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Yield and Quality of Radish Seed as Affected by Time of Sowing and Spacing

M.T. Rahman, A.K.M.A. Hossain and M.A. Rashid

Bangladesh Agricultural Research Institute,
Joydebpur, Gazipur 1701,
Bangladesh.

ABSTRACT: An experiment evaluated the effect of time of sowing and spacing on yield, yield components, and quality of radish seeds. Plant spacing and time of sowing significantly influenced most characters pertaining to seed yield per plant and quality of seeds. Days to flowering and pod maturity which ranged from 41 to 71 days and 98 to 119, days respectively were influenced by time of sowing. With delayed sowing days to flowering and pod maturity were shortened. Comparatively higher seed yield was obtained from 1st and 15 November sowing at closer spacings. The highest seed yield (1.02 t/ha) was obtained from 15 November sowing at a spacing of 30 x 15 cm which was closely followed by 15 November sowing having 30 x 30 and 15 x 15 cm spacings and 1st November sowings having 30 x 15, 15 x 15 and 45 x 30 cm spacings. There was drastic reduction in per plant seed yield when sown in December.

INTRODUCTION

Radish (*Raphanus sativus Linn.*) is a popular vegetable in both tropical and temperate regions. Radish is the third major vegetable crop in Bangladesh with respect to both area and production (BBS, 11987). The crop is raised from seeds. Inadequate supply of quality seed is the main constraint to its production. Farmers depend on imported seeds for its cultivation which is very costly and very often not available in time for sowing. Hence, production of good radish crop becomes uncertain every year. Hence radish production depends on timely availability of quality seeds in desired quantity. This is possible by improving local seed production technology.

Seed production of radish, especially of biennial type is greatly influenced by temperature (Bose and Som, 1986). It is also reported that low temperature accompanied with long day length have a remarkable influence for radish seed production (Hegiya, 1952 and Park,

1976). The high yielding radish varieties popularly cultivated in Bangladesh are of biennial type which do not produce seeds under field condition. An open-pollinated annual type variety named Tasaki san Mula-1 was released from the Bangladesh Agricultural Research Institute in 1983. It is a high yielding variety and able to produce seeds abundantly under field condition (Rashid *et al.*, 1985). Its bolting habit is influenced to a great extent by time of sowing. This study was, therefore, undertaken to find a suitable time of sowing of this variety for higher seed yield with least field duration. Plant population is another important factor which influences production of quality seeds (Hussain *et al.*, 1964); Saini *et al.*, 1982 and Singh and Singh, 1985). The information as obtained from literature leads to the inference that maximization of quality radish seed production is possible through manipulation of time of sowing and adjustment of plant population. So, the present study also included plant spacing to determine their influence on seed production.

MATERIALS AND METHODS

The study was carried out at the Bangladesh Agricultural Research Institute, Joydebpur, during November, 1987 to March 1988. The radish variety Tasaki San Mula-1 was used as the planting material. It was laid out in split plot design with four replications. The unit plot size was 3.60 x 1.8 m. There were four treatments, e.g. sowings in 1st November (T_1), 15 November (T_2), 1st December (T_3) and 15 December (T_4) and six spacings, 60 x 45(S_1), 60 x 30(S_2), 45 x 30(S_3), 30 x 30(S_4), 30 x 15(S_5) and 15 x 15 cm(S_6). Time of sowing was in the main plots and spacings in the subplots. Recommended fertilizer and crop management practices were followed. Optimal moisture condition was maintained carefully during flowering and seed development. Bamboo stick support was provided to the plants at bolting to prevent lodging. The crop was harvested when approximately 80% seed pods attained maturity (pods turned to grey colour). Harvesting continued from 1st March to 22 March, 1988. Harvested plants were hung in shed for about six to seven days for drying. Ten plants were selected at random for each plot for collection of data, such as, plant height, days to flowering and pod maturity, number of flower stalks and pods per plant, number of seeds per pod, 1000 seed weight, seed yield per plant and per cent germination. 1000 seed weight and per cent germination of seeds were considered seed quality for this

study. Germination test was conducted with seeds at 8% moisture content on moist blotting paper under room temperature (30 C).

The data were statistically analyzed and the treatment means were compared using DMRT. The mean sum of squares of all the parameters studies are presented in Table 1.

RESULTS AND DISCUSSION

Results obtained in this study are presented in Table 1, 2, 3 and 4.

Effect of time of sowing

Most of the characters studied were significantly influenced by time of sowing (Tables 1 and 2). The maximum plant height (128.0 cm) was recorded from 1st November sowing (Table 1) which was closely followed by 15 November (124.48) and first December sowing (125.5). The minimum plant heigh was obtained from 15 December sowing (103.7). The plant height obtained from 15 December planting might be due to prevailing low temperature which restricted vegetative growth of the plants. Days to flowering significantly decreased from 71 to 40 days as the date of sowing was delayed. This was expected since low temperature helps early onset of reproductive phase. Low temperature is considered to be a critical factor causing flowering in radish (Hegiya, 1952). The largest number of flowering stalks (12.0) was recorded from 1st November sowing followed by 15 November (10.9), 1st December (10.1) and 15 December sowings (10.0). Relatively warm temperature (average 23^{o}C) during first sowing encouraged vegetative growth of the plants. The temperature during the period of experimentation was shown in the Table 5. This resulted in production of larger number of flower stalks per plant. Maximum number of pods per plant (308.0) and seeds per pod (6.0) were obtained from 1st November sowing which decreased gradually as the sowing was delayed. It might be due to favourable temperature during November which encouraged maximum growth of the plants and production of larger number of leaves which, in turn, contributed to more number of pods per plant and seeds per pod. The per plant seed yield obtained from 1 November sowing (11.4 g) and 15 November sowing (11.8 g) was significantly higher than that

Table 1. Analysis of variance (as value) for different characters on seed components and seed yield of radish as influenced by time of sowing and spacing.

Sources of variation	D.F.	Mean sum of squares									
		Plant height (cm)	Days to flowering	No. of flower stalks per plant	No. of pods per plant	No. of seeds per pod	Days to pod maturity	1000 seed weight (g)	Seed yield per plant (g)	Seed yield (t/ha)	Germination (%)
Replication	3	30.39	0.94	0.31	1574.80	0.03	0.54	0.56	0.41	254.42	0.37
Time of sowing (A)	3	3077.23 ::	3945.25 ::	18.18 ::	215975.70 ::	33.79 ::	1986.81 ::	3.70 ::	375.64 ::	163009.51 ::	123.68 ::
Error	9	69.60	3.32	2.62	2024.38	0.54	1.20	0.48	1.91	6743.98	2.60
Spacing (B)	5	243.23 ::	8.33 :	49.26 ::	75143.33 ::	4.90 ::	8.94 ::	NS 0.66	203.81 ::	225093.64 ::	NS 4.04
Interaction of (A x B)	15	NS 23.52	NS 3.64	2.04 :	5112.91 ::	1.97 ::	NS 2.37	NS 0.43	15.58 ::	17180.38 ::	4.69 :
Error (B)	60	32.59	2.98	1.24	976.59	0.36	1.56	0.30	1.48	3276.75	2.19

: Significant at 5% level of probability.
:: Significant at 1% level probability.

Table 2. Effect of time of sowing on yield and yield contributing characters and quality of radish seeds.

Time of sowing	Mean sum of squares									
	Plant height (cm)**	Days to flowering **	No. of flower stalks per plant **	No. of pods per plant **	No. of seeds per pod **	Days to pod maturity **	1000 seed weight (g) **	Seed yield per plant (g) **	Seed yield (t/ha) **	Germination (%) **
1 November (T1)	128.31 A	71.33 A	12.06 A	306.94 A	6.16 A	119.50 A	11.43 B	11.45 A	0.74 B	99.11 A
15 November (T2)	124.48 A	60.71 B	10.19 B	294.45 A	6.05 A	111.54 B	11.58 B	11.80 A	0.82 A	99.88 A
1 December (T3)	125.58 A	54.88 C	10.17 B	179.26 B	5.20 B	107.13 C	11.94 AB	8.01 B	0.59 C	98.63 A
15 December (T4)	103.71 B	40.58 D	10.00 B	110.03 C	3.59 C	97.79 D	12.32 A	3.28 C	0.23 D	95.00 B

Means followed by common letters are not significantly different from each other by DMRT at 5% & 1% level.
** Indicates significant at 1% level of probability.

Table 3. Effect of spacing on yield and yield contributing characters and quality of radish seeds.

Spacing	Plant height (cm)**	Days to flowering *	No. of flower stalks per plant **	No. of pods per plant **	No. of seeds per pod **	Days to pod maturity **	1000 seed weight (g)	Seed yield per plant (g) **	Seed yield (t/ha) **	Germination (%)
60 x 45 cm (S1)	114.34 C	56.38 BC	13.24 A	313.32 A	5.55 A	108.00 C	11.65	13.77 A	0.41 E	98.81
60 x 30 cm (S2)	120.68 AB	56.13 C	11.66 B	256.66 B	5.43 A	108.81 ABC	11.95	10.43 B	0.50 D	99.00
45 x 30 cm (S3)	119.35 BC	56.56 BC	11.57 B	238.06 B	5.66 A	108.38 BC	12.10	9.90 B	0.60 C	98.19
30 x 30 cm (S4)	119.76 ABC	56.69 BC	10.66 B	235.47 B	5.68 A	109.31 AB	11.87	8.33 C	0.70 A	97.88
30 x 15 cm (S5)	125.64 A	57.50 C	9.54 C	180.59 C	4.87 B	109.38 AB	11.81	5.44 D	0.71 A	97.89
15 x 5 cm (S6)	123.64 AB	58.00 A	8.24 D	113.41 D	4.30 C	110.06 A	11.53	3.93 E	0.66 B	98.19

Means followed by common letters are not significantly different from each other by DMRT at 5% & 1% level.
* Indicates significant at 5% level of probability
** Indicates significant at 1% level of probability.

Table 4. Interaction effect of time of sowing and spacing on yield, yield components and quality of radish seeds.

Time sowing X spacing (T X S)	Plant height (cm) NS	Days to flowering NS	No. of flower stalks per plant s	No. of pods per plant ss	No. of seeds per pod ss	Days to pod maturity NS	1000 seed weight (g) NS	Seed yield per plant (g) ss	Seed yield (t/ha) ss	Germination (%) s
T1 X S1	120.50	71.75	15.20 A	447.62 A	6.20 A	117.00	11.54	17.75 A	0.51 IJ	99.25 AB
T1 X S2	127.57	71.00	13.24 B	329.14 B	6.61 A	119.50	11.93	13.64 BCD	0.61 FGH	100.00 A
T1 X S3	127.82	72.00	13.25 B	328.51 B	6.22 A	118.25	11.68	14.63 BC	0.84 BCD	99.50 AB
T1 X S4	125 75	69.25	12.25 BCD	357.44 B	6.17 A	120.50	11.45	11.31 DEF	0.78 CDE	100.00 A
T1 X S5	132.40	71.25	10.55 DEF	247.04 CD	6.11 AB	120.75	11.38	6.65 HI	0.89 BC	99.75 AB
T1 X S6	135.81	72.75	7.88 I	137.93 FG	5.61 ABCDE	121.00	10.59	4.70 IJKL	0.84 BCD	99.75 AB
T2 X S1	119.47	60.75	12.07 BCD	423.96 A	5.97 ABC	112.00	11.01	20.00 A	0.59 GHI	100.00 A
T2 X S2	122.14	59.75	10.23 EFG	316.67 B	5.97 ABC	11.50	11.74	15.13 B	0.76 DE	100.00 A
T2 X S3	122.19	60.75	10.98 CDEF	301.48 BC	6.01 ABC	110.75	12.01	10.65 EF	0.76 DE	100.00 A
T2 X S4	125.08	60.50	10.50 DEF	298.35 BC	6.47 A	111.25	11.71	11.38 DEF	0.91 B	99.50 AB
T3 X S5	129.73	61.50	9.20 FGHI	245.45 CDE	6.03 ABC	111.50	11.95	7.90 GH	1.02 A	99.75 AB
T2 X S6	128.27	61.00	8.15 HI	180.79 EF	5.82 ABCD	112.25	11.07	5.75 HIJ	0.86 BC	100.00 A
T3 X S1	122.88	54.25	12.43 BC	243.95 CDE	5.10 CDEF	106.25	11.88	12.38 CDE	0.38 K	99.25 AB
T3 X S2	126.88	53.50	11.02 CDEF	233.35 DE	5.05 CDEFG	107.00	11.97	9.18 FG	0.48 J	98.00 ABC
T3 X S3	123.55	53.50	10.50 DEF	184.73 DEF	5.65 ABCDE	107.50	12.17	9.83 FG	0.55 HIJ	99.25 AB
T3 X S4	125.53	55.25	10.80 CDEF	190.00 DEF	5.68 ABCDE	107.00	12.12	7.55 GH	0.77 DE	99.25 AB
T3 X S5	128.80	55.75	8.55 GHI	141.75 FG	5.13 ABDEF	107.25	11.76	5.00 JIK	0.69 EF	97.25 BC
T3 X S6	125.88	57.00	7.70 I	81.78 GH	4.60 FG	107.75	11.76	4.13 IJKL	0.67 FG	98.75 ABC

Table 4. (Continued)

Time sowing X spacing (T X S)	Plant height (cm) NS	Days to flowering NS	No. of flower stalks per plant *	No. of pods per plant **	No. of seeds per pod **	Days to pod maturity NS	1000 seed weight (g) NS	Seed yield per plant (g) **	Seed yield (t/ha) **	Germination (%) *
T4 x S1	94.50	38.75	13.25 B	137.75 FG	4.93 DEFG	96.75	12.16	4.97 IJK	0.16 M	96.75 L
T4 X S2	106.13	40.25	12.15 BCD	147.50 FG	4.10 G	97.25	12.15	3.80 JKL	0.17 LM	98.00 ABC
T4 X S3	103.85	40.00	11.57 BCDE	137.55 FG	4.75 EFG	97.00	12.53	4.50 IJKL	0.21 LM	94.00 D
T4 X S4	102.70	41.75	9.90 EFGH	96.10 GH	4.40 FG	98.50	12.19	3.08 KLM	0.34 K	92.75 D
T4 X S5	110.45	41.50	9.85 EFGH	88.10 GH	2.20 H	98.00	12.16	2.20 LM	0.26 L	94.25 D
T4 X S6	104.60	41.25	9.25 FGHI	53.15 H	1.15 J	99.25	12.73	1.15 M	0.21 L	94.25 D

Remarks. Means followed by common letters are not significantly different from each other DMRT at 5% and 1% level.
* Indicates significant at 5% level probability
** Indicates significant at 1% level of probability.

T1 = 1 November
T2 = 15 November
T3 = 1 December
T4 = 15 December

S1 = 60 x 45 cm
S2 = 60 x 30 cm
S3 = 45 x 30 cm
S4 = 30 x 30 cm
S5 = 30 x 15 cm
S6 = 15 x 15 cm

Table 5. Monthly air temperature, day-length and rainfall during the period from November, 1987 to April, 1988 at the experimental site at the Central Research Farm of the Bangladesh Agricultural Research Institute, Joydebpur, Gazipur.

Period of month (1987-88)	Air temperature (^{0}C)				
	Maximum	Minimum	Average	Day length (hour)	Rainfall (mm)
November	29.18	17.81	23.50	11.0	25.50
December	26.33	13.73	20.03	10.7	29.75
January	25.59	12.33	18.96	10.8	-
February	28.55	14.78	21.67	11.4	71.5
March	31.18	14.59	22.89	12.0	47.5
April	33.44	23.04	28.24	12.8	143.95

Source: Meterological Section, BARI, Joydebpur, Gazipur

of 15 December sowing (3.3 g). The lowest seed yield per plant (3.2) was obtained from 15 December sowing. This might be due to plants of short stature and smaller number of leaves in December sowing caused by prevailing low temperature (20°C). The seed yield was highest (0.82 t/ha) from 15 November sowing. It was significantly higher than the yields obtained from other treatments. The lowest seed yield (0.23 t) was obtained from 15 December sowing. Germination percentage of the seeds obtained from 15 December sowing was significantly lower than others. However the percent germination of seeds of all the sowings was within acceptable range (95–99%).

Effect of spacing

All the characters studied, except 1000 seed weight and per cent germination, were significantly influenced by different plant population per unit land (Table 3). Hussain *et al.*, (1964) reported significant effect of spacing on seed yield of radish. The highest plant height (126 cm) was recorded in 30 x 15 cm spacing. Days to flowering ranged from 56 to 58 days which gradually increased with closer spacings. Maximum number of flower stalks (13.0) were obtained from the widest spacing (60x45 cm). The number of flower stalks per plant decreased gradually with closer spacings. The lowest number of flower stalks (8.0) was recorded in 15 x 15 cm spacing. The reason for producing more flower bearing branches per plant with decreasing plant population per unit of land might be availability of more space for growth and development. Similar results were also reported by Saini *et al.*, (1982). The largest number od pods per plant (313.0) was obtained from the widest spacing (60x45 cm), and the lowest (113) at closer spacing (15 x 15 cm). Minimum number of seeds per pod (4.0) was obtained from the closer spacing (15 x 15 cm). The 1000 seed weight was found statistically similar in all the treatments. Seed yield per plant (13.7 g) was the highest in 60 x 45 cm spacing, and lowest (3.9 g) in 15 x 15 cm spacing. Seed yield of individual plants decreased with decreasing spacing. However, highest seed yield (0.71 t/ha) was obtained from closer spacing (13x15 cm). The lowest seed yield (0.41 t/ha) was obtained from the widest spacing (60 x 45 cm). Saini *et al.*, (1982); Hussain *et al.*, (1964); Brar and Kaul (1977) reported similar findings. The highest seed yield in 30 x 15 cm spacing resulted from increased plant population and the lowest yield (0.41 t/ha) in 60 x 45 cm spacing for least plant population.

There was no real difference in percent germination of seeds obtained from plants having different spacings.

Interaction effect of time of sowing and spacing

The data on interaction effect of time of sowing and plant spacing on different characters are presented in Table 3 and Figure 1. The highest seed yield per plant (20.0 g) was obtained from 15 November sowing having 60 x 45 cm spacing followed by 1st November sowing (17.7 g). The lowest seed yield per plant (1.15 g) was obtained from 15 December sowing having 15 x 15 cm spacing. However, highest seed yield (1.02 t/ha) was obtained from 15 November sowing having 30 x 15 cm spacing which was closely followed by 1st and 15 November sowings having different spacings. The seed yield was remarkably higher in 1st and 15 November sowings with closer spacings. The finding of this study led to recommend sowing of radish seeds by mid November with 30 x 15 cm spacing. The interaction in respect of per cent germination of seeds obtained from different treatment was significant. However, percent germination ranged from 92 – 100. The lowest acceptable germination percentage of radish seed was reported to be 75% (Rashid, 1976). So, delay in planting reduces the seed yield but percent germination of seeds remains within acceptable range.

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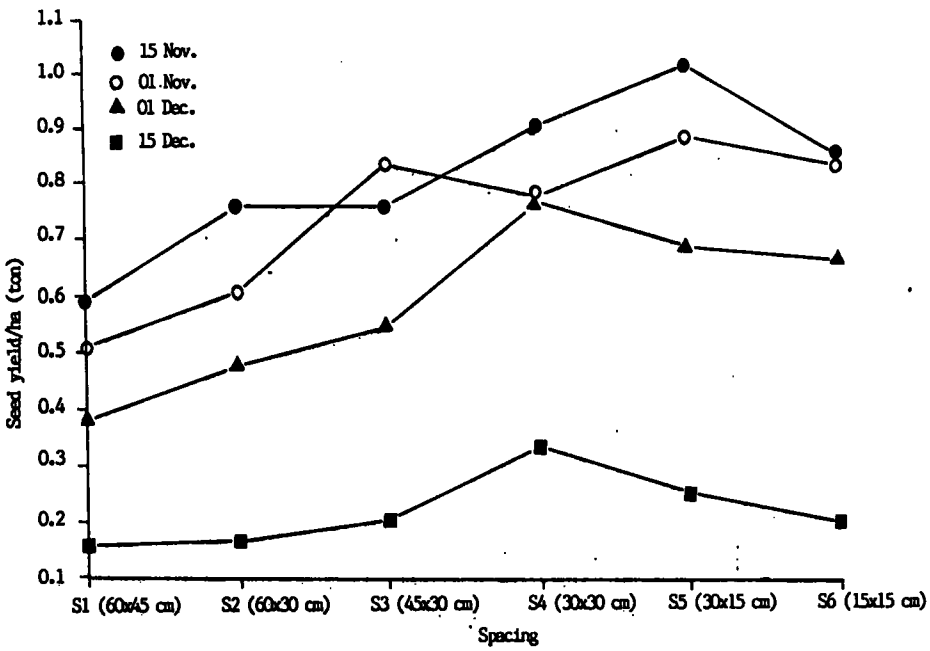

Fig. 1. Interaction effect of time of sowing and spacing on seed yield/ha.

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