 2). The maximum number of pods was recorded in combine effect of BARI Mung-6 with Topstar 40 WP (23.44) and minimum number of pods was found in combine effect of BARI Mung-4 with Whipsuper (9.84).

Number of seeds pod^{-1}

Mungbean varieties produced positively significant values of number of seeds pod^{-1} (Figure 2). The maximum number of seeds pod^{-1} was found in V_2 (BARI Mung-6) and minimum number of seeds pod^{-1} was recorded in V_3 (BARI Mung-4). The values of seeds pod^{-1} number in BARI Mung-6 was 13.66. The values of number of seeds pod^{-1} in BARI Mung-4 was 12.73. This might be due to less competition among the plants and weeds in BARI Mung-6 treatment. Probably, BARI Mung-6 variety had allelopathic effect to control weeds. The finding is close conformity of finding Lertmongkol *et al.* (2011).

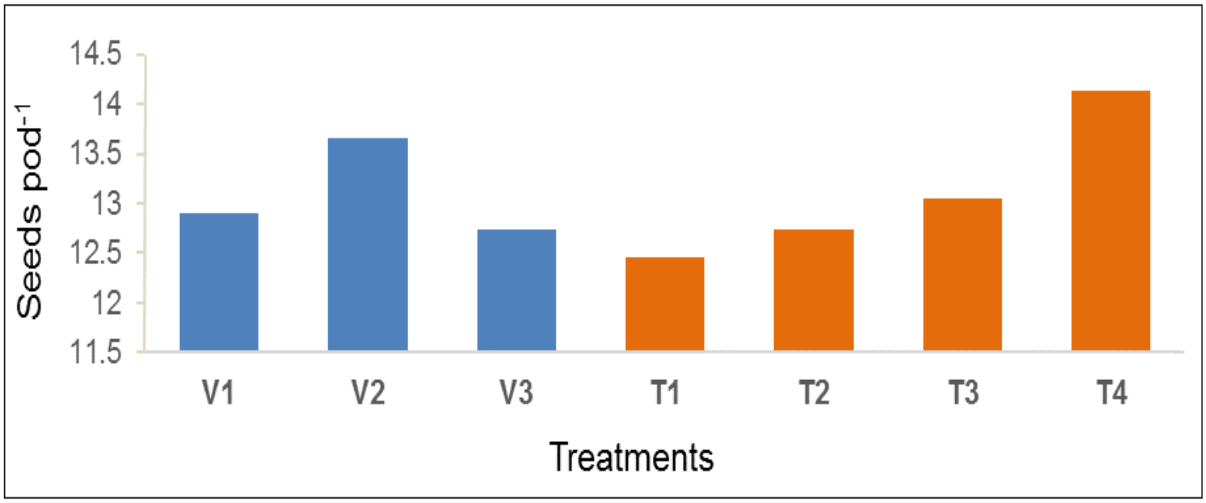
Application of herbicides showed significant effects on number of seeds pod^{-1} (Figure 2). The maximum number of seeds pod^{-1} (14.14) was recorded in T_4 (Topstar 40 WP) while minimum number of seeds pod^{-1} (12.46) was found in T_1 (Whipsuper). This might be due to less competition among weeds and mungbean plants. Because less number of weeds and weeds dry weight was recorded in Topstar 40 WP and highest number of weeds and weeds dry weight was found in Whipsuper. Our finding agreed with the finding of Aktar *et al.* (2016); Bibi *et al.* (2016); Chaudhari *et al.* (2016).



V_1 = BARI Mung-5, V_2 = BARI Mung-6, V_3= BARI Mung-4; T_1 = Whipsuper, T_2 = Panida 33 EC, T_3 = Paraxon, T_4 = Topstar 40 WP

Fig. 1. Influence of varieties and herbicide on number of pods plant^{-1}.

The combination effect of mungbean varieties and herbicides showed non-significant effect on number of seeds pod^{-1} (Table 2). Although having non-significant effect, the maximum number of seeds pod^{-1}was recorded in combine effect of BARI Mung-6 with Topstar 40 WP (15.41) treatments and minimum number of seeds pod^{-1}was found in combine effect of BARI Mung-4 with Whipsuper (12.36).



V_1 = BARI Mung-5, V_2 = BARI Mung-6, V_3= BARI Mung-4; T_1 = Whipsuper, T_2 = Panida 33 EC, T_3 = Paraxon, T_4 = Topstar 40 WP

Fig. 2. Influence of varieties and herbicide on number of seeds pod^{-1}.

Weight of 1000-seed

Weight of 1000-seed of mungbean is positively affected by the varieties and showed statistically significant variation (Figure 3).

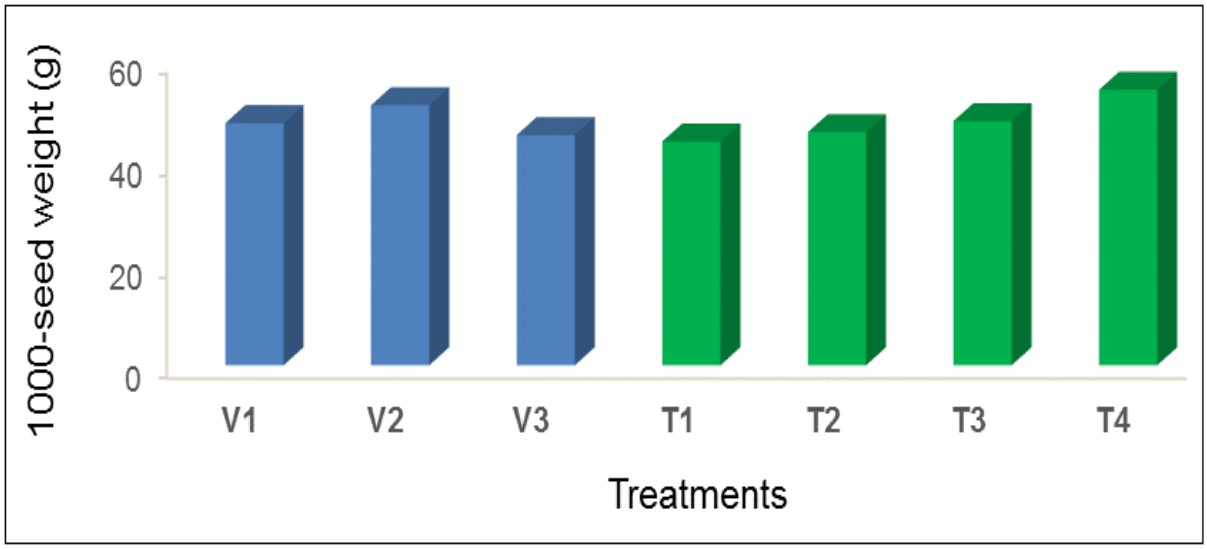
The highest weight of 1000-seed (51.01 g) was found in V_2 (BARI Mung-6) and lowest 1000-seed weight (45.16) was recorded in V_3 (BARI Mung-4). The 1000-seed weight is directly associated with the varieties of mungbean. This might be due to allelopathic effect of BARI Mung-6 variety. The finding is close conformity of finding Lertmongkol *et al.* (2011).

Application of different herbicides had significant impact on 1000-seed weight of mungbean (Figure 3). The highest 1000-seed weight was recorded in T_4 and

lowest 1000-seed weight was found in T_1. The values of 1000-seed weight in T_4 (Topstar 40 WP) was 54.04 g. The values of 1000-seed weight in T_1 (Whipsuper) was 43.89 g. Our finding agreed with the finding of Khaliq *et al.* (2012); Khan *et al.* (2011).

The combination effect of varieties and herbicides produced positively significant effect on 1000-seed weight of mungbean (Table 2).

The highest 1000-seed weight (545.41 g) was found in combine effect of BARI Mung-6 with Topstar 40 WP. The lowest plant was produced by combine effect of BARI Mung-4 with Whipsuper (414.01 g).



V_1 = BARI Mung-5, V_2 = BARI Mung-6, V_3= BARI Mung-4; T_1 = Whipsuper, T_2 = Panida 33 EC, T_3 = Paraxon, T_4 = Topstar 40 WP

Fig. 3. Influence of varieties and herbicide on 1000 seeds weight of mungbean.

Pods yield

Mungbean varieties produced positively significant values of pods yield (Figure 4). The highest pods yield was found in V_2 (BARI Mung-6) and lowest pods yield was recorded in V_3 (BARI Mung-4). The values of pods yield in BARI Mung-6 was 1835.5 kg ha^{-1}.

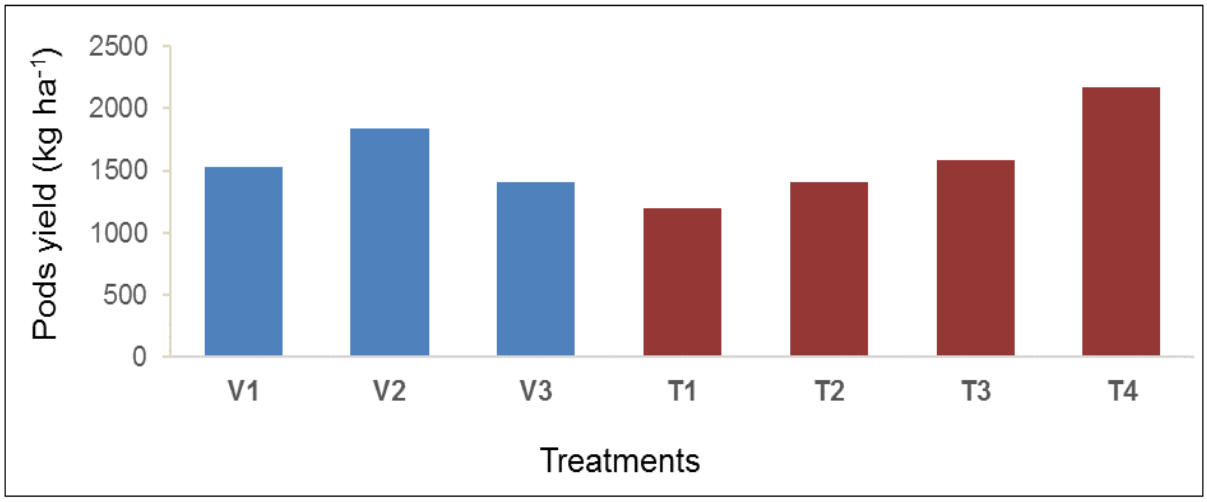
The values of pods yield in BARI Mung-4 was 1403.8 kg ha^{-1}. This might be due to less competition among the plants and weeds in BARI Mung-6 treatment. Probably, BARI Mung-6 variety had allelopathic effect to control weeds. The finding is close conformity of finding Lertmongkol *et al.* (2011).

Application of herbicides showed significant effects on pods yield of mungbean (Figure 4). The highest pods yield (2170.3 kg ha^{-1}) was recorded in T_4 (Topstar 40 WP) while lowest pods yield (1195.5 kg hs^{-1}) was found in T_1 (Whipsuper). Our finding agreed with the finding of Bibi *et al.* (2016); Chaudhari *et al.* (2016); Tamang *et al.* (2015).

The combination effect of mungbean varieties and herbicides showed significant effect on pods yield (Table 2). The highest pods yield in combine effect of BARI Mung-6 with Topstar 40 WP (2827.63 kg ha^{-1}) and lowest pods yield was found in combine effect of BARI Mung-4 with Whipsuper (1065.77 kg ha^{-1}).

Seeds yield

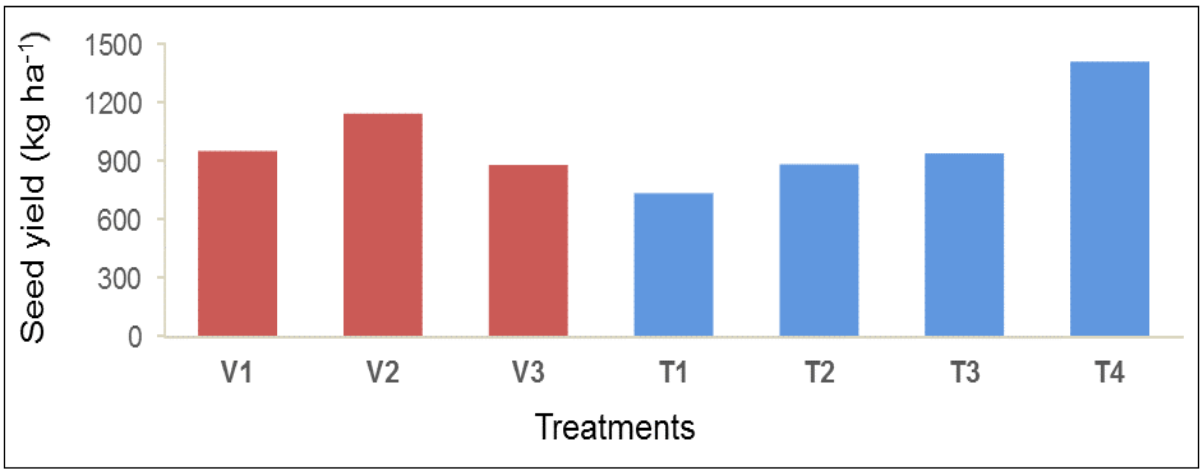
Seeds yield of mungbean is positively affected by the varieties and showed statistically significant variation (Figure 5). The highest seeds yield (1142.90 kg ha^{-1}) was found in V_2 (BARI Mung-6) and lowest seeds yield (880.61 kg ha^{-1}) was recorded in V_3 (BARI Mung-4). The seeds yield is directly associated with the varieties of mungbean. This might be due to allelopathic effect of BARI Mung-6 variety. The finding is close conformity of finding Lertmongkol *et al.* (2011).



V_1 = BARI Mung-5, V_2 = BARI Mung-6, V_3= BARI Mung-4; T_1 = Whipsuper, T_2 = Panida 33 EC, T_3 = Paraxon, T_4 = Topstar 40 WP

Fig. 4. Influence of varieties and herbicide on pods yield of mungbean.

Application of different herbicides had positively significant impact on seeds yield of mungbean (Figure 5). The seeds yield range was 735.77 kg ha^{-1} to 1408.50 kg ha^{-1}. The highest seeds yield was recorded in T_4 (Topstar 40 WP) and lowest seeds yield was found in T_1 (Whipsuper). The value of seeds yield in Topstar 40 WP was 1408.50 kg ha^{-1}. The value of seeds yield in Whipsuper was 735.77 kg ha^{-1}. This might be due to less competition among weeds and mungbean plants. Because less number of weeds and weeds dry weight was recorded in Topstar 40 WP treatment and highest number of weeds and weeds dry weight was found in Whipsuper treatment. Our finding agreed with the finding of Sumalapao *et al.* (2018); Ali *et al.* (2011).



V_1 = BARI Mung-5, V_2 = BARI Mung-6, V_3= BARI Mung-4; T_1 = Whipsuper, T_2 = Panida 33 EC, T_3 = Paraxon, T_4 = Topstar 40 WP

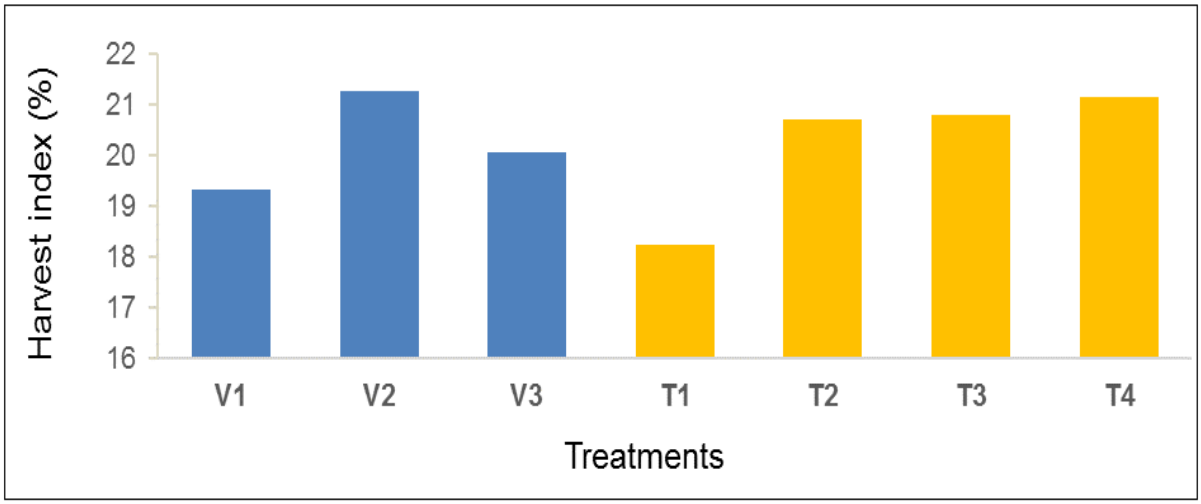
Fig. 5. Influence of varieties and herbicide on seeds yield of mungbean.

The combination effect of varieties and herbicides produced positively significant seeds yield (Table 2). The highest seeds yield (1982.99 kg ha^{-1}) was found in combine effect of BARI Mung-6 with Topstar 40 WP. The lowest plant was produced by combine effect of BARI Mung-4 with Whipsuper (685.62 kg ha^{-1}).

Harvest index

Mungbean varieties produced positively significant values of harvest index of mungbean (Figure 6). The

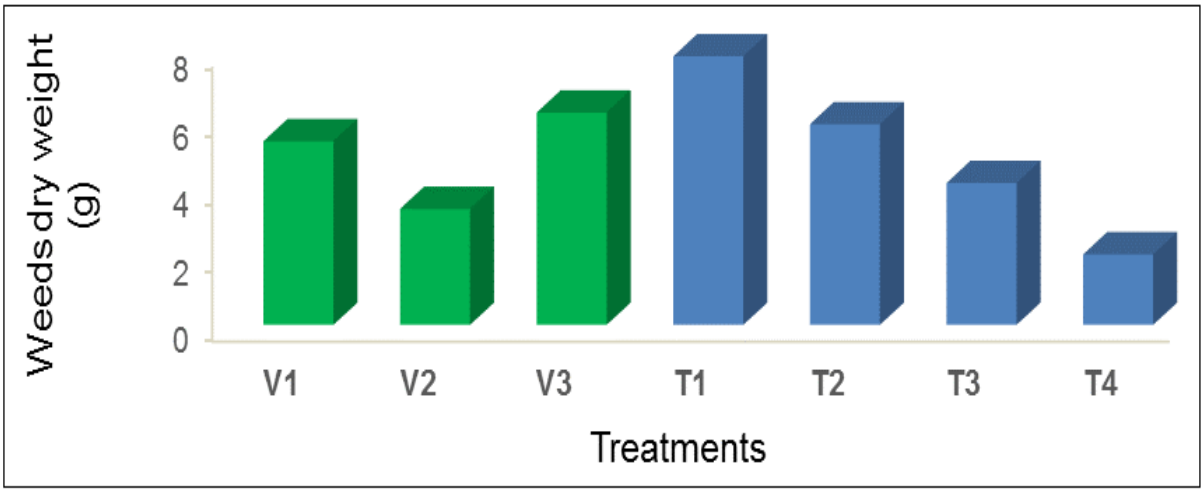
highest harvest index was found in V_2 (BARI Mung-6) and lowest harvest index was recorded in V_1 (BARI Mung-5). The values of harvest index in BARI Mung-6was 21.28%. The values of harvest index in BARI Mung-5 was 19.32. This might be due to less competition among the plants and weeds in BARI Mung-6. Probably, BARI Mung-6 variety had allelopathic effect to control weeds. The finding is close conformity of finding Lertmongkol *et al.* (2011).



V_1 = BARI Mung-5, V_2 = BARI Mung-6, V_3= BARI Mung-4; T_1 = Whipsuper, T_2 = Panida 33 EC, T_3 = Paraxon, T_4 = Topstar 40 WP

Fig. 6. Influence of varieties and herbicide on harvest index of mungbean.

Application of herbicides showed significant effects on harvest index of mungbean (Figure 6). The highest harvest index (21.16%) was recorded in T_4 (Topstar 40 WP) while lowest harvest index (18.23%) was found in T_1 (Whipsuper). Our finding agreed with the finding of Tamang *et al.* (2015); Soltani *et al.* (2013). The combination effect of mungbean varieties and herbicides showed positively significant impact on harvest index (Table 2). The highest harvest index recorded in combine effect of BARI Mung-6 with Topstar 40 WP (24.98%) treatments and the lowest harvest index was found in combine effect of BARI Mung-4 with Whipsuper (17.64%).



V_1 = BARI Mung-5, V_2 = BARI Mung-6, V_3= BARI Mung-4; T_1 = Whipsuper, T_2 = Panida 33 EC, T_3 = Paraxon, T_4 = Topstar 40 WP

Fig. 7. Influence of varieties and herbicide on weeds dry weight m^{-2} of mungbean.

Weeds dry weight

Weeds dry weight of mungbean is positively affected by the varieties and showed statistically significant variation (Figure 7). The highest weeds dry weight (6.21 g) was found in BARI Mung-4 and lowest weeds dry weight (3.39 g) was recorded in BARI Mung-6. This might be due to allelopathic effect of BARI Mung-6 variety. The finding is close conformity of finding Lertmongkol *et al.* (2011).

Application of different herbicides had significant impact on weeds dry weight (Figure 7). The highest weeds dry weight was recorded in T_1 (Whipsuper) and lowest weeds dry weight was found in T_4 (Topstar 40 WP). The values of weeds dry weight in Topstar 40 WP was 2.06 g. The values of weeds dry weight in Whipsuper was 7.86 g. This might be due to positive impact of herbicides. Our finding agreed with the finding of Bibi *et al.* (2016); Chaudhari *et al.* (2016).

The combination effect of varieties and herbicides produced positively significant weeds dry weight (Table 2). The highest weeds dry weight (10.33 g) was found in combine effect of BARI Mung-4 with Whipsuper compared to others combinations. The lowest weeds dry weight was produced by combine effect of BARI Mung-6 with Topstar 40 WP (1.03 g).

Conclusion

Results of the present findings lead towards a conclusion that, among the three tested cultivars BARI Mung-6 showed a best result in respect of yield contributing characters and gave a highest seed yield (1142.90 kg ha^{-1}) than other varieties. Among the different herbicides, Topstar 40 WP gave the best performance than that of other herbicides. Therefore, BARI Mung-6 with Topstar 40 WP showed the best result and gave a highest seed yield (1982.99 kg ha^{-1}) compare than other combinations. Therefore, Topstar 40 WP herbicide could be used to cultivate mungbean for increasing production.

References

Aktar S, Hossain MA, Amin MR, Khatun F, Begum A. 2016. Efficacy of herbicides in controlling weeds in Mungbean (*Vigna radiata* L. Wilczek) Field. The Agriculturist **13,** 127- 132. https://doi.org/10.3329/agric.v13i1.26556

Ali S, Patel JC, Desai LJ, Singh J. 2011. Effect of herbicides on weeds and yield of rainy season green gram (*Vigna radiatal* L. Wilczek). Legume Research **34,** 300- 303.

Arif M, Khan MA, Habib A, Sajjad A. 2006. Prospects of wheat as a dual purpose crop and its impact on weeds. Pakistan Journal of Weed Science and Research **12,** 13- 17.

Asante SK, Tamo M, Jackai LEN. 2002. Integrated management of cowpea insect pests using elite cultivars date of planting and minimum insecticide application. African Crop Science Journal **3,** 23– 25.

BARI. 2013. Hand book of agricultural technology. Bangladesh Agricultural Research Institute, Joydebpur, Gazipur, Bangladesh, 01- 215.

Bibi S, Khan IA. 2016. Impact of weed control techniques on intercropping of mungbean with maize under agro climate condition of Peshawar. Sarhad Journal of Agriculture **32,** 62-69. http://dx.doi.org/10.17582/journal.sja/2016/32.2.62.69

Chaudhari VD, Desai LJ, Chaudhari SN, Chaudhari PR. 2016. Effect of weed management on weeds, growth and yield of summer green gram. The Bioscan **11,** 531- 534.

Cheema ZA, Khaliq A, Akhtar S. 2001. Use of sorgaab (sorghum water extract) as a natural weed inhibitor in spring mungbean. International Journal of Agriculture and Biology **3,** 515– 518.

Duncan DB. 1955. Multiple range and multiple F-tests, Biometrica, II. **11**, 1- 42.

FAO (Food and Agriculture Organization).

2011. Agriculture, pesticides, food security and food safety, 140- 151.

Ghafoor A, Ahmad Z, Quyyum A. 2003. Black grain (*Vigna mungo* L. Hepper) germplasm catalogue, plant genetic resources programme, PARC/JIGA, Ohio, 17.

Gupta OP. 2003. Weed management: Principles and Practices. 2nd edition. Agribios India, 11- 24 & 77- 101.

Heap. 2014. International survey of herbicide resistant weeds. Accessed November 1, 2014. www.weedscience.org.

Hoorman JJ, Islam R, Sundermeier A. 2009. Sustainable crop rotations with cover crops, Ohio State University, Extension.

Khaliq A, Matloob A, Mahmood S, Abbas RN, Khan MB. 2012. Seeding density and herbicide tank mixtures furnish better weed control and improve growth, yield and quality of direct seeded fine rice. International Journal of Agriculture and Biology **14,** 499-508.

Khan RU, Rashid A, Khan MS. 2011. Impact of various rates of pendimethalin herbicide on weed control, seed yield and economic returns in mungbean under rainfed conditions. Journal of Agricultural Research **49,** 491- 498.

Lambridges CJ, Godwin ID. 2006. Mungbean', in K. Chittarajan (ed.), Genome mapping and molecular breeding in plants. Wagenigen **3,** 69– 90.

Lertmongkol S, Sarobol E, Premasthira CU. 2011. Allelopathic effects of mungbean (*Vigna radiata*) on subsequent crops. *Witthayasan Kasetsart (Sakha Witthayasat)*. Kasetsart Journal-Natural Science **45,** 773- 779.

Punia SS, Malik RS, Yadav A, Rinwa RS. 2004. Effect of varying density of Cyperus rotundus, Echinochloa colona and Trianthemaportula castrum on mungbean. Indian Journal of Weed Science **36**, 280– 281.

Raman R, Krishnamoorthy R. 2005. Nodulation and yield of mungbean (*Vigna radiata* L.) influenced by integrated weed management practices. Legume Research **28**, 128– 130.

Shafique M, Nadeem S, Hamed M, Atta BM, Shah TM. 2009. Performance of some advance desi chickpea genotypes against pod borer, *Helicoverpa armigera* (Hubner) resistance. Pakistan Journal of Zoology **41,** 277- 280.

Soltani N, Shropshire C, Sikkema PH. 2013. Tolerance of mungbean to post emergence herbicides. Agricultural Science **4,** 558- 562. http://dx.doi.org/10.4236/as.2013.410075

Sumalapao DEP, Tuppil CG, Urtula AAC, Valdestamon DM, Villanueva LMD, Ledesma NAA. 2018. Tolerance of mung bean (*Vigna radiata* (L.) wilczek) to lactic acid, a potential herbicide: growth and morphology. Journal of Animal and Plant Science **28**, 138- 145.

Tamang D, Nath R, Sengupta K. 2015. Effect of herbicide application on weed management in green gram [*Vigna radiata* (L.) Wilczek]. Advances in Crop Science and Technology. http://dx.doi.org/10.4172/2329-8863.1000163.

Walsh MJ, Powles SB. 2007. Management strategies for herbicide-resistant weed populations in Australian dry land crop production systems. Weed Technology **21,** 332- 338. https://doi.org/10.1614/WT-06-086.1