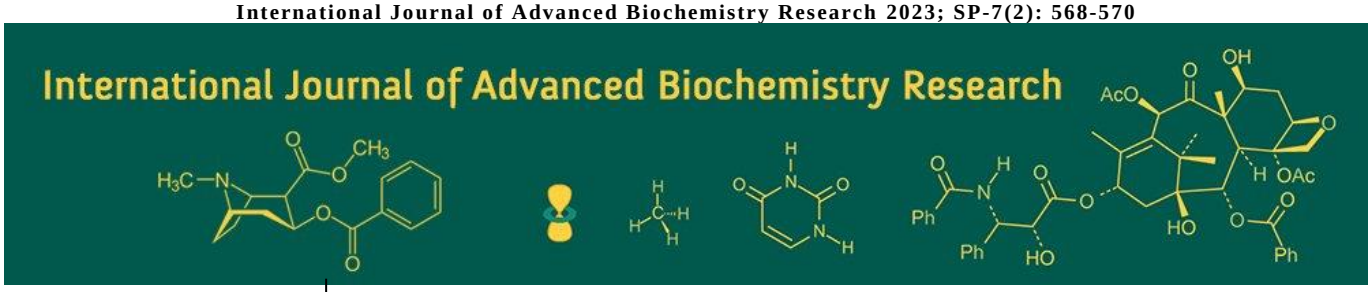

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Effect of spacing and fertilizer levels on growth and yield of amaranth (*Amaranthus hypochondriacus* L.)

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Abstract
A field experiment was conducted during Rabi-2022 at Experimental Farm, Agronomy Department, College of Agriculture, Parbhani to investigate the impact of spacing and fertilizer levels on growth and yield of amaranth. The experiment was laid out in split plot design with two factors and replicated thrice. Main plots were assigned to the different spacing *viz* S1: 45cm x 15cm, S2: 45cm x 20cm and S3: 30cm x 20cm and subplot comprises of four fertilizer levels *viz*. F1: 30:20:10 NPK kg ha^{-1}, F2:45:30:15 NPK kg ha^{-1}, F3:60:40:20 NPK kg ha^{-1} and F4:75:50:25 NPK kg ha^{-1}. The experimental gross plot size was 5.4 x 4.8 m2 and net plot size varied as per treatment. On 21st November, 2022, sowing was carried out by dibbling the seed @ 2 kg ha^{-1}. The result of experiment revealed that sowing of amaranth at spacing of 45cm×15cm and application of 75:50:25 NPK Kg ha^{-1} were found more productive. While spacing of 45 cm×20 cm produced higher value of growth attributes except plant height.

Keywords: Amaranth, spacing, fertilizer levels, growth, yield

Introduction
Grain Amaranth is called as pseudo cereal as it is not a member of Gramineae family but it has grain like seeds. It belongs to the family Amaranthaceous. It has rich sources of protein, carbohydrates, lipids and minerals as well as balanced composition of essential amino acids. Which are lacking in other cereals (Raiger *et al*. 2009) [11]. Amaranth plays a beneficial role of dietary in human nutrition. It is an excellent source of folic acid helps in increasing the blood haemoglobin level. The tender leaves of amaranth are used as vegetables and are rich in vitamin-A, calcium and iron content. Amaranth grows best under hot and humid climate although, it tolerates drought, low fertility and adverse climate condition. It has C4 metabolism as well as deep root system. The crop can be grown in any type of soil. Amaranth has a short growing period, grain amaranth can be harvested at 90 days. In India, Amaranth is cultivated both in hills as well as plains covering states of Madhya Pradesh, Uttar Pradesh, Uttarakhand, Maharashtra, Gujarat, Orissa, Karnataka, Bihar. The exact information about area, production and productivity of grain amaranth at national level is lacking.

Plant spacing is one of the most important factors that can manipulate by farmers or growers to increase the production of the crop. It plays an important role in increasing crop yield which indirectly affects growth, yield and nutrient uptake of plant. Higher plant population may compensate the lower individual plant yield. Hence, it is necessary to maintain optimum plant population to get high productivity. The balanced use of fertilizer plays a vital role in enhancing the productivity of crop. Grain yield have been increased, across the world, by application of mineral fertilizers to different crops. Additional nutrients like nitrogen, phosphorus and potassium are the essential plant nutrients required for healthy growth of plants. Availability of low concentration of these nutrients in plants rigorously limits the yield and produces more or less distinct deficiency symptoms. In one of the study, it has been observed that the grain amaranth respond good up to fertilizer dose of 60:40:20 NPK kg ha^{-1} (Raiger *et al*., 2009) [11]. There is limited and preliminary information available on the plant spacing and fertilizer requirements of amaranth (Olaniyi *et al*., 2008) [6] Hence to investigate its production potential under different spacing and fertilizer levels the field experiment was under taken during rabi-2022 at the experimental farm of Agronomy Department, VNMKV, Parbhani.

Material and Methods

A field experiment was carried out at PG Research Farm, Department of Agronomy, College of Agriculture Parbhani, Maharashtra during Rabi season of 2022.The soil of the experimental plot was clayey in texture, low in organic carbon, medium in available nitrogen and phosphorus, but very high in available potassium and slightly alkaline in reaction.

The experiment was laid out in split plot design with two factors and replicated thrice. Main plots were assigned to the different spacing *viz* S1: 45cm x 15cm, S2: 45cm x 20 cm and S3: 30cm x 20cm and subplot comprises of three fertilizer levels *viz*. F1: 30:20:10 NPK kg ha^{-1}, F2:45:30:15 NPK kg ha^{-1}, F3:60:40:20 NPK kg ha^{-1} and F4:75:50:25 NPK kg ha^{-1}. The experimental gross plot size was 5.4 x 4.8 m2 and net plot size varied as per treatment. Sowing was done by dibbling seeds @ 2 kg ha^{-1} on 21st November, 2022. The harvest took place on April 05, 2023.

Results and Discussion

Growth attributes

The data presented in Table 1 revealed that various growth parameter of amaranth were significantly influenced by different spacing and fertilizer levels. The sowing of amaranth seed at spacing of 45 x20 cm recorded maximum number of branches plant^{-1} (41.58), number of functional leaves plant^{-1} (121.1), leaf area plant^{-1} (41.17), drymatter accumulation plant^{-1} (49.16 g) which was significantly superior over rest of the spacings. The maximum growth was recorded in wider spacing as compared to close spacing. The higher growth might be due to sufficient space, moisture and nutrients in wider spacing, which accelerated the growth and development of the crop. These findings are in conformity with the earlier findings reported by Rahman *et al*. (2007) [10], Patel *et al*. (2011) [9], Chaudhari *et al*. (2022) [1].

As regards to fertilizer levels, application of 75:50:25 NPK kg ha^{-1} (F4) recorded the higher growth attributes like plant height (157.2 cm), number of branches plant^{-1} (42.60), number of leaves plant^{-1} (120.9), leaf area plant^{-1} (42.00 dm2), total dry matter accumulation plant^{-1} (48.25 g). The higher growth of plant might be due to beneficial effect of nutrients which resulted in higher amaranth growth. These findings are in line with the earlier findings of Kushare *et al*. (2010) [4], Dehariya *et al*. (2019) [7], Srujan*et al*. (2021) [14]

Yield and yield attributes

The data presented in Table 2 revealed that the effect of spacing and fertilizer levels was found significant on yield andyield attributes. Maximum number of inflorescence plant^{-1} (57.68), grain yield plant^{-1} (12.00g) were recorded under spacing 45cm x 20 cm (S2). while maximum grain yield (1419 kg ha^{-1}), harvest index (25.06) were recorded under the spacing of 45 cm x 15 cm and was significantly superior over spacing of 45cm x20 cm, however, it was at par with 30 cm x 20 cm. The higher yield might be due to higher plant population under closer spacing that resulted in higher photosynthetic activity along with proper grain filling and thus contributed to higher yield. These findings are parallel with the earlier findings reported by Vaghela *et al*. (2018) [15], Verma *et al*. (2022) [16].

Application of 75:50:25 NPK kg ha^{-1} (F4) recorded the higher yield and yield attributes like number of inflorescence plant^{-1}(55.72), grain yield plant^{-1} (12.55 g), grain yield (1544 kg ha^{-1}), harvest index (25.70) but it was found at par with 60:40:20 NPK kg ha^{-1}(F3). It might be due to balanced application of nutrients which enhanced growth and development of the crop and resulted higher yield. Similarly, application of 75:50:25 NPK kg ha^{-1} recorded higher harvest index (25.70) closely followed by harvest index obtained with application of 60:40:20 NPK kg ha^{-1}. The higher harvest index might be due to higher grain yield obtained under fertilizer level 75:50:25 NPK kg ha^{-1}. These findings are in line with the earlier findings reported by Parmar *et al*. (2009), [8] Solanki *et al*. (2016) [13], Keraliya *et al*. (2017) [3], Jangir *et al*. (2019) [2], Srujan*et al*. (2021) [14], Rana *et al*. (2022) [12].

Table 1: Effect of different treatments on growth- related attributes of amaranth

Treatments	Plant Height (cm)	No. of branches plant^{-1}	No. of functional leaves plant^{-1}	Leaf area plant^{-1} (dm2)	Dry matter Accumulation plant^{-1} (g)
Spacing (S)					
S1: 45 cm × 15 cm	148.7	37.41	115.5	37.76	40.76
S2: 45 cm × 20 cm	140.3	41.58	121.1	41.17	49.16
S3: 30 cm × 20 cm	158.6	36.53	107.4	35.65	37.16
SE (m) ±	3.1	0.89	2.6	0.96	0.86
C.D. at 5%	12.0	3.50	10.1	3.77	3.36
Fertilizer levels (F)					
F1: 30:20:10 NPK kg ha^{-1}	138.7	33.58	106.3	33.87	35.27
F2: 45:30:15 NPK Kg ha^{-1}	146.8	36.34	113.1	35.78	39.39
F3: 60:40:20 NPK Kg ha^{-1}	154.1	41.49	118.3	41.12	46.54
F4: 75:50:25 NPK Kg ha^{-1}	157.2	42.60	120.9	42.00	48.25
SE (m) ±	1.3	0.45	1.8	0.57	0.97
C.D. at 5%	3.9	1.33	5.2	1.69	2.89
SxF					
SE (m) ±	2.2	0.78	3.1	0.98	1.68
C.D. at 5%	NS	NS	NS	NS	NS
GM	149.2	38.50	114.7	38.19	42.36

Table 2: Effect of different treatments on yield and yield- related attributes of amaranth.

Treatments	No. of Inflorescence plant^{-1}	Grain yield plant^{-1} (g)	Grain yield (kg ha^{-1})	Harvest Index
Spacing (S)				
S1: 45 cm × 15 cm	51.37	10.16	1419	25.06
S2: 45 cm × 20 cm	57.68	12.00	1206	24.39
S3: 30 cm × 20 cm	48.73	9.19	1318	24.69
SE (m) ±	1.11	0.36	38	-
C.D. at 5%	4.37	1.41	150	-
Fertilizer levels (F)				
F1: 30:20:10 NPK kg ha^{-1}	49.24	8.05	1026	23.25
F2: 45:30:15 NPK Kg ha^{-1}	50.64	9.31	1187	23.92
F3: 60:40:20 NPK Kg ha^{-1}	54.76	11.89	1500	25.53
F4: 75:50:25 NPK Kg ha^{-1}	55.72	12.55	1544	25.70
SE (m) ±	0.42	0.25	29	-
C.D. at 5%	1.24	0.73	85	-
SxF				
SE (m) ±	0.72	0.42	50	-
C.D. at 5%	NS	NS	NS	-
GM	52.59	10.45	1314	24.73

Conclusion

On the basis of the present investigation it may be concluded that dibbling of amaranth at spacing of 45 x15 cm was found more productive. Application of 75:50:25 NPK kg ha^{-1} recorded significantly higher growth and yield attributes of amaranth. However, it was comparable with 60:40:20 NPK kg ha^{-1}.

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