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Yield Performance of Mungbean as Affected by Planting Date, Variety and Plant Density

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Abstract: An experiment was carried out to study the effect of planting date and plant density on the yield and yield attributes of five varieties of mungbean. The experiment comprised of four planting dates viz. 03 February,18 February, 05 March and 20 March, five varieties viz. BARIMung-2, BARIMung-3, BARIMung-4, BARIMung-5 and BINA Mung-2 and three planting densities viz., 20x20 cm, 30x10 cm and 40x30 cm. The experiment was laid out in a split-split plot design with three replications. It was observed that early planted (03 and 18 February) crops produced higher yield as compared to late planted (05 and 20 March) crops. Variety BARIMung-2, BARIMung-3 and BARIMung-4 produced higher seed yield as compared to variety BARIMung-5 and BINAMung-2.The 30x10 cm plant density always showed the highest yield performance. Variety BINAMung-2 produced the highest branches plant^{-1} when planted on 03 February at a spacing of 40x30 cm. The highest pods plant^{-1} was found in the variety BARIMung-3 when planted at a density of 30x10 cm and planted on 18 February. Pod length was the highest in variety BARIMung-5 planted on 05 March with a plant density of 20x20 cm. The highest 1000- seed weight was obtained in case of variety BARIMung-5 planted on 03 February at densities of 20x20 cm and 30x10 cm. Variety BARIMung-2 planted on 3 February at plant density of 30x10 cm significantly produced the highest seed yield and harvest index and the lowest seed yield and harvest index were found in the variety BARIMung-3 planted on 20 March at a plant density of 40x30 cm.

Key words: *Vigna radiata*, planting date, variety, plant density, yield

INTRODUCTION

Mungbean (*Vigna radiata* L.) is an important quality pulse crop of Bangladesh which contains high graded vegetable proteins, satisfactory minerals and vitamins. Due to good taste, easy digestibility, better palatability and acceptable market price mungbean may be the first choice of farmers. In Bangladesh, among the pulses cultivated area only 8.10% lands are used for the cultivation of mungbean[1]. According to World Health Organization (WHO) report, per capita requirement of pulse is 45 g. But in Bangladesh, only 12 g of pulse is available per capita per day. About 6.01 million metric tons of pulse will be required to meet the present per capita requirement of Bangladesh[1].There has been a continuous decline in production of pulses in Bangladesh during the last decade. In farmers level, the average yield of mungbean is very low due to lack of knowledge of selecting and planting the suitable variety and using appropriate agronomic practices. Among the various agronomic practices, planting time is single most important factor influencing the yield of mungbean[3]. A significant effect of planting time on seed yield was found in mungbean[4]. Planting time is important for pulses that have to be adjusted or alternative cropping patterns developed[5]. Time of sowing is the most important non-monetary factor for obtaining potential yield of a variety since it ensures the complete harmony between the vegetative and reproductive phases[6]. Optimum planting time of mungbean may vary from one variety to another and also from one region to another due to variation of agro-ecological conditions. Several research works on different varieties of mungbean with time of planting have been done in different regions of Bangladesh. But little information is available particularly for old Brahmaputra alluvium soil under agro-ecological zone-9. In this zone, farmers usually sow local variety of mungbean without maintaining proper time schedule and planting density. They hesitate to grow mungbean in rows, although row planting facilitates easy intercultural operations resulting in higher yield[7]. Line planting maintaining proper planting density can help to ensure optimum plant population per unit area thereby increasing the yield[2]. The present study was therefore undertaken to find out (I) the suitable planting date of mungbean specially in kharif-I season, (ii) the relative yielding ability of five varieties of

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mungbean, (iii) optimum planting density of mungbean and (iv) yield performance of mungbean varieties with combined effect of planting date and plant density.

MATERIALS AND METHODS

The experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh, Bangladesh during the period from February to June, 2002. The soils of experimental plot was silty loam with pH 6.7, organic matter 1.25%, total nitrogen (N) 0.05%, available phosphorus (P) 12 ppm, available sulphur (S) 16 ppm and exchangeable potassium (K) 0.38 me 100 g $^{-1}$ soil[8]. The experiment comprised of five varieties of mungbean viz., (I) BARIMung-2, (ii) BARIMung-3, (iii) BARIMung-4, (iv) BARIMung-5 and (v) BINAMung-2; four planting dates viz., (I) 03 February, (ii)18 February, (iii) 05 March and (iv) 20 March, 2002 and three planting densities represented by three plant spacings viz., (I) 20x20 cm, (ii) 30x10 cm and (iv) 40x30 cm. The experiment was laid out in a split-split plot design with three replications assigning planting dates in the main plots, varieties in the sub-plots and planting densities in the sub-sub-plots. Size of each unit plot was 6 m^2 (3x2 m). Experimental land was uniformly fertilized with 20 kg N,40 kg P_2O_5 and 20 kg K_2O ha^{-1} in the form of urea, triple super phosphate (TSP) and muriate of potash (MP), respectively, at final land preparation[9]. Crop management practices such as gap filling, weeding, thining and plant protection measures were done as per requirement. Data on yield attributes were taken from 5 randomly selected plants per plot. The crops of 33 m^2 (3x1 m) in each plot were harvested by picking of pods at different dates as per maturity of different varieties. Yield was recorded at 16% moisture content of mungbean seed which was the safe level without reducing germination[10]. The collected data were compiled and tabulated properly for statistical analysis. Analysis of variance was done with the help of computer package M-stat program. Differences among treatment means were tested with Duncan's multiple range test (DMRT) and Least significant difference (LSD) test where necessary[11].

RESULTS AND DISCUSSION

Effect of planting dates: Planting dates showed significant effect on the growth duration of mungbean (Table 2). Crops planted on 18 February and 20 March matured in 83.56 and 83.80 days, respectively followed by 5 March planting in 86.40 days. Poehlman[12] stated that abundant rainfall, short photoperiod and high mean temperature resulted in early maturity of mungbean. Shorter growth of those plantings might be due to high mean temperature and excessive rainfall (Table 1) during the growth period of those plantings. Crops of 3 February planting required longer duration (95.80 days) for maturity which might have occurred due to deficit of soil moisture content, received from no rainfall (Table 1) especially at the early growing period of crops that delayed plant establishment and maturity.

Seed yield was significantly affected by planting dates. Crops planted on 3 and 18 February produced highest seed yield (908.60 and 889.70 kg ha^{-1}) followed by 5 March (727.20 kg ha^{-1}) and 20 March (627.20 kg ha^{-1}) planting. The higher yield was obtained might be due to higher performance of number of branches $plant^{-1}$, number of pods $plant^{-1}$, pod length, number of seeds pod^{-1} and 1000-seed weight (Table 2).

Number of branches $plant^{-1}$ was significantly affected by planting dates. Earlier planted (3 and 18 February) crops produced higher number of branches $plant^{-1}$ (3.58 and 3.44) as compared to later planted crops. The highest number of pods $plant^{-1}$ (18.60) was found on 18 February planting followed by 3 February, 5 and 20 March planting, respectively. Pod length and number of seeds pod^{-1} of earlier planted crops were higher than that of later planted crops. The highest (6.78 cm) and the lowest (6.12 cm) pod length were found on 5 and 20 March planting, respectively. Higher number of seeds pod^{-1} was found on 3 February (9.96), 18 February (10.32) and 5 March (10.55) planting which were statistically similar and the lowest (9.11) was found on 20 March planting. The highest 1000-seed weight (29.40 g) was found on 3 February planting followed by 18 February (27.97 g), 5 March (24.68 g) and 20 March (23.26 g) planting might be due to higher accumulation occurred in the growth period of earlier planting.

In case of harvest indices, highest performance was found (38.56%) in crops planted on 3 February followed by the crops planted on 18 February (33.60%), 20 March (28.08%) and 5 March (27.48%), respectively. According to Poehlman[12] the period of mungbean production required mean temperature of air and soil ranging from 20 to 30°C, monthly rainfall ranging from 50 to 84 mm. The trend of higher harvest indices to lower might be due to optimum ranges of both air and soil temperature and rainfall (Table 1) during the growth phases of crops especially first and second planting that enhanced assimilates production and transport into reproductive sink organ like grain.

Table 1: Air and soil temperature, sun shine and rainfall during experimental period (February to June, 2002)

Experimental period	Air temperature (°C) Maximum	Minimum	Average	Soil temperature (°C) (up to 20 cm depth)	Sun shine (h)	Rainfall (mm)
01-15 Feb	26.48	14.14	20.34	20.82	8.21	00.00
16-28 Feb	29.05	16.80	22.95	22.77	8.73	00.00
01-15 Mar	29.62	17.16	23.75	24.17	9.00	06.40
16-31 Mar	30.37	20.09	25.22	24.15	7.15	28.00
01-15 Apr	29.33	21.05	25.19	26.42	7.32	125.60
16-30 Apr	30.47	22.34	26.40	27.96	7.56	133.60
01-15 May	29.79	22.87	26.33	27.63	6.87	259.80
16-31 May	28.53	22.21	25.39	29.26	4.84	135.80
01-15 June	29.86	24.94	27.40	29.09	2.94	524.40
16-30 June	31.48	26.38	28.93	29.69	3.01	112.50

Source: Weather Yard, Department Irrigation and Water management, Bangladesh Agricultural University, Mymensingh

Table 2: Effects of planting dates, varieties and plant densities on growth duration, yield and yield attributes of mungbean

Treatments	Growth duration (days)	Branches plant^{-1} (No)	Pods plant^{-1} (No)	Pod length (cm)	Seeds pod^{-1} (No)	1000 seed weight (g)	Seed yield (kg ha^{-1})	Harvest Index (%)
Planting dates								
03 Feb	95.80a	3.58a	16.55b	6.38ab	9.96a	29.40a	908.60a	38.56a
18 Feb	83.56c	3.44a	18.60a	6.46ab	10.32a	27.97b	889.70a	33.60b
05 Mar	86.40b	3.00b	16.04c	6.78a	10.55a	24.68c	727.20b	27.48d
20 Mar	83.80c	2.90b	13.03d	6.12b	9.11b	23.26d	627.20c	28.08c
LSD	0.55	0.21	0.29	0.42	0.78	0.31	30.04	0.34
S$\bar{x}$	0.10	0.04	0.05	0.08	0.15	0.05	8.68	0.06
Level of Sig.	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Varieties								
BARIMung-2	86.50c	2.98cd	17.72a	6.36bc	10.20ab	26.52b	866.90a	35.35a
BARIMung-3	87.19b	3.11c	15.14d	6.24bc	9.68b	24.18c	806.40b	33.81b
BARIMung-4	87.25b	2.86d	15.58c	6.48b	9.87ab	23.45d	777.90c	29.90c
BARIMung-5	79.00d	3.34b	15.66c	7.09a	10.38a	34.49a	739.90d	29.96c
BINAMung-2	97.00	3.85a	16.18b	6.01c	9.78b	22.99e	749.80d	30.63c
LSD	0.58	0.17	0.22	0.41	0.50	0.18	17.35	0.74
S$\bar{x}$	0.15	0.04	0.05	0.10	0.17	0.04	6.02	0.19
Level of Sig.	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Planting densities								
20 x 20 cm	87.40	3.00b	15.88b	6.47	10.16	26.36b	880.00b	34.53b
30 x 10 cm	87.40	3.38a	17.07a	6.41	9.88	26.86a	1183.00a	41.64a
40 x 30 cm	87.37	3.31a	15.21c	6.44	9.91	25.76c	301.50c	19.62c
LSD	0.30	0.12	0.17	0.13	0.32	0.13	11.90	0.55
S$\bar{x}$	0.13	0.03	0.04	0.05	0.13	0.03	4.23	0.14
Level of Sig.	NS	0.01	0.01	NS	NS	0.01	0.01	0.01
C V (%)	1.17	7.83	2.22	6.92	10.58	1.10	4.16	3.63

Means having same letter(s) in a column do not differ significantly as per DMRT. NS= Not significant

Effect of varieties: Varieties of mungbean differed significantly for growth duration (Table 2). BARIMung-5 variety required shortest growth duration (79.00 days) followed by BARIMung-2 (86.50 days), BARIMung-3 (87.19 days) and BARIMung-4 (87.25 days). BINAMung-2 variety required the longest (97.00 days) growth duration. Variation of growth duration of varieties might have occurred due to their differences in genetic make-up.

Significant variation in seed yield was observed among five varieties of mungbean (Table2). Variety BARI-Mung-2 gave significantly higher grain yield (866.90 kg ha^{-1}). The high yield potential of BARI-Mung-2 was realized mainly through increased number of pods plant^{-1} (17.72) and seeds pod^{-1}(10.20). Similar results were reported by Samanta *et al.*[13]. The variety BARIMung-3 recorded the second highest yield (806.40 kg ha^{-1}) mainly due to higher number of seeds pod^{-1} (9.69) and was followed by BARIMung-4 (777.90 kg ha^{-1}), BARIMung-5 (739.90 kg ha^{-1}) and BINAMung-2 (749.80 kg ha^{-1}).

The variety BINAMung-2 produced the highest number of branches plant^{-1} and was followed by BARIMung-5, BARIMung-3 and BARIMung-2 (Table 2). BARIMung-4 variety produced the lowest number of branches plant^{-1}. The highest number of pods plant^{-1} was produced from the variety BARIMung-2 and was followed by BINAMung-2, BARIMung-5 and BARIMung-4. BARI-Mung-3 variety produced the lowest number of pods plant^{-1}. The highest length of pod was

Table 3: Interaction effects of planting dates and varieties on growth duration, yield and yield attributes of mungbean

Treatment Combination	Growth Duration	Branches plant^{-1}	Pods plant^{-1}	Pod length cm)	Seeds pod^{-1}	1000 seed weight (g)	Seed yield (kg ha^{-1})	Harvest Index (%)
03 Feb X BARI-2	98.00bc	3.09d-f	20.81a	6.36	9.85b-d	29.87d	1028.00a	45.21a
03 Feb X BARI-3	95.00e	3.41cd	14.53h	6.37	10.25bc	26.71f	897.40c	40.04b
03 Feb X BARI-4	97.00cd	3.18d-f	15.64f	6.36	9.91b-d	25.84g	951.80b	37.73 cd
03 Feb X BARI-5	90.00g	3.83b	15.23fg	6.81	10.15bc	38.98a	792.40ef	31.70ef
03 Feb X BINA-2	99.00ab	4.37a	16.56e	6.02	9.63b-d	25.61gh	873.10cd	38.11 cd
18 Feb X BARI-2	81.00kl	3.31de	17.33d	6.61	10.98b	29.02e	981.40b	36.73d
18 Feb X BARI-3	81.78k	3.30de	20.91a	6.05	10.02bc	24.21i	981.30b	38.88 bc
18 Feb X BARI-4	80.00lm	3.08d-f	19.04c	6.91	10.49bc	24.49i	873.20cd	29.74 gh
18 Feb X BARI-5	75.00n	3.74bc	15.12g	6.95	9.52b-d	38.33b	741.30fg	32.23e
18 Feb X BINA-2	100.00a	3.76bc	20.58a	5.80	10.59bc	23.81j	830.10e	30.42fg
05 Mar X BARI-2	86.00hi	2.94e-g	19.83b	6.67	10.41bc	25.32h	811.10e	29.40 gh
05 Mar X BARI-3	89.00g	2.86fg	10.87l	6.41	9.45b-d	23.52j	727.20g	28s.58 h-j
05 Mar X BARI-4	85.00i	2.79fg	15.43fg	6.55	9.99bc	22.14kl	675.00h	24.82l
05 Mar X BARI-5	79.00m	2.99ef	18.69c	7.95	13.44a	31.12c	744.60fg	29.75 gh
05 Mar X BINA-2	93.00f	3.43gh	15.38fg	6.31	9.43b-d	21.29m	678.10h	24.86l
20 Mar X BARI-2	81.00kl	2.59gh	12.90j	5.80	9.55b-d	21.88l	646.80hi	30.05 gh
20 Mar X BARI-3	83.00j	2.86fg	14.23h	6.14	9.03cd	22.28k	619.70i	27.74ij
20 Mar X BARI-4	87.00h	2.40h	12.20k	6.11	9.10cd	21.32m	611.40i	27.31jk
20 Mar X BARI-5	72.00o	2.80fg	13.59i	6.65	8.42d	29.53d	640.40hi	26.15kl
20 Mar X BINA-2	96.00de	3.84b	12.21k	5.92	9.47b-d	21.27m	617.80	29.14g-i
LSD	1.17	0.34	0.45	0.51	1.34	0.36	46.66	1.49
S$\bar{x}$	0.30	0.09	0.11	0.21	0.34	0.09	12.05	0.38
Level of Sig.	0.01	0.01	0.01	NS	0.01	0.01	0.01	0.01
C V (%)	1.17	7.83	2.22	6.92	10.58	1.10	4.16	3.63

Table 4: Interaction effects of planting dates and plant densities on growth duration, yield attributes and yield of mungbean

Treatments combination	Growth duration	Branches plant^{-1}	Pods plant^{-1}	Pod length (cm)	Seeds pod^{-1}	1000 seed weight (g)	Seed yield (kg ha^{-1})	Harvest Index (%)
03 Feb X (20x20 cm)	95.80	3.33	16.24e	6.29d-f	10.45	29.90a	1004.00d	40.91c
03 Feb X (30x10 cm)	95.80	3.76	17.41c	6.39b-e	10.74	29.44b	1393.00a	52.95a
03 Feb X (40x30 cm)	95.80	3.64	16.00e	6.48b-e	10.42	28.87c	329.60h	21.81i
18 Feb X (20x20 cm)	83.60	3.15	18.46b	6.33c-f	10.48	27.42e	979.70d	37.09e
18 Feb X (30x10 cm)	83.60	3.55	20.14a	6.39b-e	9.14	28.71c	1344.00b	42.64b
18 Feb X (40x30 cm)	83.47	3.61	17.19c	6.67a-c	9.21	27.78d	345.10h	21.06ij
05 Mar X (20x20 cm)	86.40	2.77	15.99e	7.01a	8.99	24.43g	826.60f	29.44h
05 Mar X (30x10 cm)	86.40	3.26	16.77d	6.73ab	8.27	25.16f	1068.00c	32.67f
05 Mar X (40x30 cm)	86.40	2.97	15.36f	6.59b-d	9.86	24.45g	287.30i	20.33j
20 Mar X (20x20 cm)	83.80	2.73	12.84h	6.23d-f	9.90	23.69i	709.90g	30.66g
20 Mar X (30x10 cm)	83.80	2.95	13.96g	6.13ef	9.43	24.14h	927.50e	38.29d
20 Mar X (40x30 cm)	83.80	3.02	12.28i	6.01f	9.84	21.94j	244.20j	15.29k
LSD	0.619	0.15	0.34	0.32	0.64	0.27	31.55	1.11
S$\bar{x}$	0.263	0.06	0.09	0.11	0.27	0.07	8.45	0.29
Level of Significance	NS	NS	0.01	0.05	NS	0.01	0.01	
C V (%)	1.17	7.83	2.22	6.92	10.5	1.10	4.16	3.63

Means having same letter(s) in a column do not differ significantly as per DMRT. NS= Not significant

Table 5: Interaction effects of varieties and planting densities on growth duration, yield attributes and yield of mungbean

Treatments combination	Growth duration	Branches plant^{-1}	Pods plant^{-1}	Pod length (cm)	Seeds pod^{-1}	1000 seed weight (g)	Seed yield (kg ha^{-1})	Harvest Index (%)
BARI-2 X (20x20 cm)	86.50	2.76	17.84 b	6.37c-f	10.82	26.92d	980.00d	37.38cd
BARI-2 X (30x10 cm)	86.50	3.21	19.19 a	6.31c-f	9.86	26.06f	1275.00a	47.08a
BARI-2 X (40x30 cm)	86.50	2.97	16.12 d-f	6.41c-f	9.90	26.60e	346.00g	21.58g
BARI-3 X (20x20 cm)	87.25	2.81	14.85 ij	6.00fg	9.43	24.67g	873.70e	37.92c
BARI-3 X (30x10 cm)	87.25	3.22	16.07 ef	6.29c-g	9.84	26.03f	1263.00a	46.03a
BARI-3 X (40x30 cm)	87.08	3.28	14.49 j	6.44c-e	9.78	21.83k	282.70h	17.48i
BARI-4 X (20x20 cm)	87.25	2.73	15.25 hi	6.61b-d	10.11	22.73j	875.30e	31.64f
BARI-4 X (30x10 cm)	87.25	2.89	16.45 de	6.64bc	10.06	23.70h	1155.00b	36.39d
BARI-4 X (40x30 cm)	87.25	2.97	15.04 i	6.20d-g	9.46	23.92h	303.00h	21.67g
BARI-5 X (20x20 cm)	79.00	3.04	15.55 gh	7.18a	10.52	34.58b	818.90f	32.58ef
BARI-5 X (30x10 cm)	79.00	3.56	16.48 d	6.93ab	10.08	35.30a	1125.00h	40.06b
BARI-5 X (40x30 cm)	79.00	3.42	14.94 i	7.16a	10.56	33.58c	276.00h	17.23i
BINA-2 X (20x20 cm)	97.00	3.63	15.92 fg	6.16e-g	9.89	22.90j	851.80ef	33.12e
BINA-2 X (30x10 cm)	97.00	4.02	17.17 c	5.89g	9.58	23.22i	1098.00c	38.63c
BINA-2 X (40x30 cm)	97.00	3.90	15.46 h	5.99fg	9.88	22.86j	300.00h	20.15h
LSD	0.692	0.17	0.38	0.36	0.71	0.31	35.28	1.24
S$\bar{x}$	0.294	0.07	0.10	0.12	0.30	0.08	9.45	0.33
Level of Sig.	NS	NS	0.01	0.05	NS	0.01	0.01	0.01
C V (%)	1.17	7.83	2.22	6.92	10.58	1.10	4.16	3.63

found from the variety BARIMung-5 and the lowest length of pod was found from the variety BINAMung-2. The variety BARIMung-5 produced the highest number of seeds pod^{-1} and was followed by BARIMung-2 and BARIMung-4. Variety BARIMung-3 and BINAMung-2 produced the lowest and statistically similar number of seeds pod^{-1}. Thousand seed weight of BARIMung-5 variety was the highest and was followed by BARIMung-2, BARIMung-3, BARIMung-4 and BINAMung-2. Variation in 1000-seed weight among the varieties of mungbean might be due to their different genetic characteristics. Similar trend of performance in 1000-seed weight was observed by Samanta *et al.*[13].

The highest harvest index was obtained from the variety BARIMung-2 might be due to highest production of seed yield (Table 2) and was followed by BARIMung-3 and other varieties which were statistically similar.

Effect of plant densities: Growth duration was not significantly influenced by planting densities (Table 2). The highest seed yield was obtained in the spacing of 30x10 cm followed in order by spacing of 20x20 cm and 40x30 cm. This highest seed yield in the spacing of 30x10cm was mainly due to higher number of pods plant^{-1} and higher weight of 1000 seeds (Table 2). More branching tendency was noticeable in the wider spacing especially in 40x30 cm. The highest havest index was found in 30x10 cm spacing followed in order by 20x20 cm and 40x30 cm spacing. Pod length and seeds pod^{-1} were not significantly affected by plant densities.

Interaction effects: Interaction effects between planting dates and varieties were found significant in growth duration, yield and all yield attributes except pod length (Table 3).The BARIMung-5 variety planted on 20 March required shortest growth duration (72 days) and the variety BINAMung-2 planted on 18 February required the longest growth duration (100 days). The variety BARIMung-2 planted on 3 February gave the highest seed yield mainly be due to increased number of pods plant^{-1} and the variety BARI-Mung-3 and BARI-Mung-4 planted on 20 March gave the lowest seed yield (619.70 and 611.40 kg ha^{-1}) might be due to decreased number of seeds pod^{-1}.

The highest number of branches plant^{-1} was observed on 3 February planting of BINAMung-2 variety and the lowest number of branches plant^{-1} was observed on 20 March planting of BARIMung-4 variety. Number of pods plant^{-1} was the highest on 3 February planting of BINAMung-2 variety and statistically similar results were found on 18 February planting of BARIMung-3 and BINAMung-2 variety and the lowest number of pods plant^{-1} was found on 20 March planting of BARIMung-2 variety. The highest number of seeds plant^{-1} was observed on 5 March planting of BARIMung-5 variety and the lowest number of seeds plant^{-1} was observed on 20 March planting of BARIMung-5 variety. Weight of 1000-seed was the highest on 3 February planting of BARIMung-5 variety and the lowest on 5 March and 20 March planting of BINAMung-2 and 20 March planting of BARIMung-4 variety. The highest harvest index was obtained on 3 February planting of BARIMung-2 variety and the lowest was obtained on 5 March planting of BARIMung-4 variety (Table 3).

Interaction effects between planting dates and plant densities were not significant in growth duration but significant in yield and yield attributes except branches plant^{-1} and seeds pod^{-1} (Table 4). The highest seed yield was obtained on 3 February planting at a density of 30x10 cm probably due to gaining proper ambient temperature and soil moisture received from rainfall during the growth period as shown in Table 1 and getting proper space for photosynthesis as well as up-taking the essential nutrients and the lowest seed yield was obtained on 20 March planting at a density of 40x30 cm. The number of pods plant^{-1} was the highest on 18 February planting at a density of 30x10cm and the lowest was found on 20 March planting at a density of 40x30 cm.The highest pod length and 1000-seed weight were observed on 5 March and 3 February planting, respectively at a planting density of 20x20 cm might be due to getting equal surrounding space for growing the individual pod. Harvest index was the highest on 3 February planting at a density of 30x10 cm might be due to the highest seed yield (Table 4).

Interaction effects between varieties and planting densities were not significant in growth duration, but significant in yield, yield attributes except number of branches plant^{-1} and seeds pod^{-1}(Table 5). The variety BARIMung-2 planted at a density of 30x10 cm gave the highest seed yield might be due to the highest number of pods produced plant^{-1}.

The variety BARIMung-2 planted at a density of 30x10 cm produced the highest number of pods plant^{-1} might be due to genetic capability of producing higher number of pods (Table 2). The variety BARIMung-5 showed the highest pod length planted at densities of 20x20 cm and 40x30 cm, respectively and the highest weight of 1000-seed (Table 5) might be due to genetic capability of producing the longest pod and the heaviest seed (Table 2).

The highest harvest index was observed in the variety BARIMung-2 planted at a density of 30 X 10 cm might be due to genetic capability of obtaining higher harvest index (Table 2).

Interaction effects among planting dates, varieties and planting densities were not significant in growth duration, but significant in yield, yield attributes except

Table 6: Interaction effects of planting dates, varieties and plant densities on growth duration, yield and yield attributes of mungbean

Treatments combination	Growth duration	Branches plant^{-1}	Pods plant^{-1}	Pod length (cm)	Seeds pod^{-1}	1000 seed weight (g)	Seed yield (kg ha^{-1})	Harvest Index (%)
03 Feb x BARI-2 x (20x20 cm)	98.00	2.993n-u	20.49de	6.08f-j	11.00	30.31e	1165.00d-f	46.57e
03 Feb x BARI-2 x (30x10 cm)	98.00	3.56d-n	21.83ab	6.35d-j	9.33	27.66h	1490.00a	64.18a
03 Feb x BARI-2 x (40x30 cm)	98.00	2.72p-u	20.10ef	6.66c-j	9.22	31.63d	429.70r	24.88rs
03 Feb x BARI-3 x (20x20 cm)	95.00	3.10l-t	14.27r-u	6.05f-j	10.53	27.38hi	968.70i-k	43.29f
03 Feb x BARI-3 x (30x10 cm)	95.00	3.58d-n	15.17pq	6.33d-j	10.33	29.26f	1456.00a	60.20b
03 Feb x BARI-3 x (40x30 cm)	95.00	3.55e-n	14.17s-v	6.73b-i	9.88	23.50o	268.00s-u	16.62wx
03 Feb x BARI-4 x (20x20 cm)	97.00	2.80p-u	15.28o-q	6.50d-j	9.81	25.73l	1022.00hi	38.41g
03 Feb x BARI-4 x (30x10 cm)	97.00	3.25i-r	16.50l	6.46d-j	9.77	26.49k	1493.00a	47.93de
03 Feb x BARI-4 x (40x30 cm)	97.00	3.49f-o	15.13qr	6.13f-j	10.16	25.30lm	339.70st	26.84p-r
03 Feb x BARI-5 x (20x20 cm)	90.00	3.53e-n	14.90q-t	6.59c-j	11.44	39.45a	893.30k-m	37.88gh
03 Feb x BARI-5 x (30x10 cm)	90.00	4.07a-f	16.20l-n	6.50d-j	8.89	39.19a	1210.00d	42.06f
03 Feb x BARI-5 x (40x30 cm)	90.00	3.91b-h	14.58q-t	7.35b-e	10.11	38.28b	274.30s-u	15.18xy
03 Feb x BINA-2 x (20x20 cm)	99.00	4.23a-c	16.27lm	6.23d-j	9.52	26.61jk	968.30i-k	38.42g
03 Feb x BINA-2 x (30x10 cm)	99.00	4.34ab	17.37k	6.30d-j	10.08	24.60u	1315.00b	50.38cd
03 Feb x BINA-2 x (40x30 cm)	99.00	4.54a	16.03l-o	5.53ij	9.30	25.62l	336.30st	25.53q-s
18 Feb x BAR-2 x (20x20 cm)	81.00	2.93n-u	17.98jk	7.17b-f	11.86	29.29f	1055.00gh	37.16g-j
18 Feb x BARI-2 x (30x10 cm)	81.00	3.13k-t	21.01cd	6.11f-j	10.30	29.41f	1469.00a	47.78de
18 Feb x BARI-2 x (40x30 cm)	81.00	3.86b-i	13.00wx	6.57c-j	10.78	28.38g	420.70r	25.25rs
18 Feb x BARI-3 x (20x20 cm)	82.00	2.94n-u	20.27d-f	5.60h-j	9.22	24.58n	1092.00f-h	52.05c
18 Feb x BARI-3 x (30x10 cm)	82.00	3.25i-r	22.57a	6.14f-j	10.17	26.83i-k	1513.00a	47.80de
18 Feb x BARI-3 x (40x30 cm)	81.33	3.71b-l	19.90e-g	6.41d-j	10.67	21.21q	339.30st	16.78wx
18 Feb x BARI-4 x (20x20 cm)	80.00	3.21i-s	18.67ij	6.54d-j	11.42	22.35p	980.30ij	28.34p
18 Feb x BARI-4 x (30x10 cm)	80.00	3.03m-t	20.10ef	7.69a-c	10.47	23.59o	1295.00bc	36.43g-k
18 Feb x BARI-4 x (40x 30 cm)	80.00	3.00n-u	18.37ij	6.50d-j	9.58	27.52h	344.70s	24.45rs
18 Feb x BARI-5 x (20x20 cm)	75.00	3.31h-q	15.03q-s	6.70b-i	8.45	37.35c	846.30mn	32.61l-n
18 Feb x BARI-5 x (30x10 cm)	75.00	4.15a-e	15.47m-q	6.46d-j	9.89	39.27a	1211.00d	42.96f
18 Feb x BARI-5 x (40x 30 cm)	75.00	3.76b-k	14.87q-t	7.70a-c	10.22	38.36b	289.30s-u	21.11tu
18 Feb x BINA-2 x (20x20 cm)	100.0	3.37g-p	20.37d-f	5.66h-j	10.44	23.55o	925.00j-l	35.31h-l
18 Feb x BINA-2 x (30x10 cm)	100.0	4.20a-d	21.57bc	5.56ij	10.33	24.47n	1234.00cd	38.25g
18 Feb x BINA-2 x (40x 30 cm)	100.0	3.70b-l	19.80e-h	6.18e-j	11.00	23.41o	331.30st	17.70v-x
05 Mar x BARI-2 x (20x20 cm)	86.00	2.80p-u	19.90e-g	6.59c-j	11.11	24.56n	967.00i-k	34.03k-n
05 Mar x BARI-2 x (30x10 cm)	86.00	3.38g-p	20.47de	6.93b-g	9.51	24.73mn	1178.00de	34.63i-l
05 Mar x BARI-2 x (40x30 cm)	86.00	2.64r-u	19.13g-i	6.50d-j	10.62	26.67jk	288.00s-u	19.54uv
05 Mar x BARI-3 x (20x20 cm)	89.00	2.60r-u	10.73z	6.15e-j	9.33	24.46n	772.70n-p	28.10pq
05 Mar x BARI-3 x (30x10 cm)	89.00	3.13k-t	11.53z	6.56c-j	10.22	25.66l	1119.00e-g	34.49i-m
05 Mar x BARI-3 x (40x30 cm)	89.00	2.85o-u	10.33z	6.53d-j	8.80	20.44r	290.30s-u	23.15st
05 Mar x BARI-4 x (20x20 cm)	85.00	2.55s-u	15.37n-q	7.21b-f	9.66	21.56q	775.30n-p	28.51p
05 Mar x BARI-4 x (30x10 cm)	85.00	2.19n-u	16.00l-p	6.15e-j	10.33	22.40p	961.00i-k	26.81p-r
05 Mar x BARI-4 x (40x30 cm)	85.00	2.91n-u	14.93q-t	6.28d-j	9.99	22.47p	288.70s-u	19.14 u-w
05 Mar x BARI-5 x (20x20 cm)	79.00	2.68q-u	19.03hi	8.67a	13.89	31.38d	835.70mn	31.40uo
05 Mar x BARI-5 x (30x10 cm)	79.00	3.20j-s	19.54f-h	7.80ab	13.00	31.53d	1117.00e-g	38.00gh
05 Mar x BARI-5 x (40x30 cm)	79.00	3.10l-t	17.50k	7.38b-d	13.44	30.44e	280.70s-u	19.86uv
05 Mar x BINA-2 x (20x20 cm)	93.00	3.25i-r	14.90q-t	6.43d-j	9.72	20.19rs	782.30uo	25.17rs
05 Mar x BINA-2 x (30x10 cm)	93.00	3.70b-l	16.33l	6.23d-j	9.04	21.45q	963.30i-k	29.44op
05 Mar x BINA-2 x (40x30 cm)	93.00	3.36g-p	14.90q-t	6.29d-j	9.55	22.23p	288.70s-u	19.96uv
20 Mar x BARI-2 x (20x20 cm)	81.00	2.34u	13.00wx	5.67h-j	9.33	23.51o	732.70o-q	31.74m-o
20 Mar x BARI-2 x (30x10 cm)	81.00	2.78p-u	13.47u-w	5.84g-j	10.33	22.43p	962.00i-k	41.74f
20 Mar x BARI-2 x (40x30 cm)	81.00	2.66q-u	12.23x-z	5.91g-j	9.00	29.71s	245.70u	16.64wx
20 Mar x BARI-3 x (20x20 cm)	83.00	2.61r-u	14.13t-v	6.20d-j	8.66	22.27p	661.70q	28.22pq
20 Mar x BARI-3 x (30x10 cm)	83.00	2.94n-u	15.00q-t	6.12f-j	8.66	22.38p	964.30i-k	41.63f
20 Mar x BARI-3 x (40x30 cm)	83.00	3.03m-t	13.57u-w	6.09f-j	9.77	22.19p	233.00u	13.37y
20 Mar x BARI-4 x (20x20 cm)	87.00	2.36u	11.70z	6.19e-j	9.55	21.26q	723.30o-q	13.29no
20 Mar x BARI-4 x (30x10 cm)	87.00	2.36u	13.18w	6.25d-j	9.66	22.31p	872.00lm	34.38j-m
20 Mar x BARI-4 x (40x30 cm)	87.00	2.50tu	11.72z	5.91d-j	8.10	20.39r	239.00u	16.27x
20 Mar x BARI-5 x (20x20 cm)	72.00	2.65q-u	13.25w	6.78b-h	8.27	20.15e	700.30pq	28.45p
20 Mar x BARI-5 x (30x10 cm)	72.00	2.85o-u	14.73q-t	6.96b-g	8.55	31.21d	961.30i-k	37.23g-i
20 Mar x BARI-5 x (40x30 cm)	72.00	2.92n-u	12.80w-y	6.21d-j	8.44	27.24h-j	259.70tu	12.78y
20 Mar xBINA-2 x (20x20 cm)	96.00	3.68c-m	12.13yz	6.33d-j	9.88	21.25q	731.70o-q	33.57l-n
20 Mar xBINA-2 x (30x10 cm)	96.00	3.84b-j	13.40vw	5.47j	8.88	22.37p	878.00lm	36.44g-k
20 Mar xBINA-2 x (40x30 cm)	96.00	3.99a-g	11.10z	5.96g-j	9.66	20.18rs	243.70u	17.40v-x
S$\bar{x}$	0.588	0.14	0.206	0.25	0.60	0.167	18.91	0.669
Level of significance	NS	0.01	0.01	0.01	NS	0.01	0.01	0.01

Means having same letter(s) in a column do not differ significantly as per DMRT. NS= Not significant

only number of seeds pod^{-1} (Table 6). The 3 February planting with combined effect of the variety BARIMung-3 and planting density of 30x10 cm showed (Table 6) the highest yield performance mainly due to the highest number of pods produced plant^{-1}. Statistically by similar results were found on 3 February planting with combined effect of both the varieties BARIMung-2 and BARIMung-4 and planting density of 30x10 cm and 18 February

planting with combined effect of both the varieties BARIMung-2 and BARIMung-3 and planting density of 30x10 cm (Table 6). The variety BINAMung-2 with combined effect of 3 February planting and a planting density of 40x30 cm produced the highest number of branches plant^{-1} might be due to more space for nutrient absorption in presence of proper soil moisture content during the growth period as shown in Table 1. Number of pods plant^{-1} was the highest in the variety BARIMung-3 planted on 18 February at a density of 30x10 cm and the lowest was found in the variety BARIMung-3 planted on 5 March at a density of 40x30 cm. Statistically the longest pods were observed on 5 March planting with combined effect of variety BARIMung-5 and planting density of 20X20 cm. Weight of 1000-seed was the highest in the variety BARIMung-5 with combined effect of 3 and 18 February planting and planting densities of 20x20 cm and 30x10 cm, respectively and the lowest in the variety BARIMung-2 with combined effect of 20 March planting and planting density of 40x30 cm (Table 6).

Harvest index was the highest on 3 February planting with combined effect of the variety BARIMung-2 and planting density of 30x10 cm might be due to the highest seed yield (Table 6) performance.

From the present study it may be concluded that 3 and 18 February planting dates were more suitable for the cultivation of varieties BARIMung-2 and BARIMung-3 at a planting density of 30x10 cm. The variety BARIMung-5 was found to produce the highest 1000 seed weight, the longest pod and the shortest growth duration.

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