

Seed Yield and Quality of Okra as Influenced by Sowing Time and Plant Spacing under Farmer's Situation in Northwest Bangladesh

M.M. UDDIN, M.F. MONDAL¹, S. SAMSUZZAMAN² AND M.A. SIDDIQUE¹

HRC, BARI, ¹Bangladesh Agricultural University, Mymensingh and ²RDRS Bangladesh, Rangpur

ABSTRACT An experiment was conducted in the farmers' field at Ghagot Para, Rangpur Sadar, Bangladesh during February to October 2003 as a collaborative programme of BARI and RDRS to observe the influence of sowing time and plant spacing on the growth, seed yield and quality of okra. Five sowing times, starting from February to June (15th of each month) and three different plant spacing (60 cm x 30 cm, 60 cm x 40 cm and 60 cm x 50 cm) were used as treatment variables. The highest seed yield was recorded from April sowing (1514.88 kg/ha) and the quality seed was also produced from the same sowing time (84.56% germination and 27.02 seed vigour index). The plants spaced at 60 cm x 40 cm produced the highest seed yield (1043.96 kg/ha) compared to other two tested spacings, but the best quality seed (74.00% germination and 23.79 seed vigour index) was obtained from the wider spacing (60 cm x 50 cm). Regarding combined effect, the highest seed yield was obtained from April sowing with 60 cm x 40 cm plant spacing (1609.63 kg/ha) and that of the lowest from February sowing with 60 cm x 30 cm plant spacing (325.37 kg/ha).

Key words: Seed yield, quality, sowing time, okra

Okra (*Abelmoschus esculentus* L. Moench) is an annual vegetable crop grown by botanical seed in tropical and sub-tropical parts of the world [1]. It is one of the important vegetable crops of Bangladesh grown during the summer and rainy season [2]. It is also a nutritious vegetable and plays an important role to meet the demand of vegetables of the country when vegetables are scanty in the market [3]. But in the country, total production and per hectare yield of okra are very low compared to other countries of the world [4, 5]. There are several reasons behind this low yield, among them non-availability of quality seed is the fore most one. Sowing time has a great impact on production and quality of okra seed [6]. It has been reported that higher and quality seed yield was obtained when planted during April in southern part of Bangladesh [7]. Plant spacing of okra, has a great influence on its seed production [8]. It has been reported that higher seed yield of okra may be achieved by sowing seed at closer

spacing [9]. Hossain et al. [7] was in favour of closer spacing for higher seed yield in southern part of Bangladesh, but the optimum time of sowing and plant spacing for seed production of okra (BARI Dherosh-1) in northwest Bangladesh under farmers' situation are not yet standardized. The northwest part of Bangladesh is located at 24°50'-26°30'N latitude and 88°20'-89°77'E longitudes having mostly high and medium high land. Soil texture is silty loam to clay and clay loam with pH range 4.5-6.5 [10]. Average maximum temperature is 32.9°C and minimum is 10.2°C (average of last 10 years) and annual rainfall 1800-2400 mm with relatively early onset and late cessation. Generally a wide gap always prevails between on-station and on-farm results of any technology due to differences in managements, input use, agro-ecology, etc. The management practices and input use are likely to be influenced by various socio-economic factors such as, farmers' age, education, occupation, experience in farming,

resource base, family size, access to information, physical infrastructure, demand of the family, market, etc. [11]. To minimize the gap between on-station and on-farm yields, and for rapid dissemination and adoption of developed technologies through fine-tuning, experimentation under farmers' situation is crucially needed. Therefore, the present study was designed to establish the suitable sowing time and optimum plant spacing for higher seed yield and quality of okra, variety BARI Dherosh-1 under farmers' situation.

MATERIALS AND METHODS

The experiment was conducted in the farmers' field at Ghagot Para of Darsona Union under Rangpur Sadar (Bangladesh) during February 2003 to October 2003 as a collaborative programme of Bangladesh Agricultural Research Institute (BARI) and Rangpur Dinajpur Rural Service (RDRS). The seeds of okra (BARI Dherosh-1) having virus tolerance and higher yield were used as the planting material. The experiment was laid out in split-plot design with three replications. The treatments were in two sets, such as, (a) five sowing times viz., 2nd week of each month starting from February to June and (b) three plant spacing viz., 60 cm x 30 cm, 60 cm x 40 cm and 60 cm x 50 cm. The sowing times were considered as the main plot treatments and the plant spacing were kept under sub-plot. The unit plot size was 6.0 m x 3.0 m. Manures and fertilizers were used as per BARC fertilizer recommendation guide [12]. Three to four seeds were sown per hill and after germination 2 healthy seedlings were kept. After 12-15 days of sowing (attaining 5-6 leaves stage) comparatively one weak seedling was removed from each hill keeping the healthy and vigorous one for equal plant growth in the plot. Irrigation, drainage, different intercultural operations and plant protection measures were done as and when needed. Twenty plants from the middle three lines of each plot were randomly selected for data collection. Fruits were harvested periodically at their mature stages, when they turned brown but prior to shattering. Twenty fruits of each plot were selected randomly from each harvesting. After proper sun drying the sample fruits of all harvestings for a particular treatment were

gathered and stored in quality gunny bag. After one month of last harvesting, the seeds were extracted from the mature fruits and the relevant data like number of seeds per fruit, 1000-seed weight, seed yield per plant and per hectare etc. were recorded and calculated. After extracting the seeds of all the plots, 100-seeds from each treatment were taken for germination and vigour tests that were conducted during October 2003. The germination test was carried out by sand method in plastic pots. The seed vigour was measured through its speed of germination. The germinated seeds were counted every day until germination is completed. An index of the speed of germination was then calculated by adding the quotients of the daily counts divided by the number of days of germination using the formula [13] as below:

$$\text{Seed vigor index (SVI)} = \frac{X_1}{D_1} + \frac{X_2}{D_2} + \dots + \frac{X_n}{D_n}$$

Where, X_1, X_2, \dots, X_n are the number of seeds germinated and D_1, D_2, \dots, D_n are the number of respective days of seed germination. Thus the seeds with higher index has faster germination rate and would be considered higher in vigour.

The recorded data were analyzed statistically and the means were compared by LSD method. The effective seed yield was calculated by using the following formula:

$$\text{Effective seed yield (kg/ha)} = \frac{\text{Seed yield (kg/ha)} \times \text{Germination (\%)}}{100}$$

RESULTS AND DISCUSSION

Effects of sowing time

Sowing time significantly influenced all the parameters under study (Table 1). Days required for seedling emergence ranged from 5 to 17 and the earliest (5 days) emergence was observed in May and June sowing whereas, the maximum time (17 days) required in February sown crop. Seeds of May and June sowing emerged in minimum days, might be due to prevailing favourable environment, whereas, in February sowing emerged in maximum days might be due to the prevalence of lower temperature (Fig. 1). Days required for 50 per cent flowering ranged from 31 to 51. The earliest

Table 1. Effects of sowing time on seed yield and quality of okra

Sowing time	Days to 80% seedling emergence	Days to 1st flowering	Days to harvest (mature fruit)	Plant height (cm)	Mature fruits/plant (no.)	Length of mature fruit (cm)	Breadth of mature fruit (cm)	Seeds/fruit (no.)	1000-seed weight (g)	Seed yield/plant (g)	Seed yield/ha (kg)	Germi-nation (%)	Seed vigour index (SVI)	Effective seed yield (kg/ha)
February 15	17	51	80	53.7	07	13.36	1.37	32	49.90	11.43	381.98	56.89	12.77	217.31
March 15	07	43	75	107.3	13	17.93	1.64	48	59.89	37.92	1313.58	79.89	26.07	1049.42
April 15	06	34	70	145.6	14	20.51	1.93	51	61.02	43.76	1514.88	84.56	27.02	1280.98
May 15	05	31	75	121.6	11	18.23	1.64	42	59.53	29.93	965.00	76.78	23.66	740.93
June 15	05	35	78	89.1	09	15.59	1.41	37	51.08	17.89	630.55	67.78	18.68	427.39
LSD (0.05)	0.28	0.47	1.49	2.22	0.79	0.57	0.03	0.98	0.68	1.45	30.66	0.98	0.81	-
CV (%)	3.30	1.10	1.80	2.00	6.70	3.00	1.50	2.20	1.10	4.80	2.90	1.20	3.50	-

Table 2. Effects of plant spacing on the seed yield and quality of okra

Plant spacing (cm)	Days to 80% seedling emergence	Days to 1st flowering	Days to harvest (mature fruit)	Plant height (cm)	Mature fruits/plant (no.)	Length of mature fruit (cm)	Breadth of mature fruit (cm)	Seeds/fruit (no.)	1000-seed weight (g)	Seed yield/plant (g)	Seed yield/ha (kg)	Germi-nation (%)	Seed vigour index (SVI)	Effective seed yield (kg/ha)
60 x 30	8	39	75	108.7	8	15.99	1.50	38	54.25	18.65	857.37	72.27	18.68	619.62
60 x 40	8	39	76	103.1	11	17.25	1.62	43	56.76	29.82	1043.96	73.27	22.44	764.91
60 x 50	8	39	76	98.6	13	18.13	1.68	45	57.84	35.49	982.26	74.00	23.79	726.87
LSD (0.05)	NS	NS	NS	2.09	0.40	0.40	0.03	0.67	0.72	0.61	12.98	0.88	0.46	-
CV (%)	8.80	2.30	1.90	2.60	4.80	3.10	2.10	2.10	1.70	2.90	1.80	1.60	2.80	-

flowering (31 days) occurred in May sowing whereas, the latest (51 days) in February sowing. Days to first harvesting were minimum (70) in April sowing followed by May sowing (75) whereas, the February sowing required the maximum days (80). Significantly the maximum plant height (145.6 cm) was obtained from April sowing whereas, the minimum plant height was recorded from February sowing (53.7 cm). The minimum plant height in February sowing might be due to prevailing low temperature, which ultimately restricted the vegetative growth of the plants. The highest number of mature fruits was obtained in April sowing (14/plant) which was identical with March sowing (13/plant) and the lowest in February sowing (7/plant). The mature fruits of April sowing showed the highest length (20.51 cm) and breadth (1.93 cm). The number of seeds per fruit was ranged from 32 (February) to 51 (April). The weight of 1000-seeds was the highest in April sowing (61.02 g) whereas, the lowest in February sowing (49.90 g). The highest seed yield was recorded from April sowing (43.76 g/plant and 1514.88 kg/ha) followed by March sowing (37.92 g/plant and 1313.58 kg/ha). The lowest seed yield was obtained from February sowing (11.43g/plant and 381.98 kg/ha).

The seeds obtained from April sowing produced the best quality seed (84.56% germination and 27.02 SVI) followed by March sowing (79.89% germination and 26.07 SVI). February sowing produced the inferior seed (56.89% germination and 12.77 SVI). The highest germination per cent of the seeds obtained from April sowing might be due to better environment i.e., optimum temperature and

no excessive rainfall (Fig. 1) prevailed during its harvesting, drying and seed processing period. The inferior quality seeds of February sowing might be due to the improper vegetative growth and development of plants. The prevailing lower temperature and foggy weather caused pests and diseases infestations leading to lower yield and inferior quality seeds. Comparatively, inferior quality seeds were obtained from May (76.78% germination; 23.66 SVI) and June (67.78% germination; 18.68 SVI) sowing which might be due to excessive rainfall prevailed during their harvesting and processing period. The present findings are in agreement with Hossain et al. [7] who recommended that April was the best time for quality seed production of okra for southern region of Bangladesh. Palanisamy et al. [14] observed that the best quality seed of okra cv. Pusa Sawani was obtained through planting during March, April and May at Tamil Nadu Agricultural University, India. The findings also partially corroborate with that of Huda and Samiruddin [15] who reported that mid March is the best time for quality seed production of okra under Bangladesh situation. Mondal et al. [16] obtained the highest seed yield of okra cv. Pusa Sawani planted on April 20 at Kalyani, West Bengal. Passam et al. [17] conducted similar trials on okra with the cultivars Boyiatiou and Veloudo for seed during 1993 and 1996 at Agricultural University of Athens, Greece and obtained the higher yield with quality seeds when planted in March. The estimated effective seed yield was highest in April sowing (1280.98 kg/ha) followed by March sowing (1049.42 kg/ha) and that of the lowest was observed in February sowing (217.31 kg/ha).

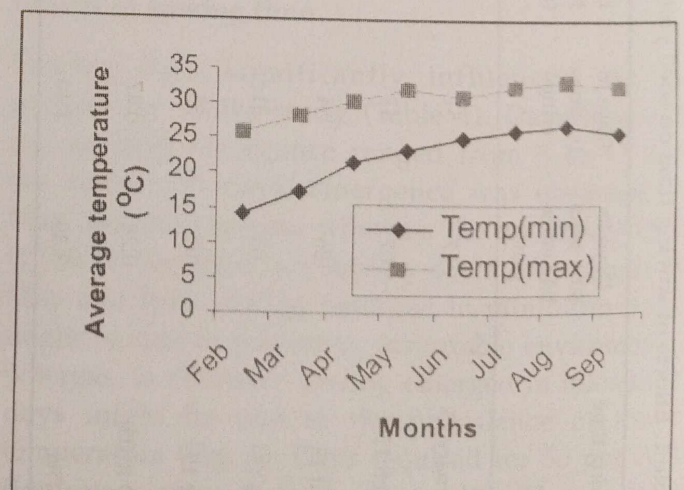
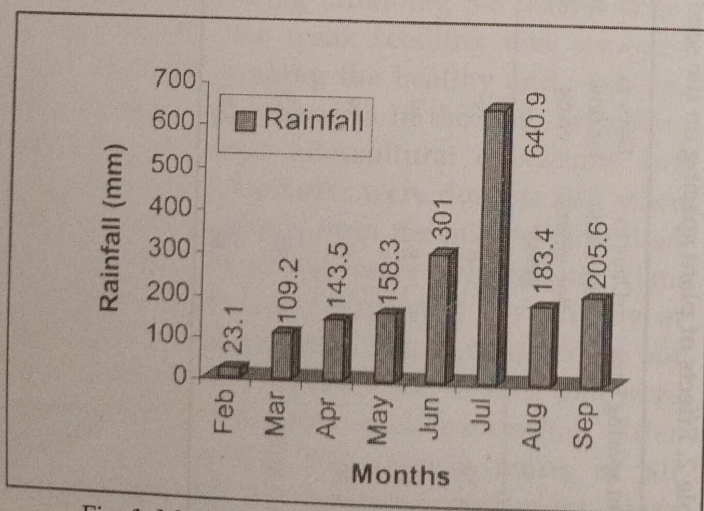


Fig. 1. Monthly rainfall (mm) and average maximum and minimum temperature (°C) during experimentation

Effects of plant spacing

Plant spacing significantly affected the plant height, number of mature fruits per plant, length and breadth of mature fruit, number of seeds per fruit, 1000-seed weight, seed yield and seed quality (Table 2). It was observed that the closest spacing (60 cm x 30 cm) increased only the plant height but reduced all other parameters. The spacing had no significant influence on days to seedling emergence, days to first flowering and days to first harvesting of mature fruits. Hossain et al. [7] and Rastogi et al. [18] had the similar findings. The highest seed yield (35.49 g/plant) was obtained from the plants having 60 cm x 50 cm spacing, whereas, the lowest (18.65 g/plant) in 60 cm x 30 cm spacing. The seed yield/ha (1043.96 kg) was the highest in plants spaced at 60 cm x 40 cm followed by 60 cm x 50 cm spacing (982.26 kg). The highest seed yield per unit area was associated with the closer spacing leading to accommodation of higher number of plants and more number of fruits/plant. The similar result was reported from India by Rastogi et al. [18] having the plants spaced at 60 cm x 40 cm. The lowest seed yield (857.37 kg/ha) was obtained from the plants having 60 cm x 30 cm spacing, which might be due to the lowest number of fruits (8/plant) and seeds (38/fruit) and the lowest weight (54.25g) of 1000-seed. Bisen et al. [19] reported from India that the highest number of seeds/fruit was obtained from the plants spaced at 60 cm x 45 cm, is in partial agreement with the present findings. Mondal et al. [16] obtained the highest seed yield of okra cv. Pusa Sawni having planting spacing of 60 cm x 45 cm at Kalyani, West Bengal. The estimated effective seed yield (764.91 kg/ha) was highest in plants spaced at 60 cm x 40 cm, whereas, the lowest (619.62 kg/ha) was at 60 cm x 30 cm spacing.

Interaction effect of sowing time and plant spacing

Most of the parameters varied significantly under study due to interaction of sowing time and plant spacing (Table 3). The plant height was the maximum (150.6 cm) in April sowing with 60 cm

x 30 cm spacing and the minimum (48.7 cm) in February sowing with 60 cm x 50 cm spacing. The highest number of mature fruits (16/plant) was obtained from April sowing with 60 cm x 50 cm spacing followed by March sowing with the similar spacing (15/plant). Hossain et al. [7] observed the similar results in okra seed production with cv. BARI Dherosh-1 in the southern part of Bangladesh. The lowest number of fruits (5/plant) was observed from the plants sown in February spaced at 60 cm x 30 cm. Almost similar trends were observed in length and breadth of mature fruits, number of seeds/fruit and 1000-seed weight.

The highest seed yield was obtained from April sowing with 60 cm x 40 cm spacing (1609.63 kg/ha), which was significantly different from other treatments. February sowing with 60 cm x 30 cm spacing gave the minimum seed yield (325.37 kg/ha). It might be due to prevailing lower temperature that ultimately restricted the vegetative growth and later developments of the plants in their respective field trial in southern part of Bangladesh. Hossain et al. [7] obtained the highest seed yield of okra cv. BARI Dherosh-1 in April sowing with closer (60 cm x 30 cm) spacing. April sowing with 60 cm x 50 cm spacing produced the best quality seed (85.33% germination and 29.23 SVI) followed by the similar sowing time with 60 cm x 40 cm spacing (84.33% germination and 28.37 SVI). February sowing with closer spacing (60 cm x 30 cm) produced the inferior quality seeds (56.67% germination and 11.07 SVI).

From the above observations and discussions it may be concluded that for higher yield and quality seed of okra BARI Dherosh-1, seeds should be sown in mid April with spacing 60 cm x 40 cm. In favour of April planting the farmers put some arguments, which are: (i) prevalence of favourable environment for proper growth and development of plants, (ii) less production costs due to less infestation of pests, (iii) scope for improvement of existing cropping pattern (Potato-Jute-T.aman rice) through introduction of new crop in the cropping pattern (Potato-Okra seed-T.aman rice).

Table 3. Interaction effects of sowing time and plant spacing on the seed yield and quality of okra

Sowing time	Plant spacing (cm)			Plant spacing (cm)		
	60x30	60x40	60x50	60 x 30	60x40	60x50
	Plant height (cm)			Mature fruits/plant (no.)		
February 15	50.5	53.8	48.7	05	07	09
March 15	113.4	106.7	101.7	10	13	15
April 15	150.6	145.7	140.6	11	14	16
May 15	127.4	120.8	116.6	08	12	13
June 15	93.5	88.7	85.3	07	10	11
	CV (%) = 2.60; LSD (0.05) = 6.35			CV (%) = 4.80; LSD (0.05) = 1.36		
	Seeds/fruit (no.)			1000-seed weight (g)		
February 15	29	33	34	48.33	50.00	51.37
March 15	44	49	51	57.80	60.32	61.57
April 15	46	53	53	59.17	61.50	62.40
May 15	37	44	46	57.60	60.07	60.93
June 15	33	38	40	48.37	51.93	52.93
	CV (%) = 2.10; LSD (0.05) = 2.12			CV (%) = 1.70; LSD (0.05) = 2.16		
	Seed yield/plant (g)			Seed yield/ha (kg)		
February 15	6.54	12.09	15.68	325.37	422.41	398.15
March 15	26.28	39.67	47.81	1176.67	1413.70	1350.37
April 15	30.87	46.41	54.00	1426.85	1609.63	1508.15
May 15	17.74	31.71	37.35	811.30	1080.93	1002.78
June 15	11.83	19.22	22.60	546.67	693.15	651.85
	CV (%) = 2.90; LSD (0.05) = 2.20			CV (%) = 1.80; LSD (0.05) = 46.62		
	Germination (%)			Seed vigour index (SVI)		
February 15	56.67	57.33	56.67	11.07	12.73	14.50
March 15	79.00	79.67	81.00	22.90	27.07	28.23
April 15	84.00	84.33	85.33	23.47	28.37	29.23
May 15	75.33	77.00	78.00	21.03	24.13	25.80
June 15	66.33	68.00	69.00	14.93	19.90	21.20
	CV (%) = 1.60; LSD (0.05) = 2.70			CV (%) = 2.80; LSD (0.05) = 1.52		

REFERENCES

- THAKUR, M.R. & S.K. ARORA (1986). Okra. In: T.K. Bose and M.G. Som (eds.) *Vegetable Crops in India*. Naya Prokash, Calcutta, pp. 610-618.
- RAZZAQUE, M.A., M.A. SATTAR, M.S. AMIN, M.A. QUAYUM & M.S. ALAM (2000). *Krishi Projukti Hatbai*. 2nd edition. Bangladesh Agricultural Research Institute, Gazipur, Bangladesh, p. 464.
- AHMAD, K.U. (1995). *Phul-Phal O Shak-Shabji* (In Bangla). 5th edition. Mrs. Momtaj Kamal. Mirpur, Dhaka, Bangladesh.
- BBS (2000). *Monthly Statistical Bulletin of Bangladesh* (October). Bangladesh Bureau of Statistics, Ministry of Planning, Government of People's Republic of Bangladesh, Dhaka.
- YAMAGUCHI, M. (1998). *World Vegetables - Principles, Production and Nutritive Values*. Van Nostrand Reinhold, New York, USA. p. 415.
- SINGH, K.P., Y.S. MALIK, S. LAL & M.L. PANDITA (1986). Effect of planting dates and spacing on seed production of okra (*Abelmoschus esculentus* (L.) Moench). *Haryana J. Hort. Sci.*, 15(3-4): 267-271.
- HOSSAIN, M.D., M.A. SALAM, M.S. ISLAM & M.A.T. MASUD (1999). Yield and quality of okra (BARI Dherosh-1) seed as influenced by time of

- sowing and plant spacing. Bangladesh J. Seed Sci. & Tech., 3(1&2): 83-87.
8. ABSAR, N. & M.A. SIDDIQUE (1982). Influence of plant density on the yield of three varieties of okra. Bangladesh J. Agric., 7(3-4): 15-21.
 9. KHAN, A.R. & R.C. JAISAL (1988). Effects of nitrogen, spacing and green fruit pickings on the seed production of okra (*Abelmoschus esculentus* L. Moench). Vegetable Sci., 15(1): 8-14.
 10. SRDI (SOIL RESOURCE DEVELOPMENT INSTITUTE) (1998). District soil survey report. Dhaka, Bangladesh.
 11. ALAM, Q.M., M.A. RASHID & A.S.M.A. HUQ (1998). An investigation into the yield gap of mustard in selected districts of Bangladesh. Bangladesh J. Agri. Res., 20(2): 105-114.
 12. FRG (FERTILIZER RECOMMENDATION GUIDE) (1997). Bangladesh Agricultural Research Council (BARC). Farmgate, Dhaka, Bangladesh.
 13. AGRAWAL, R.L. (1995). Seed Technology. Second edition. Oxford & IBH Publishing Co., New Delhi.
 14. PALANISAMY, V., K. VANANGAMUDI, T. JAYARAJ & T.V. KARIVARATHARAJU (1986). Influence of date of sowing and spacing on seed quality in bhendi (*Abelmoschus esculentus* (L.) Moench). South Indian Hort., 34(1): 23-25.
 15. HUDA, M.N. & M. SAMIRUDDIN (1987). Vegetable Seed Technology in Bangladesh. First Publication. BADC, Dhaka, p. 282.
 16. MONDAL, B., S.C. MALIK & T.K. MAITY (1989). Effects of sowing date and spacing on the growth and yield of okra. Crop Res. Hisar, 2(2): 230-231.
 17. PASSAM, H.C., K. AKOUMIANAKIS & A. SARIGIANMDI (1998). The effect of time of sowing on the production of okra (*Hibiscus esculentus* L.) seed in the Mediterranean region. Plant Varieties & Seeds, 11(3): 145-150.
 18. RASTOGI, K.B., P.P. SHARMA, N.P. SINGH & B.N. KORLA (1987). Effect of different levels of nitrogen and plant spacing on seed yield of okra (*Abelmoschus esculentus* (L.) Moench). Vegetable Sci., 14(2): 120-123.
 19. BISEN, R.K., J. SURENDRA, C.S. BISEN & S. JOGDAND (1994). Effect of sowing dates and spacing on the yield of okra seed (*Abelmoschus esculentus* (L.) Moench). Advances in Plant Sci., 7(2): 244-250.