The Pharma Innovation Journal 2022; 11(7): 2274-2278

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(7): 2274-2278

www.thepharmajournal.com
Received: 08-05-2022
Accepted: 18-06-2022

RH Chaudhari
M.Sc. Sholar, Department of Vegetable Science, College of Horticulture, Dapoli, Ratnagiri, Maharashtra, India

PC Mali
Department of Horticulture, Associate professor, College of Horticulture, Dapoli, Ratnagiri, Maharashtra, India

YR Parulekar
Department of Horticulture Assistant professor, College of Horticulture, Dapoli, Ratnagiri, Maharashtra, India

BR Salvi
Department of Horticulture Head & Associate Dean, College of Horticulture, Dapoli, Ratnagiri, Maharashtra, India

SG Mahadik
Vegetable Breeder & Vegetable improvement scheme, central experimental station Wakvali, Ratnagiri, Maharashtra, India

Corresponding Author:
RH Chaudhari
M.Sc. Sholar, Department of Vegetable Science, College of Horticulture, Dapoli, Ratnagiri, Maharashtra, India

Effect of consecutive sowings and spacing on growth and yield of Amaranthus

RH Chaudhari, PC Mali, YR Parulekar, BR Salvi and SG Mahadik

Abstract
An investigation was carried out at the College of Horticulture, Dapoli, Ratnagiri (Dist.), during the period Rabi season to study the effect of consecutive sowings and spacing on growth and yield of amaranthus. The study was conducted with three consecutive sowings of radish *viz.* C_1- Sowing during second fortnight of October., C_2-Sowing during second fortnight of November and C_3- Sowing during second fortnight of December *viz.*, T_1-20 cm spacing between two rows., T_2-30 cm spacing between two rows., T_3-40 cm spacing between two rows and T_4-Broadcasting. The C_1 *i.e.* (Sowing during second fortnight of October), C_2 *i.e* (Sowing during second fortnight of November) observed better performance in number of leaves and average leaf area However, C_3 *i.e.*, sowing during second fortnight of December was performed better and found significantly superior over other sowing time in respect of weight of per plant and yield per plot. However, days to germination, plant height, dry matter of leaves and ascorbic acid content was found significantly superior in C_1 *i.e.*, sowing during second fortnight of October. In respect of spacing, the spacing T_1 *i.e.*, 20 cm row spacing was found significantly superior in plant height and average leaf area while, the spacing T_3 *i.e.*, 40 cm row spacing significantly superior in dry matter of leaves, however the spacing T_4 *i.e*, broadcasting significantly superior in yield per plot. In respect of interaction of consecutive sowings and spacing, the treatment combination C_1T_3 was found significantly superior in plant height while, average leaf area was and highest yield per plot was found in C_3T_1 and the maximum dry matter of leaves was found in C_1T_4. Hence, the treatment C_1T_3 (October sowing with 40 cm row spacing) was found to be most profitable.

Keywords: Amaranthus, consecutive sowings, spacing, yield

Introduction
Amaranthus (*Amaranthus spp*.) is belonging to the family Amaranthaceae originated from India or Indo Chinese region. It is extensively cultivated throughout India during summer and rainy season for its leaves and grains. Amaranthus is one of the forgotten food crops of the world and also called as Gentle Giant. It is often described as 'poor-man's vegetable' or 'poor-man's spinach' (Sekar, 2010) [14]. Many compounds and extracts from amaranth possessed anti-diabetic, antioxidant and antimicrobial activity (Anon., 2010) [2]. The tender green leaves are used as vegetable and considered as purgative.

The scientific vegetable production reveals the significance and importance of sowing time and spacing to get higher production of good quality vegetables. In vegetables, spacing is a non-monetary input, but it plays a vital role by changing the magnitude of competition. Uniform distribution of crop plants over an area results in efficient use of nutrients, moisture, and suppression of weeds leading to high yield. Farmer has to adapt intensive repeated cultivation by consecutive sowing of these crops in same piece of land because of the scattered land and scanty irrigation. The effect of such consecutive sowing on the growth of leafy vegetables have not been studied so for. The studies on the aspects of consecutive sowings of leafy vegetable in same piece of land as it may affect the growth and yield of these crops and further the herbage yield is directly related with the production of leafy vegetables per unit area as well as the returns from these crops.

Hence, considering the importance of these aspects the present investigation was taken on amaranthus at College of Horticulture, Dapoli, Ratnagiri (Dist.) during the *rabi* season to determine the suitable sowing time and optimum spacing in order to have maximum vegetative growth and higher yield.

Materials and Methods

A field experiment was conducted at Experimental field of College of Horticulture, Dapoli. Dist. Ratnagiri during *rabi* season, 2020-2021. The experiment was designed to study the effect of consecutive sowings and spacing on growth and yield of amaranth. The experiment was laid out in a factorial randomised block design with three replications having 12 treatment combinations. The treatments comprised of the combination of four consecutive sowings (C_1- Sowing during second fortnight of October., C_2-Sowing during second fortnight of November and C_3- Sowing during second fortnight of December and four row spacings (T_1-20 cm spacing between two rows., T_2-30 cm spacing between two rows., T_3-40 cm spacing between two rows and T_4-Broadcasting)

The beds (3.6 m x 1.8 m) were prepared and fertilizers were applied to the experimental plot according to recommended dose. Seeds were sown in well-prepared land by opening small shallow furrows with pick axe. The furrows were made according to the spacing *i.e.*, in T_1 plot, 20 cm spacing between rows was maintained due to which 18 rows were obtained likewise in T_2 (30 cm spacing between two rows) 12 rows and in T_3(40 cm spacing between two rows) 9 rows were obtained. In T_4 plot seeds were broadcasted uniformly. After emergence of seedling, other intercultural operations like weeding, irrigation were followed as per recommendation for better growth and development of the plant. The observations were recorded on growth and yield parameters and data was analyzed by using the standard methods as described by Panse and Sukhatme (1995).

Result and Discussion

Table 1: Effect of consecutive sowings, spacing and their interactions on days to germination and plant height at harvest (cm) of amaranthus.

Consecutive Sowings	Days to germination					Plant height at harvest (cm)				
	Row Spacing									
	T_1	T_2	T_3	T_4	MEAN	T_1	T_2	T_3	T_4	Mean
C_1	3.60	3.54	3.61	3.71	3.61	37.30	36.36	31.91	26.31	32.97
C_2	4.36	4.32	4.74	4.53	4.48	30.82	28.16	28.52	25.21	28.18
C_3	5.56	5.57	5.28	5.44	5.45	31.80	30.13	31.66	27.26	30.21
MEAN	4.51	4.48	4.53	4.56	4.52	33.31	31.55	30.70	26.26	30.45
	S.Em±		CD at 5%		F-test	S.Em±		CD at 5%		F-test
C	0.13		0.39		SIG	1.07		1.34		SIG
T	0.15		0.45		NS	1.23		1.54		SIG
CXT	0.27		0.78		NS	2.13		2.67		SIG

Days to germination

It is clearly seen from table 1 the effect of consecutive sowings on the average mean number of days to germination of amaranthus was found to be significant. The minimum days to germination were recorded in C_1 (3.61) while, maximum days to germination were recorded in C_3 (5.45).The crop under study showed maximum days to germination were recorded in C_3,this may be due to decrease in minimum temperature during 3rd sowing as a result of which seed germination period was increased. Similar result of effect of temperature on germination were reported by Jyrwa *et al.* (2016) [3]. The effect of spacing on the average mean number of days to germination of amaranthus was found to be non-significant. The minimum days to germination were recorded in T_2 (4.48) while, the maximum days to germination were recorded in T_4 (4.56). In case of effect of spacing, non-significant results were observed on days to germination. This might be due to the fact that different spacing's took same number of days to germinate because of factors like soil moisture, temperature, seed vigour and dormancy of seed which usually influence the days to germinate. This is in agreement with the findings of Pervez *et al.* (2004) [122], Lavanya *et al.* (2017) [6, 7] and Prasad *et al.* (2020) [13]. The interaction effect between consecutive sowings and spacing showed non-significant effect on the average mean number of days to germination of amaranthus. The minimum days to germination were recorded in C_1T_1 (3.60) while, the maximum days to germination were recorded in C_3T_2 (5.57).

Plant Height (cm)

It is clearly indicated that the effect of consecutive sowings on plant height was found significant. The treatment C_1 (32.97 cm) recorded significantly maximum plant height at harvest whereas, the minimum plant height was recorded in C_2 (28.18 cm). A significant variation was observed on plant height in spacings. The maximum plant height was recorded in T_1 (33.31 cm) whereas, the minimum plant height was recorded in T_4 (26.26 cm). Similar results were obtained by and Pandita *et al.* (1994) [9] and Sharma *et al.* (2016). They stated that closure spacing limits the availability of space for lateral growth, resulting in increased plant height. The interaction effect on plant height was found to be significant. The maximum plant height of amaranth was recorded in C_1T_1 (37.230 cm) whereas, the minimum was recorded in C_2T_4 (25.21 cm). The results obtained in the first sowing with closer spacing might be due to availability of more nutrients during first sowing which might have decreased during subsequent first sowing and also can be attributed because of closer spacing and competition for lights. Similar trends of result also obtained by Lavanya *et al.*, (2017) [6, 7].

Table 2: Effect of consecutive sowings, spacing and their interactions on number of leaves at harvest and average leaf area (cm^2) at harvest of amaranthus.

Consecutive Sowings	Number of leaves (at harvest)					Average leaf area (cm^2) at harvest				
	Row Spacing									
	T_1	T_2	T_3	T_4	Mean	T_1	T_2	T_3	T_4	Mean
C_1	8.43	8.40	9.01	8.99	8.71	135.31	140.04	173.33	141.19	147.47
C_2	7.01	7.51	7.03	6.90	7.11	242.91	129.06	233.30	69.53	168.70
C_3	10.96	11.21	10.30	10.43	10.72	222.68	214.30	272.34	174.34	220.91
MEAN	8.80	9.04	8.78	8.77	8.85	200.30	161.13	226.32	128.35	179.03
	S.Em±		CD at 5%		F-test	S.Em±		CD at 5%		F-test
C	0.37		1.09		SIG	8.75		25.65		SIG
T	0.43		1.25		NS	10.10		29.62		SIG
CXT	0.74		2.17		NS	17.49		51.3		SIG

Number of leaves

Consecutive sowing had significant influenced on the number of leaves of amaranth at harvest. The maximum number of leaves were observed in C_3 (10.72) and the minimum number of leaves were recorded in C_2 (7.11). It is reported from the data the effect of spacing on number of leaves of amaranthus was found to be non-significant. The maximum number of leaves were recorded in T_2 (9.04) whereas, the minimum number of leaves were recorded in T_4 (8.77). Row spacing did not show any significant effect on the number of leaves per plant. Similar results were reported by Prasad (2020) [13]. The interaction effect of consecutive sowings and spacing showed non-significant variation on number of leaves. However, the maximum number of leaves were recorded in C_3T_2 (11.21) and the minimum were recorded in C_2T_4 (6.90). The maximum number of leaves might be due to maximum nodes produced because of favourable climatic conditions prevailing during the season of sowing and availability of enough space for vertical as well as horizontal expansion of the plant in wider spacing than in the closer spacing. Similar trends with respect to sowing time, spacing and interaction have been obtained by Lavanya *et al.* (2017) [6, 7].

Average leaf area (cm^2)

The data indicated that the effect of consecutive sowings on average leaf area of amaranth at harvest was found to be significant. The maximum average leaf area of amaranthus was observed in C_2 (220.91 cm^2) whereas, the minimum average leaf area was recorded in C_1 (147.47 cm^2). It might be attributed to availability of favourable climatic conditions during the growing period of November. Similar variation in results with respect to sowing time was reported by Panwar *et al.* (2013) [11]. The data presented that the effect of spacing on average leaf area of amaranthus was found to be significant. The maximum average leaf area of amaranthus was recorded in T_3 (226.32 cm^2) whereas, the minimum was recorded in T_4 (128.35 cm^2). This might be attributed to the availability of more space, nutrients and light irrespective time of sowing. The interaction effect on average leaf area of amaranthus was found to be significant. The maximum average leaf area of amaranthus was recorded in C_3T_1 (272.34 cm^2) whereas, the minimum average leaf area was recorded in C_1T_2 (69.53 cm^2). Similar variation in average leaf area with respect to sowing, spacing and their interaction was reported by Prasad (2020) [13]

Table 3: Effect of consecutive sowings, spacing and their interactions on weight of plant (g) and yield per plot (kg/ha) of amaranth.

Consecutive Sowings	Weight of the plant (g)					Yield per plot (kg/ha)				
	Row Spacing									
	T_1	T_2	T_3	T_4	Mean	T_1	T_2	T_3	T_4	Mean
C_1	9.00	8.50	8.93	8.20	8.66	10.09	5.98	12.80	4.58	8.36
C_2	6.90	7.11	7.31	6.77	7.02	11.35	8.86	10.40	7.18	9.44
C_3	12.18	11.99	11.95	12.18	12.07	16.80	12.09	16.10	13.40	14.60
MEAN	9.36	9.20	9.40	9.05	9.25	12.75	8.98	13.1	8.39	10.8
	S.Em±		CD at 5%		F-test	S.Em±		CD at 5%		F-test
C	0.37		1.08		SIG	0.33		0.96		SIG
T	0.43		1.25		NS	0.38		1.10		SIG
CXT	0.74		2.16		NS	0.65		1.91		SIG

Weight of the plant (g)

The presented data showed that the effect of consecutive sowings on plant weight of amaranth was found to be significant. The maximum plant weight of amaranthus was observed in C_3 (12.07 g) whereas, the minimum plant weight was recorded in C_2 (7.02 g). The maximum weight of plant may be attributed due to the congenial climatic conditions available in the season. The similar variation in plant weight was reported by Amur *et al.* (2019) [1]. The spacing shows non-significant effect on plant weight of amaranth. The maximum plant weight of amaranthus was recorded in T_3 (9.40 g) whereas, the minimum plant weight was recorded in T_4 (9.05 g). Fresh weight per plant was highest in T_3 (40 cm row spacing) which may be due to wider space available for vegetative growth and less competition for nutrient, sunlight and aeration. Similar results were also reported by Sharma *et al.* (2001) and Tahsin *et al.* (2010) [18] in lettuce. The interaction effect between consecutive sowings and spacing on plant weight of amaranth was found to be statistically non-significant. However, the maximum plant weight of amaranthus was recorded in C_3T_1 (12.18 g) whereas, the minimum plant weight was recorded in C_2T_4 (6.77 g). The highest weight of plant may be attributed due to the congenial climatic conditions available in the season as well availability of nutrient, sunlight and space was more as in wider spacing as compared to other spacing which resulted in highest weight

of plant.

Yield per plot (kg/ha)

The consecutive sowing produced a significant influence on the yield per plot of amaranth. The maximum yield per plot of amaranthus was observed in C_3 (14.60 kg) whereas, the minimum was recorded in C_1 (8.36 kg). The season C_3 produced the highest number of leaves, leaf area and weight of plant which ultimately resulted yield per plot.The data rerported that the effect of spacing on yield per plot of amaranth was significant. The maximum yield was recorded in T_3 (13.10 kg) whereas, the minimum was recorded in T_4 (8.39 kg). It might be due to the reason that reduction in spacing increased yield percentage. Present findings are similar with that of Tahsin (2010) [18] in Lettuce. It is clearly indicated from the interaction effect between consecutive sowings and spacing showed significant variation on yield per plot of amaranthus. The maximum yield per plot was recorded in C_3T_1 (16.80 kg) which was at par with C_3T_3 (16.10 kg) whereas, the minimum was recorded inC_1T_4 (4.58 kg) which was at par with C_1T_2 (5.98 kg). The higher yield is due to better plant survival owing to the favourable environmental conditions for growth and development of plant and the closer spacing accommodates more number of plants per unit area. Present findings are similar with Prasad (2020) [13].

Dry matter of leaves

The dry matter of leaves of amaranthus significantly differ by consecutive sowings. The maximum dry matter of leaves was observed in C_1 (14.79%) whereas, the minimum was recorded in C_3 (12.39%). This might be attributed to availability of more nutrients during first sowing which might have decreased during subsequent sowing as the crop was grown in same piece of land. Similar trends of result with respect to sowing was reported by Khan (2011) [5] and Prasad (2020) [13].

Table 4: Effect of consecutive sowings, spacing and their interactions on dry matter of leaves (%) and ascorbic acid content (mg/100g) of amaranthus.

Consecutive Sowings	Dry matter of leaves (%)					Ascorbic acid content				
	Row Spacing									
	T_1	T_2	T_3	T_4	Mean	T_1	T_2	T_3	T_4	Mean
C_1	14.01	13.65	14.88	16.63	14.79	73.55	73.80	76.01	78.77	75.53
C_2	14.10	12.50	12.02	12.10	13.41	75.40	74.88	75.70	73.90	74.97
C_3	11.12	9.22	15.03	14.19	12.39	70.10	62.23	69.15	65.35	66.71
MEAN	13.08	11.79	13.98	14.31	13.53	73.02	70.30	73.62	72.67	72.40
	S.Em±		CD at 5%		F-test	S.Em±		CD at 5%		F-test
C	0.32		0.94		SIG	0.80		2.35		SIG
T	0.37		1.08		NS	0.93		2.72		NS
CXT	0.64		1.88		NS	1.61		4.17		NS

The dry matter of leaves of amaranth under study varied non-significantly due to the spacing. The maximum dry matter of leaves of amaranthus was recorded in T_4 (14.31%) whereas, the minimum was recorded in T_2 (11.79%). This might be attributed to the plant receives enough light and nutrients which leads to maximum assimilation of nutrients that leads to attain highest dry matter content of plant in wider spacing. Similar results with respect to spacing were found by Prasad (2020) [13] in amaranthus and Sharma *et al*. (2013) [15] in radish. The data indicated that the interaction effect between consecutive sowings and spacing on dry matter of leaves of amaranth was found to be non-significant. The maximum dry matter of leaves of amaranthus was recorded in C_1T_4 (16.63%) whereas, the minimum was recorded in C_3T_2 (9.22%). Similar result was agreement with the findings of Muzumdar (2007) in amaranthus.

Ascorbic acid content

The data presented in Table 4 reported that the effect of consecutive sowings on ascorbic acid content of amaranthus was significant. The maximum was observed in C_1 (73.53 mg/100g) whereas, the minimum was recorded in C_3 (66.71 mg/100g).The more increase in ascorbic acid contentin first sowing than in consecutive sowing may be attributed to availability of more nutrients during first sowing which might have decreased during subsequent sowing as the crop was grown in same piece of land. Similar variation in results also obtained by Panwar *et al*., (2013) [11] in radish. The ascorbic acid had non-significant effect due to the effect of spacing. The maximum ascorbic acid content of amaranth was recorded in T_3 (73.62 mg/100g) and minimum was recorded in T_2 (70.30 mg/100g).Spacing does not showed any significant effect on ascorbic acid content. Similar results were reported by Spaldon *et al*., (1968) [17] in spinach.The interaction effect between consecutive sowings and spacing showed non-significant variation on ascorbic acid content of amaranthus. The maximum was recorded in C_1T_4 (78.77 mg/100g) whereas, the minimum was recorded in C_3T_2 (62.23 mg/100g). The present findings are in accordance with results obtained by Prasad (2020) [13] in amaranth, radish, spinach and coriander.

Economic analysis (B.C ratio)

The data showed that the treatment C_3 (sowing during second fortnight of December) was found to be the economically profitable with respect to different sowing months whereas, the different spacing treatment T_1 *i.e.* (20 cm spacing between two rows) was recorded highest BC ratio. Considering the interaction effect of different sowing months and spacing the treatment C_3T_1 (sowing during second fortnight of December with 20 cm row spacing) was found economically best.

Table 5: Comparative economics of amaranth cultivation

Consecutive Sowings	B.C ratio				
	Row Spacing				
	T_1	T_2	T_3	T_4	Mean
C_1	1.08	0.97	1.23	0.89	1.04
C_2	1.20	0.91	1.04	0.91	1.01
C_3	1.76	1.15	1.09	0.99	1.25
Mean	1.35	1.03	1.12	0.93	1.1

Conclusion

Based on the present investigation, it may be concluded that the treatment C_3 (sowing during second fortnight of December) was found to be the most profitable with respect to different sowing months whereas, for the higher yield closer spacing (20 cm row spacing) was economically best. Considering the interaction effect of different sowing months and spacing, the treatment C_3T_1 (December sowing with 40 cm row spacing) was found to be most profitable for obtaining higher yield.

References

1. Amur AH, Al – juboori, Shamil YH, Al-hamdani, Merwa M, Hamdon. Effect of sowing date on growth and yield of four radish (*Raphanus sativus* L.) varieties. Mesopotamia J of Agric. 2019;47(2):96-103
2. Anonymous. All India coordinated research project on underutilized and under exploited plants, NBPGR, Pusa Campus, New Delhi. Annu. Prog. Rep., 2007-08, 2010.
3. Jyrwa EK, Mehera B. Influence of Date of Sowing on Growth and Yield of Different Varieties of Radish (*Raphanus Sativus* L.) Under Allahabad Agro Climatic Conditions. Int. J Sci. Res. 2016;7(6):199-200.
4. Kabir A, Ali A, Waliullah MH. Effect of spacing and sowing time on growth and yield of carrot (*Daucus carrota* L.). Int. J Sustainable Agriculture. 2013;5(1):29-36.
5. Khan NUR. Effect of different sources of organic manure and sowing time on the growth and yield of carrot. A Thesis Submitted to the Dept. of Horticulture, Faculty of Agriculture Sher-e-Bangla Agricultural University, Dhaka, 2011.
6. Lavanya AVN, Vani VS, Reddy PSS, Chaitanya K. Root Yield of Radish as Affected by Sowing Dates and Spacing. Int. J Pure App. Biosci. 2017;5(4):1780-1784.
7. Lavanya AVN, Vani VS, Reddy PSS, Chaitanya K. Effect of sowing dates and spacing on growth and root yield of radish cv. Pusachetki Plant Archives. 2017;14(1):619-623
8. Majumder NU. Effect of nitrogen and spacing on growth and yield of stem amaranth (*Amaranthus viridus* I.) A Thesis submitted to the Department of Horticulture and Postharvest Technology Sher-e-Bangla Agricultural University, Dhaka, 2007.
9. Pandita VK, Randhawa KS. Row spacing and leaf cutting in relation to seed production of fenugreek (*Trigonella corniculata* L.) cv. Pusa Kasuri. Seed Research. 1994;22(2):127-129
10. Panse VG, Sukhatame PV. Statistical methods for agricultural workers. ICAR, New Delhi, 1995.
11. Panwar NS, Mishra AC, Uniyal SP, Pandey V, Bali RS. Effect of dates of sowing on yield and quality of radish (*Raphanus sativus* L.) cultivars under rainfed mid-hill conditions of Uttarakhand. Annuals of Agro-Biotech Research. 2013;18(3):360-363
12. Pervez MA, Ayub CM, Saleem BA, Virk NA, Mahmood N. Effect of nitrogen levels and spacing on growth and yield of radish (*Raphanus sativus* L.). Int. J Agri. Biol. 2004;6(3):504-506.
13. Prasad. Effect of consecutive sowings and spacing on growth and yield of amaranth, radish, spinach and coriander. A M.Sc. thesis submitted at Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli (Unpublished), 2020.
14. Sekar. Comparative effectiveness of animal manure on soil chemical properties, yield and root growth of (*Amaranthus caudatus* L.). Blomisterji, 2010;48(10):303310.
15. Sharma UG, Vihol NJ, Chavda JC. Influence of plant density and nutrient management on growth, yield and quality of radish (*Raphanus sativus* L.) cv. 'Pusa Chetki'. Asian Journal of Horticulture. 2013;8(2):671-676.
16. Singh D, Sani SS, Salaria A, Gill BS. Agronomic manipulations for maximum production of *Trigonellafoenum-graecum* L. in Punjab. Indian Journal of Arecanut, Spices and Medicinal Plants. 2005;7(2):69-71.
17. Spaldon E. Some problem of crop quality in spinach, Acta Flytotech Nittra. 1968;17:135-147. (Hort. Abst. 38:2970).
18. Tahsin AKMM. Effect of nitrogen and spacing on growth and yield of lettuce (*Lactuca sativa* L.). A Thesis Submitted to the Department of Horticulture Sher-e-Bangla Agricultural University, Dhaka, 2010.