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OPTIMIZING PLANT DENSITY AND WEED CONTROL TECHNIQUES IN YIELD ENHANCEMENT OF MUNGBEAN

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Abstract

Field experiment was carried out at the Agronomy farm, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh to investigate the effect of plant density and weed control techniques on yield enhancement of mungbean. The experiment consisted of two factors *viz.* plant densities and weed control. Plant densities were 30 cm×continuous (D_1), 30 cm×5 cm (D_2), 30 cm×10 cm (D_3) and 30 cm×15 cm (D_4) arranged in the main plot. Weed control techniques were no weeding (W_0), two hand weeding at 15 and 30 DAS (W_1), Topstar 80 WP @ 75 g ha^{-1} as pre-emergence at 3 DAS (W_2) and Whip Super 9 EC @ 750 ml ha^{-1} at 15 and 30 DAS as post-emergence herbicide (W_3) arranged in the sub plot in a split plot design. Results showed that both plant density and weed control techniques significantly influenced most of the parameters studied. It was observed that application of pre and post emergence herbicide controlled weeds effectively compared to other weed control techniques whereas weed population and weed biomass were less in 30 cmx10 cm plant density. Considering yields, combination of 30 cm×10 cm plant density with application of Topstar 80 WP (D_3W_2) attributed to highest seed yield (1.47 t ha^{-1}), stover yield (1.94 t ha^{-1}) and biological yield (3.41 t ha^{-1}) of mungbean.

Key words: Plant density, Pre emergence herbicide, Post emergence herbicide

Introduction

Mungbean (*Vigna radiata* L.) belonging to family Fabaceae, is an important pulse crop of Bangladesh. It ranks third in protein content and fourth in area and production (MoA 2014). It also plays significant role in sustaining crop productivity by fixing nitrogen through rhizobial symbiosis and adding crop residues (Sharma and Behera 2009). Mungbean is a cheap source of easily digestible dietary protein which contains 24.7% protein, 0.6% fat, 0.9 fiber and 3.7% ash (Potter and Hotchkiss 1997). However, yield of mungbean is very poor (1.04 t ha^{-1}) as compared to many mungbean growing countries of tropical and sub-tropical regions of the world.

One of the reason of poor yield of mungbean is not to maintaining proper planting density which is a pre-requisite for obtaining higher yield (Rafiei 2009). Plant density affects the plant growth as well as grain yield in mungbean (Jahan and Hamid 2004). Plant density not only is defined in terms of number of plants per unit area but also in

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terms of arrangement of plants on the ground (Kaulm and Singh 2002). The optimum density favors the plants to grow well through efficient utilization of solar radiation and nutrients and thus increase grain yield of mungbean (Miah *et al*. 1990).

Another important factor responsible for low yield of mungbean is weed infestation. It competes with crop for space, nutrients, water and light and reduces yield of crop (Pandey and Mishra 2003). Weed crop competition commences with germination of the crop and continues till its maturity where emergence, growth, flowering and pod setting stages of mungbean are greatly hampered by weed. Weed infestation at these stages causes low pod setting and ultimately reduces grain yield of mungbean. This indicates that yield enhancement of mungbean can be possible by controlling weed to tolerable level. Yield improvement resulting from weeding has also been reported in mungbean by many researchers (Kumar and Kairan 1990 and Musa *et al*. 1996). However, information on plant density and weed control in yield improvement of mungbean is very scarce. Therefore, the study was undertaken to find out the effect of plant density and weed control techniques on yield enhancement of mungbean.

Materials and Methods

The field experiment was conducted in medium fertile soil at Sher-e-Bangla Agricultural University (90º33´ E longitude and 23º77´ N latitude), Dhaka, Bangladesh during April to June, 2014. The pH value of the soil was 5.60. A modern variety of mungbean, BARI Mung-6 was used as plant material for the present study. The experiment was carried out with four plant population densities *viz*. 30 cm×continuous (D_1), 30 cm×5 cm (D_2), 30 cm×10 cm (D_3) and 30 cm×15 cm (D_4) in the main plot and four weed management methods *viz.* no weeding (W_0), two hand weeding at 15 and 30 DAS (W_1), Topstar 80 WP @ 75 g ha^{-1} as pre-emergence at 3 DAS (W_2) and Whip Super 9 EC @ 750 ml ha^{-1} at 15 and 30 DAS as post-emergence herbicide (W_3) in the sub plot in a split plot design. All the intercultural operations were done as per necessity of the crop. Data related on weed parameters, yield contributing characters and yield were collected and subjected to analyze statistically and analysis of variance was done with the help of computer package MSTAT-C. The mean differences among the treatments were compared by Duncan's Multiple Range Test (DMRT) at 5% level of significance (Gomez and Gomez 1984).

Results and Discussion

Weed parameters : Weeds grow everywhere and interfere the normal growth and development of crop plants. Weed population at 20 and 40 DAS varied significantly due to different plant density under the present trial (Table 1). At 20 and 40 DAS, the maximum weed population (7.67 m^{-2}) were recorded in D_4 (30 cm×15 cm) and (14.00 m^{-2}) in D_1 (30 cm×continuous), respectively. On the other hand, the minimum weed population (6.08 m^{-2}) was observed in D_1 (30 cm×continuous) treatment and (11.50 m^{-2}) in D_3 treatment, at 20 and 40 DAS, respectively. In general, the lesser the space available, result is the minimum weed population. An increasing trend of weed biomass was observed with decreasing plant density D_4 (30 cm×15 cm) in this experiment at both sampling dates. It might be due to increasing weed competition in lower plant populations which favored to increase weed biomass.

Table 1. Effect of plant density and weed control techniques on weed population and weed biomass of BARI mug-6, Mean ± SE (n=3). Values labelled with different low case letters are significantly different at *P<0.05* by DMRT.

Treatment	Weeds population (m^{-2})		Dry weight of weed biomass (g m^{-2})	
	20 DAS	40 DAS	20 DAS	40 DAS
Plant density				
D_1	6.08 c	14.00 a	3.92 b	4.88 b
D_2	6.58 b	12.67 b	3.95 b	4.92 b
D_3	7.00 b	11.50 c	3.93 b	4.91 b
D_4	7.67 a	12.58 b	4.21 a	5.24 a
SE	0.142	0.108	0.029	0.024
Weed control techniques				
W_0	15.92 a	26.58 a	4.72 a	6.46 a
W_1	3.92 bc	7.92 c	3.81 b	4.54 b
W_2	4.00 b	7.00 d	3.72 b	4.47 b
W_3	3.50 c	9.25 b	3.77 b	4.48 b
SE	0.158	0.219	0.040	0.048
CV (%)	8.00	5.98	6.92	5.61

Weed population and weed biomass showed a significant relationship with weed control techniques (Table 1). Application of pre and post emergence herbicides controlled weeds successfully and weed biomass was least in case of herbicide treated plots. On the other hand, highest weed biomass was recorded from no weeding (W_0) due to severe weed infestation which supports the findings of Naeem *et al.* (2000) who reported that weed density decreased significantly for different weed management as compared to control. Weed population and weed biomass (g m^{-2}) had significant effect on various combinations of planting density and weed control techniques (Table 2). Lower plant density combined with no weeding resulted in maximum weed population and weed biomass. Contrary, herbicidal treatments combined with optimum plant density performed better over other treatment combinations. This might be due to minimum space availability by the weed species combined with herbicide application which controlled them successfully and results in minimum number of weed population and weed biomass.

Table 2. Interaction effect of plant density and weed control techniques on weed population and weed biomass of BARI mug-6, Mean ± SE (n=3). Values labelled with different low case letters are significantly different at *P<0.05* by DMRT.

Treatment	Weed population (m^{-2})		Dry weight of weed biomass (g m^{-2})	
	20 DAS	40 DAS	20 DAS	40 DAS
D_1W_0	15.33 b	28.33 a	4.81 a	6.65 a
D_1W_1	3.33 de	9.33 de	3.69 d-f	4.34 f-h
D_1W_2	3.33 de	8.00 ef	3.62 d-f	4.30 f-h
D_1W_3	2.33 e	10.33 d	3.58 ef	4.22 gh
D_2W_0	16.33 a	27.33 ab	4.68 a	6.33 b
D_2W_1	3.67 cd	7.33 fg	3.69 d-f	4.44 e-h
D_2W_2	3.33 de	6.67 fg	3.73 c-e	4.52 d-g
D_2W_3	3.00 de	9.33 de	3.68 d-f	4.40 f-h
D_3W_0	15.33 b	24.33 c	4.58 a	6.28 b
D_3W_1	4.00 cd	7.67 f	3.86 b-d	4.60 c-f
D_3W_2	4.67 c	6.00 g	3.44 f	4.15 h
D_3W_3	4.00 cd	8.00 ef	3.84 b-e	4.59 c-f
D_4W_0	16.67 a	26.33 b	4.79 a	6.58 ab
D_4W_1	4.67 c	7.33 fg	3.98 bc	4.78 cd
D_4W_2	4.67 c	7.33 fg	4.09 b	4.90 c
D_4W_3	4.67 c	9.33 de	3.99 bc	4.72 c-e
SE	0.922	0.438	0.080	0.097
CV (%)	8.00	5.98	6.92	5.61

Yield contributing characters: Significant variations were observed in case of yield contributing characters due to different plant density and weed control techniques (Table 3). Maximum number of pods plant^{-1} (18.92), number of seeds pod^{-1} (12.23) and 1000-seed weight (45.36 g) was recorded from 30 cm×10 cm (D_3) which was attributed due to the lesser competition within the plant populations and higher dry matter partitioning to the sink. On contrary, increasing planting density showed least values in case of yield contributing parameters of mungbean than others. This result supports the findings of Zaher *et al.* (2014) who observed the similar trend of yield attributes with increasing planting density. Present study also revealed that application of Topstar 80 WP (W_2) resulted in highest number of pods plant^{-1} (18.82), number of seeds pod^{-1} (12.17) and 1000-seed weight (44.74 g) which was due to weed free condition of the field that supported proper growth and development of the mungbean plants (Table 3). The result is in agreement with the findings of Akter *et al*. (2013). Considering interaction of plant density and weed control, it was evident that plant density of 30 cm×10 cm combined with Topstar 80 WP (D_3W_2) was the best treatment combination for all the yield contributing parameters of mungbean than rest of the others (Table 4).

Table 3. Effect of plant density and weed control techniques on yield contributing attributes of BARI mug-6, Mean ± SE (n=3). Values labelled with different low case letters are significantly different at *P<0.05* by DMRT.

Treatment	Number of pods plant^{-1}	Number of seeds pod^{-1}	Weight of 1000-seeds (g)
Plant density			
D_1	15.02 c	10.63 c	41.17 b
D_2	17.47 b	11.70 b	42.54 ab
D_3	18.92 a	12.23 a	45.36 a
D_4	17.63 b	11.83 b	44.39 a
SE	0.163	0.09	0.83
Weed control techniques			
W_0	13.72 c	10.38 b	40.92 b
W_1	18.63 a	12.02 a	44.12 a
W_2	18.82 a	12.17 a	44.74 a
W_3	17.87 b	11.81 a	43.68 a
SE	0.188	0.119	0.565
CV (%)	4.76	3.56	4.51

Table 4. Interaction effect of plant density and weed control techniques on yield contributing attributes of BARI mug-6, Mean ± SE (n=3). Values labelled with different low case letters are significantly different at *P<0.05* by DMRT.

Treatment	Number of pods plant^{-1}	Number of seeds pod^{-1}	Weight of 1000-seeds (g)
D_1W_0	12.03 h	10.07 e	40.06 d
D_1W_1	16.40 e	10.97 d	42.97 b-d
D_1W_2	16.17 e	10.80 de	40.63 d
D_1W_3	15.47 ef	10.67 de	41.02 d
D_2W_0	14.43 fg	10.63 de	42.81 b-d
D_2W_1	18.63 cd	12.07 bc	42.13 cd
D_2W_2	18.90 b-d	12.27 a-c	42.95 b-d
D_2W_3	17.90 d	11.83 c	42.28 cd
D_3W_0	14.57 fg	10.50 de	40.34 d
D_3W_1	20.50 a	12.80 ab	46.50 ab
D_3W_2	20.63 a	12.90 a	48.35 a
D_3W_3	19.97 ab	12.70 ab	46.26 ab
D_4W_0	13.83 g	10.33 de	40.47 d
D_4W_1	18.97 b-d	12.27 a-c	44.90 a-c
D_4W_2	19.57 a-c	12.70 ab	47.01 a
D_4W_3	18.13 d	12.03 bc	45.18 a-c
SE	0.375	0.238	1.129
CV (%)	4.76	3.56	4.51

Yield and harvest index : Results of this study indicated that yield of mungbean showed significant variation due to various plant densities (Table 5). The highest seed yield (1.36 t ha^{-1}), stover yield (1.75 t ha^{-1}), biological yield (3.11 t ha^{-1}) and harvest index (43.86 %) was recorded from 30 cm×10 cm (D_3). Increasing or decreasing plant density from 30 cm×10 cm (D_3) decreased yield of mungbean. Optimum planting density ensured higher dry matter production which attributed the increasing seed and stover yield compared to other treatments. Kabir and Sarkar (2008) also reported that 30 cm×10 cm produced the highest seed yield in case of mungbean. Similarly Zaher *et al.* (2014) recorded the highest biological yield (3964 kg ha^{-1}) of mungbean by 30 cm row spacing.

Weeds compete with crop plants for the limited resources available in the crop field. Completely weed free condition allows plants to utilize those resources solely and results in better yield in respect of seed and stover compared to weedy check (control). Results revealed that various weed control techniques controlled weeds differently and showed a highly significant variation among the treatments (Table 5). Results revealed that application of pre emergence herbicide Topstar 80 WP (W_2) controlled weeds completely and produced maximum seed yield (1.39 t ha^{-1}), stover yield (1.85 t ha^{-1}) biological yield (3.24 t ha^{-1}) and harvest index (43.87%) over manual weeding and post emergence herbicide.

Table 5. Effect of plant density and weed control techniques on the yield of BARI mug-6, Mean ± SE (n=3). Values labelled with different low case letters are significantly different at *P<0.05* by DMRT.

Treatment	Seed yield (t ha^{-1})	Stover yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest Index (%)
Plant density				
D_1	1.13 c	1.56 c	2.69 c	42.04
D_2	1.26 b	1.65 b	2.91 b	43.36
D_3	1.36 a	1.75 a	3.11 a	43.86
D_4	1.33 a	1.70 ab	3.02 a	43.84
SE	0.016	0.024	0.032	0.427
Weed control techniques				
W_0	1.06 c	1.36 d	2.41 d	42.77
W_1	1.34 ab	1.78 b	3.12 b	42.84
W_2	1.39 a	1.85 a	3.24 a	43.87
W_3	1.30 b	1.67 c	2.97 c	43.61
SE	0.022	0.026	0.033	0.629
CV (%)	6.04	5.48	3.94	5.04

This might be due to the initial weed control by pre emergence herbicide which promoted plant growth effectively as weeds failed to establish properly at later (Chowdhury *et al.* 2014). Other treatments failed to control weeds successfully and severe weed infestation interfered the normal physiological processes of plants and ultimately seed and stover yield decreased drastically. Chattha *et al.* (2007) observed a significant increase (50%) in seed yield of mungbean due to chemical weed control at 2-3 leaf stage of weeds plus hand weeding at 50 DAS.

The interaction effect of plant density and weed control techniques varied significantly for yield of mungbean (Table 6). It was observed that herbicidal treatments combined with planting density performed better than rest of the other treatment combinations.

Minimum planting density coupled with herbicide (30 cm×10 cm treated with Topstar 80 WP) produced the highest seed yield (1.47 t ha^{-1}), stover yield (1.94 t ha^{-1}) and biological yield (3.41 t ha^{-1}). These were possible because of minimization of competition between intra and inter plant species provided by herbicide application and lesser plant density.

Table 6. Interaction effect of plant density and weed control techniques on the yield of BARI mug-6, Mean ± SE (n=3). Values labelled with different low case letters are significantly different at *P<0.05* by DMRT.

Treatment	Seed yield (t ha^{-1})	Stover yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest Index (%)
D_1W_0	1.02 c	1.28 d	2.30 f	44.27
D_1W_1	1.16 c	1.71 bc	2.86 d	40.27
D_1W_2	1.29 b	1.84 ab	3.13 bc	41.33
D_1W_3	1.04 c	1.42 d	2.47 ef	42.27
D_2W_0	1.05 c	1.36 d	2.40 ef	43.62
D_2W_1	1.32 ab	1.81 a-c	3.13 bc	42.26
D_2W_2	1.35 ab	1.79 a-c	3.13 bc	42.98
D_2W_3	1.33 ab	1.66 c	2.99 cd	44.59
D_3W_0	1.08 c	1.36 d	2.44 ef	44.52
D_3W_1	1.45 a	1.86 ab	3.32 ab	43.83
D_3W_2	1.47 a	1.94 a	3.41 a	43.13
D_3W_3	1.44 ab	1.84 ab	3.28 ab	43.94
D_4W_0	1.08 c	1.44 d	2.52 e	43.07
D_4W_1	1.42 ab	1.74 bc	3.16 bc	44.99
D_4W_2	1.43 ab	1.85 ab	3.29 ab	43.64
D_4W_3	1.37 ab	1.76 bc	3.14 bc	43.65
SE	0.044	0.053	0.067	1.258
CV (%)	6.04	5.48	3.94	5.04

From the results it may be concluded that sowing of mungbean at 30 cm×10 cm plant density and application of Topstar 80 WP as pre-emergence herbicide would be the best practice for yield enhancement of mungbean. Further study should be undertaken to know whether pre-emergence herbicide affects soil microorganisms or not.

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