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Effect of variety and seed rate of mungbean on weed suppression and yield under strip tillage system

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Abstract

Mungbean can successfully be grown under strip tillage system if appropriate seeding rate can determine and adjust with machine. Due to high weed pressure in strip tillage system, selection of such mungbean varieties that have some potentialities to suppress weeds need to find out and moreover, determining optimum seed rate for different varieties could help to achieve best yield. Therefore, a study was conducted at Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during March-June, 2013 to study the effect of variety and seed rate on weed suppression and yield performance of mungbean under strip tillage system. The study comprised three mungbean varieties (BARI mung-6, BINA mung-5 and BINA mung-8) and five seed rates (20, 25, 30, 35 and 40 kg ha^{-1}). The experiment was laid out in split-plot design with three replications. The study exposed that variety and seed rate had significant effect on plant population of mungbean, weed dry matter, number of pods plant^{-1}, pod length, number of seeds pod^{-1}, seed yield and stover yield of mungbean. The study results clearly found that weed population significantly reduced with increasing seeding rate of mungbean. Seeding of mungbean at 40 kg ha^{-1} and 35 kg ha^{-1} could successfully suppress weed under strip tillage system. Moreover, BINA mung-8 and BINA mung-5 had the more potentiality to suppress weeds compare to BARI mung-6. However, BINA mung-5 was found the superior among the three tested varieties that produced the highest seed yield from 35 kg ha^{-1} seed rate. In case of BARI mung-6 and BINA mung-8, maximum seed yield was also obtained from 35 kg ha^{-1} seed rate. Therefore, the study concluded that seeding of any of the three mungbean varieties at 35 kg ha^{-1} rate may help to obtain the satisfactory yield but the study suggest cultivation of BINA mung-5 at 35 kg ha^{-1} seeding rate under strip tillage system that will give not only the optimum seed yield but also provide good weed suppression.

Keywords: Conservation agriculture, Mungbean, Seed rate, Weed biomass

Introduction

Mungbean (*Vigna radiata* L.) is one of the most important pulse crops of Bangladesh. It is considered as the best of all pulses from the nutritional point of view. The total production of mungbean in Bangladesh was 32000 metric tons from an area of 39,285 hectare of land with average yield of about 0.81 t ha^{-1} during 2013-14 (BBS, 2016). The crop has already been transformed from a marginal to major crop for its additional benefits like enhancing soil fertility, improving rural household income, expanding employment opportunities, diversifying diets and increasing nutritional security (Shanmugasundaram *et al.*, 2009). The short-growth duration variety of mungbean is well fitted in rice-based cropping systems of Asia. But our country is facing an acute shortage of mungbean due to low yield of approximately 654.36 kg ha^{-1} (MOA, 2012). The reasons of low yield may be lack of high yielding varieties and some are agronomic mismanagement due to labor shortage or lack of knowledge. Several studies also have been made to understand the performance of different mungbean varieties which mainly include the contribution of various yield components towards yield (Mondal *et al.*, 2012; Singh *et al.*, 2009; Hakim, 2008). While we have limited land for mungbean cultivation, attempts must be taken to increase the yield per unit area by improving technology and management practices.

Generally mungbean is cultivated with conventional full tillage that requires considerable fuel, labour and time. Besides increasing economic inputs, conventional tillage leads to soil erosion resulting soil fertility depletion. On the other hand, strip tillage offers potential to reduce soil erosion though a narrow strip of about six inches wide and four to eight inches deep is made in a single pass that helps to conserve soil moisture and consequently ensures similar soil temperature to conventional tillage systems (Nowatzki *et al.*, 2011; Endres and Hendrickson, 2010). Seeding of mungbean in a strip by a machine reduces use of fuel and production cost by reducing the number of field passes and additionally, fertilizer can be applied at the same time of seeding with same machine.

But, the shift from conventional tillage practices to reduced tillage system (strip tillage) can be particularly difficult with respect to weed control. Because tillage has been traditionally used as a method of weed control and therefore, in reduced tillage system weed seeds remain on the surface soil and huge weed emerge at the early stage of crop establishment (Mishra and Singh, 2012; Murphy *et al*., 2006). In mungbean, yield losses due to uncontrolled weed growth ranges from 27 to 100% (Dungarwal *et al*., 2003; Shuaib, 2001; Madrid and Manimtim, 1977). Miah *et al*. (2015) also found high weed infestation in mungbean field that causes 56% yield loss. Controlling weeds is a major problem in legumes because of its slow growth at seedling stage. Therefore, quick growing mungbean varieties need to select as a result fast canopy coverage of those varieties will help to suppress early growing weeds. Furthermore, number of plant population also has an effect on weed suppression and higher population hastens the rapidity of closer the canopy and enhances canopy radiation interception resulting weed growth suppression (Mashingaidze, 2004; Zimdahl, 1999; Murphy *et al*., 1996), and thereby crop yield ultimately increased (Andrade *et al*. 2002). Plant population varies with seed rates (Taj *et al*., 2003) and however, seed rate is one of the most important factors to achieve better yield. Seed rate of different mungbean varieties varies with locations to get higher yield (Singh *et al*., 2003). Growing mungbean by sowing seeds within the strip made by using a single tine was found successful by Maghari and Woodhead (1984). But now-a-days, labour crisis forces the farmers to adopt machine for quick and easy seed sowing. Therefore, it is essential to adjust seed rate of different varieties of mungbean with machine though no report was found on adjusted seed rates of released and existing popular mungbean varieties with machine in Bangladesh. Selection of suitable mungbean variety or varieties with adjusted machine seed rate not only will help to reduce weed pressure but also help to achieve maximum yield under this system. Therefore, this study was done to examine the effect of variety and seed rate on weed suppression and yield performance of mungbean under strip tillage system.

Materials and Methods

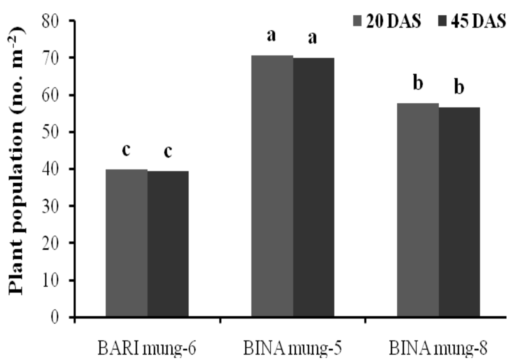
The study was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh from March to June 2013. The experimental site is located at 24^{o}75´ N latitude and 90^{o}50´ E longitude in the south-west part of Brahmaputra at an elevation of 18 m above the sea level. This site belongs to non-calcareous dark grey floodplain soil under the agro-ecological zone Old Brahmaputra Floodplain "AEZ-9" (UNDP and FAO, 1988). The experimental field was a well drained medium high land with silt loam soil texture having a pH value of 6.8. The organic matter content of the experimental field was 1.3% having particle density 2.60, soil density 1.35% and soil porosity 46.67%. The climate of the experimental site is under the subtropical region characterized by high temperature, high relatively humidity and heavy rainfall with occasional gusty winds during the experimental period (April to September). The maximum temperature was 33.1^{o}C recorded in the month of June and the minimum temperature was 22.5^{o}C recorded in April during 2013. The highest rainfall was recorded in the month of July (338.8 mm). In the study, three (03) most promising mungbean varieties *viz.* BARI mung-6, BINA mung-5 and BINA mung-8 were evaluated against five (05) seed rates (20, 25, 30, 35 and 40 kg ha^{-1}) in a split-plot design with three replications allocating variety in the main plot and seed rate in the sub-plots. Seeds of three mungbean varieties were sown in the experimental field by a two wheel tractor machine named versatile multi-crop planter (VMP) maintaining the seed rates as per experimental specification. Before one week of sowing the seeds, the pre-planting herbicide Roundup® (glyphosate) was applied in the whole field @ 75 mL/ 10 L water. Seeds of mungbean were inoculated by Rhizobial bio-fertilizer @ 100 g kg^{-1} of seeds just before sowing. Di-ammonium phosphate (DAP) and muriate of potash (MP) were applied to supply of phosphorus and potassium @ 80 and 40 Kg ha^{-1}, respectively. All fertilizers were applied at the time of seed sowing on 27 March 2013 with the help of VMP. This machine placed the seeds at about 3-4 cm depth of soil by maintaining 30 cm row to row distance. Pesticides were applied to control shoot and fruit borer and yellow mosaic of mungbean. A heavy rainfall occurred during the growing period and the excess water was drained out from the field. Number of weed population was counted from randomly selected 2 spots of 1 m^{2} area. After counting, weeds were cut at the ground level, cleaned with fresh water and dried in oven at 60^{o} C for 72 hours. At maturity, pods were harvested from 02 June to 23 June 2013. Matured pods were collected by picking from central 1 m^{2} area of each experimental plot. The data on number of plants m^{-2}, plant height, total number of pods plant^{-1}, pod length, number of seeds pod^{-1} were recorded from randomly selected five plants from outside of the harvested area.

Results and Discussion

Plant population

Plant population (no. m^{-2}) was significantly affected by variety, seed rate and their interaction (Fig. 1 and Table 1). Among the three varieties, the highest plant population (70.80 and 70.13 m^{-2}) was obtained from BINA mung-5 at both 20 and 45 DAS, respectively and the lowest values (39.93 and 39.53 m^{-2}) were recorded from BARI mung-6. Among the seed rates, the highest plant population (89.78 and 89.00 m^{-2}) was observed in 40 Kg ha^{-1} seed rate at 20 and 45 DAS, respectively whereas the lowest number of plant population (23.78 and 23.67 m^{-2}) was found from 20 Kg ha^{-1}. From the interaction effect of variety and seed rate, the highest plant population was observed from BINA mung-5 at 40 Kg ha^{-1} seed rate both at 20 and 45 DAS whereas BARI mung-6 at 20 Kg ha^{-1} produced the lowest plant population. The results expressed that increasing the seed rate gradually increased the number of plants m^{-2} area. Dainavizadeh and Mehranzadeh (2013) also reported that plant population of mungbean increased significantly with increasing seed rate.

(a)



(b)

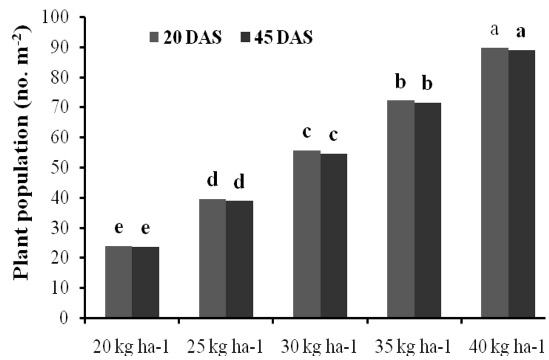


Fig. 1. Effect of (a) variety and (b) seed rate on plant population (no. m^{-2}) at 20 and 45 days after sowing of mungbean under strip tillage system during 2013 (As per DMRT, bars with same letters do not differ significantly whereas bars with dissimilar letters differ significantly).

Table 1. Interaction effect of variety and seed rate on plant population (no. m^{-2}) at 20 and 45 days after sowing of mungbean under strip tillage system during 2013

Variety	Seed rate (kg ha^{-1})	20 DAS	45 DAS
BARI mung-6	20	12.67 g	12.67 g
	25	25.33 f	25.33 f
	30	39.67 e	38.33 e
	35	54.00 d	54.00 d
	40	68.00 c	67.33 c
BINA mung-5	20	27.00 f	26.67 f
	25	53.00 d	53.00 d
	30	73.00 c	71.67 c
	35	95.33 b	94.67 b
	40	105.70 a	104.7 a
BINA mung-8	20	31.67 f	31.67 ef
	25	40.00 e	38.00 e
	30	54.33 d	53.33 d
	35	67.00 c	65.67 c
	40	95.67 b	95.00 b
$LSD_{0.05}$		7.93	7.71
P value		0.001	0.001
CV (%)		8.38	8.24

In a column figures with same letters do not differ significantly whereas figures with dissimilar letters differ significantly (as per DMRT).

Weed dry matter

Weed dry matter (g m^{-2}) at 45 days after sowing (DAS) significantly differed with variety and seed rate of mungbean under strip tillage system (Fig. 2). Results showed that BARI mung-6 had the highest weed dry matter (16.96 g m^{-2}) and identical result was also obtained from BINA mung-8 (16.35 g m^{-2}). Whereas, BINA mung-5 gave the lowest weed dry matter (11.10 g m^{-2}), may be due to its good canopy coverage. In case of seed rate, the lowest weed dry matter (8.66 g m^{-2}) was recorded from 40 kg ha^{-1} seed rate while the highest weed dry matter (23.72 g m^{-2}) was observed in 20 kg ha^{-1} seed rate. The results exposed that weed dry matter was reduced by increasing seed rate. This might be happened due to high plant population of mungbean which accelerated canopy coverage and because of their shading effect weeds were suppressed. This finding is in agreement with Mashingaidze (2004) and Zimdahl (1999) who also reported that weeds were suppressed with increasing number of crop plants.

Table 2 showed that the interaction effect of variety and seed rate on weed dry matter at 45 DAS was also significant ($p < 0.001$). The lowest weed dry matter (24.0 g m^{-2}) was found from BINA mung-8 at 40 kg ha^{-1} seed rate which was closely followed by BINA mung-5 at 35 kg ha^{-1} seed rate (28.0 g m^{-2}) and BINA mung-5 at 40 kg ha^{-1} (29.0 g m^{-2}). On the other hand, BINA mung-8 at 20 kg ha^{-1} seed rate gave the highest weed dry matter (181.3 g m^{-2}). These results demonstrated that higher seed rate of BINA mung-8 and BINA mung-5 provided better weed control whereas decreasing seed rate helped to grow more weed in strip tillage system.

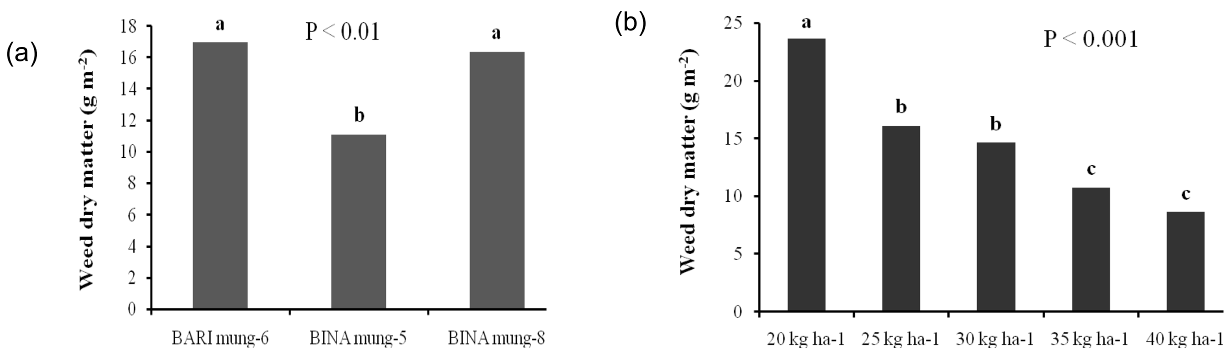


Fig. 2. Effect of (a) variety and (b) seed rate on weed biomass (g m^{-2}) at 45 days after sowing of mungbean under strip tillage system during 2013 (As per DMRT, bars with same letters do not differ significantly whereas bars with dissimilar letters differ significantly).

Table 2. Interaction effect of variety and seed rate on weed biomass (g m^{-2}) at 45 days after sowing of mungbean under strip tillage system during 2013

Variety	**Seed rate (kg ha^{-1})**				
	20	**25**	**30**	**35**	**40**
BARI mung-6	154.3 b	89.0 d	65.3 e	53.0 e	50.3 e
BINA mung-5	101.0 cd	47.3 e	54.0 e	28.0 f	29.0 f
BINA mung-8	181.3 a	113.7 c	85.3 d	46.3 e	24.0 f
$LSD_{0.05}$			2.92		
P value			< 0.001		
CV (%)			11.72		

In a column figures with same letters do not differ significantly whereas figures with dissimilar letters differ significantly (as per DMRT).

Yield contributing characters and yield of mungbean

Yield contributing characters like number of pods plant^{-1}, pod length, number of seeds pod^{-1} and 1000-grain weight were significantly affected by variety and seed rate of mungbean and therefore seed and stover yields also significantly varied with treatments (Table 3 and 4). The highest number of pods plant^{-1} (40.73), pod length (8.08 cm), seed yield (888.17 kg ha^{-1}) and stover yield (1874.25 kg ha^{-1}) were obtained from BINA mung-5. Whilst, the highest number of seeds pod^{-1} (9.68) and 1000-grain weight (37.14) were obtained from BARI mung-6. In case of seed rate, the highest number of pods plant^{-1} (40.3) was counted from 20 kg ha^{-1} seed rate and the lowest value (33.0) was found from 40 kg ha^{-1} seed rate. Taj *et al*. (2003) and Mackenzie (1985) also reported decrease in number of pods per plant in mungbean with increase in plant population. Whereas, the highest pod length (8.46 cm), number of seeds pod^{-1} (9.68), 1000-grain weight (35.13 g) and seed yield (807.31 kg ha^{-1}) were recorded from 35 kg ha^{-1} seed rate. Similar results were found in 40 kg ha^{-1} seed rate. These results are in contrast with Bonari and Macchia (1975) and Taj *et al*. (2003) who found that number of seeds per pod and 1000-grain weight decreased with increasing seed rate. The highest stover yield was obtained from 40 kg ha^{-1} seed rate might due to the presence of highest plant population. However, the highest seed yield was obtained from 35 kg ha^{-1} seed rate (807.31 kg ha^{1}) which was closely followed by 40 kg ha^{-1} seed rate (806.52 kg ha^{1}). Jahan and Hamid (2004) reported that significant variation in number of pods palnt^{-1} and seeds pod^{-1} due to difference in population density caused the variation in seed yield.

In case of interaction effect of variety and seed rate, number of pods plant^{-1}, pod length, number seeds pod^{-1}, seed yield and stover yield were also significantly varied with treatments except 1000-grain weight (Table 5). The highest number of pods plant^{-1} (44.0) was counted from BINA mung-5 at 20 kg ha^{-1} but, the highest pod length (8.79 cm) with higher number of seeds pod^{-1} were obtained from BINA mung-5 sowing at 35 kg seed ha^{-1} resulting the highest seed yield (1215.35 kg ha^{-1}). While the highest stover yield (2506.12 kg ha^{-1}) was found from BINA mung-5 at 40 kg ha^{-1} seed rate because of having the highest number of plant population. In case of BARI mung-6, 35 kg ha^{-1} seed rate also produced higher seed yield compare to other seed rates because of producing the highest number of seeds pod^{-1} (10.8). Therefore, the results demonstrated that BARI mung-6, BINA mung-5 and BINA mung-8 gave their highest seed yield at 35 kg ha^{-1} seed rate but all varieties produced their highest stover yield at 40 kg ha^{-1}. Singh *et al*. (2003), Hasan (2004) and Chowdhury (1999) also reported that seed yield of mungbean increased with increasing seed rate up to certain levels and thereafter decreased. On the other hand, all varieties gave the lowest yield (seed and stover) at 20 kg ha^{-1} seed rate and this might be happened due to production of the lowest number of mungbean plants with the highest weed dry matter as a result the lowest number of seeds produced per pods with the lowest pod length.

Table 3. Effect of variety on yield contributing characters of mungbean under strip tillage system during 2013

Variety	Number of Pods plant^{-1}	Pod length (cm)	Number of Seeds pod^{-1}	1000-grain wt. (g)	Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})
BARI mung-6	34.53 b	7.96 b	9.68 a	37.14 a	506.56 b	1026.00 b
BINA mung-5	40.73 a	8.08 a	9.61 a	32.20 b	888.17 a	1874.25 a
BINA mung-8	35.20 b	7.75 c	7.716 b	31.02 c	429.80 c	890.55 c
$LSD_{0.05}$	2.63	0.11	0.34	1.88	15.77	30.60
P value	< 0.01	< 0.01	0.001	< 0.01	< 0.001	< 0.001
CV (%)	2.96	1.58	3.03	1.78	4.87	3.18

In a column figures with same letters do not differ significantly whereas figures with dissimilar letters differ significantly (as per DMRT).

Table 4. Effect of seed rate on yield contributing characters of mungbean under strip tillage system during 2013

Seed rate ($kg\ ha^{-1}$)	Number of pods $plant^{-1}$	Pod length (cm)	Number of seeds pod^{-1}	1000-grain wt. (g)	Seed yield ($kg\ ha^{-1}$)	Stover yield ($kg\ ha^{1}$)
20	40.33 a	7.35 e	7.72 d	31.72 b	316.90 d	807.00 e
25	38.22 ab	7.66 d	8.60 c	32.7 ab	501.90 c	1094.16 d
30	37.00 ab	7.86 c	8.82 bc	33.62 ab	608.12 b	1225.07 c
35	35.56 bc	8.46 a	9.68 a	35.13 a	807.31 a	1440.00 b
40	33.00 c	8.31 b	9.25 ab	34.13 ab	806.52 a	1751.00 a
$LSD_{0.05}$	3.39	0.14	0.44	2.43	20.36	39.51
P value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
CV (%)	2.96	1.58	3.03	1.78	4.87	3.18

In a column figures with same letters do not differ significantly whereas figures with dissimilar letters differ significantly (as per DMRT).

Table 5. Interaction effect of variety and seed rate on yield contributing characters of mungbean under strip tillage system during 2013

Variety × Seed rate		Number of pods $plant^{-1}$	Pod length (cm)	Number of seeds pod^{-1}	1000-grain wt. (g)	Seed yield ($kg\ ha^{-1}$)	Stover yield ($kg\ ha^{-1}$)
BARI mung-6	20 $kg\ ha^{-1}$	38.3 de	7.52 g	8.2 de	35.16	191.15 k	430.47 k
	25 $kg\ ha^{-1}$	35.7 fg	7.75 fg	9.5 c	36.14	389.74 i	854.80 h
	30 $kg\ ha^{-1}$	34.0 gh	8.00 de	9.8 bc	37.47	521.70 g	1072.34 g
	35 $kg\ ha^{-1}$	33.7 h	8.33 b	10.8 a	39.19	730.12 e	1324.17 f
	40 $kg\ ha^{-1}$	31.0 j	8.19 bcd	10.1 b	37.74	700.30 e	1449.34 e
BINA mung-5	20 $kg\ ha^{-1}$	44.0 a	7.28 h	8.7 d	30.56	460.63 h	1307.05 f
	25 $kg\ ha^{-1}$	42.3 ab	7.70 g	9.5 c	31.14	787.08 d	1663.49 d
	30 $kg\ ha^{-1}$	41.3bc	7.94 ef	9.7 bc	32.16	876.30 c	1769.87 c
	35 $kg\ ha^{-1}$	39.7 cd	8.79 a	10.2 b	34.00	1215.35 a	2124.21 b
	40 $kg\ ha^{-1}$	36.3 f	8.69 a	10.0 b	33.15	1102.41 b	2506.12 a
BINA mung-8	20 $kg\ ha^{-1}$	38.7 d	7.26 h	6.3 h	29.44	299.20 j	683.70 j
	25 $kg\ ha^{-1}$	36.7 ef	7.53 g	6.8 g	30.73	329.10 j	765.10 i
	30 $kg\ ha^{-1}$	35.7 fg	7.64 g	7.0 g	31.24	426.43 hi	832.95 h
	35 $kg\ ha^{-1}$	33.3 hi	8.26 bc	7.6 f	32.19	619.36 f	873.30 h
	40 $kg\ ha^{-1}$	31.7 ij	8.04 cde	8.1 e	31.50	475.07 gh	1297.48 f
$LSD_{0.05}$		1.84	0.21	0.45	1.00	49.95	67.68
P value		<0.01	< 0.001	<0.05	NS	< 0.001	< 0.001
CV (%)		2.96	1.58	3.03	1.78	4.87	3.18

In a column figures with same letters do not differ significantly whereas figures with dissimilar letters differ significantly (as per DMRT).

Conclusion

The study results concluded that the performance of BINA mung-5 was the best as it provided the highest plant population and the highest weed control by machine seeding at 40 $kg\ ha^{-1}$ seed rate. The highest seed yield was obtained from BINA mung-5 at 35 $kg\ ha^{-1}$ seed rate but the highest stover yield was achieved from 40 $kg\ ha^{-1}$ seed rate. In case of BARI mung-6 and BINA mung-8, 35 $kg\ ha^{-1}$ seed rate also gave higher seed yield and 40 $kg\ ha^{-1}$ seed rate produced higher stover yield than the other seed rates. However, the study results found machine seeding effective under strip tillage system that could enhance mungbean yield if 35- 40 $kg\ ha^{-1}$ seed rate is ensured and successful weed suppression can be possible if BINA mung-5 or BINA mung-8 is grown.

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