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Research Article

EFFECT OF DATE OF SOWING AND CROP GEOMETRY ON GROWTH, YIELD ATTRIBUTES, YIELD AND QUALITY OF AMARANTHUS (*Amaranthus hypochondriacus* L.)

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Abstract: A field experiment was conducted at College Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand, Gujarat to find out the Effect of date of sowing and crop geometry on growth, yield attributes, and yield and quality of *amaranthus* during *Rabi* season of the year 2015-16. The experiment consist of twelve treatment combinations comprised of three date of sowing (7th November, 17th November, 27th November) and four crop geometry (30 cm x 15 cm, 30 cm x 30 cm, 45cm x 15 cm and 45 cm x 30 cm). Significantly the highest D_1 (7th November) recorded significantly the highest number of panicles (5.95), panicles weight plant^{-1} (159.34 g), grain yield plant^{-1} (23.97 g), test weight (0.91 g) and highest lodging percent (19.61%), grain yield (2657 kg ha^{-1}) of *amaranthus* were recorded by 7th November over 17th November, 27th November. Panicle length (74.76 cm), spikelets length (13.77 cm), least number of days required to 50 % flowering (40.56 days), maturity (103.46 days) and stover yield (6119 kg ha^{-1}). Among crop geometry S3 (45 cm x 15 cm) recorded significantly higher Panicle length (73.90 cm), spikelets length (13.78 cm), number of panicles plant^{-1} (5.26), panicles weight plant^{-1} (153.39 g). In case less number of days required for maturity (103.95), grain and stover yields were observed due to different spacings. Spacing S_3 (45 cm x 15 cm) recorded significantly higher grain yield (2520 kg ha^{-1}) and stover yield (5762 kg ha^{-1}). The higher net realization of ₹90736 ha^{-1} and higher B.C.R. value of 5.88 were recorded in date of sowing D_1 (7th November). Among crop geometry S_3 (45 cm x 15 cm) resulted in higher net realization ₹ 85059 ha^{-1} with B.C.R. of 5.57.

Keywords: Crop Geometry, Grain yield

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Introduction

Grain amaranthus / Rajagara (*Amaranthus hypochondriacus* L.) is a potential upcoming subsidiary food crop of the future. It belongs to the family Amaranthaceae. The word 'Amaranth' comes from Greek word 'amarantos, which means the one that does not wither or never -fading flower. *Amaranthus* is a quick growing, bushy plant with thick stalks. Being a C4 plant it has more efficiency of nitrogen utilization and photosynthesis [1] along with yield potential of more than 50 q ha^{-1}. Amaranthus (*Amaranthus hypochondriacus* L.) is regarded as a rich source of minerals like iron, phosphorus, and calcium. Grain amaranth protein (17-19 %) contains about 5 % lysine and 4.4 % sulfo-amino acids, which are limiting in other grains. Besides having a significant value as fast food, it is also used as a leafy vegetable and the stalks are used as a fuel for household cooking. Amaranth apply termed as 'Poor man's spinach" has enough potential for competing under and malnutrition prevalent in many parts of the world. Among the crop management factors, time of sowing and spacing play a vital role in boosting the yields. Environmental factors could be governed possibly by sowing time which have great bearing on the realization of the yield potential of the crop. Besides, weather parameters, management practices also influence the overall performance of the crop. There is need to understand the crop response to management practices in relation to weather factors, which will help in manipulating crop agronomic practices for better exploitation of environmental conditions. Time of sowing plays a significant role in crop production. Grain *amaranthus* shows considerable variation in growth habit, yield potential and respond differently to plant population. Therefore, crop geometry plays an important role in increasing yield.

Materials & Methods

A field experiment was conducted at Agronomy farm, Anand Agricultural University, Anand to find out the "Effect of date of sowing and crop geometry on growth, yield attributes, yield and quality of grain amaranthus (*Amaranthus hypochondriacus* L.) under middle Gujarat conditions" during *rabi* season of 2015-16. The experiment consists of twelve treatment combinations comprised three date of sowing (7th November, 17th November & 27th November) and four spacing (30 cm x 15 cm, 30 cm x 30 cm, 45 cm x 15 cm & 45 cm x 30 cm). The experiment was laid out in Split Plot Design with four replications. The soil of experimental plot was loamy sand in texture. The soil was low in organic carbon (0.40 %) available nitrogen (230.50 kg ha^{-1}) and medium in available phosphorous (37.97 kg ha^{-1}) and potash (310.28 kg ha^{-1}). The *amaranthus* were sown with seed rate of 2.5 kg ha^{-1}. The economics was workout on current market price basis. Nitrogen was given as per recommended in the form of urea. The full dose of phosphorus from SSP and half dose of nitrogen applied as basal dose at the time of sowing and other half dose in equal split at 30 DAS. The protein content (%) in seed was estimated from the nitrogen was estimated as per Kjeldahl's method [2] and protein was calculated by multiplying nitrogen with a factor of 6.25. The values off "F" was worked out and compared with the values of table F at 5 percent level of significance. The value of S. Em±, C.D. and C.V. per ent were also calculated [3].

Result & Discussion

The finding of present study as well as relevant discussion have been presented under following heads:

Table-1 *Grain yield, Stover yield and protein percent growth, yield attributes, yield, quality parameter and economics of as amaranthus influence by different date of sowing and spacing*

Treatments	Plant height at harvest (cm)	Days to 50% flowering	Days to maturity	Panicle Length (cm)	Number of panicles	Grain yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Protein content (%)	Net realization (₹ ha^{-1})	B. C. R.
Date of sowing (D)										
D_1 : 7th November	156.57	40.56	103.46	74.76	5.95	2657	6119	16.13	90736	5.88
D_2 : 17th November	148.40	42.94	106.15	69.83	5.13	2356	5649	15.41	78461	5.22
D_3 : 27th November	138.54	45.32	112.63	66.04	4.21	2156	4983	15.95	70128	4.77
S.Em. ±	3.78	1.05	2.07	1.81	0.12	68.86	146.72	0.26	-	-
C.D. at 5%	13.06	3.62	7.16	6.26	0.42	238.32	507.70	NS	-	-
C.V. %	10.21	9.76	7.71	10.31	9.60	11.53	10.51	6.82		
Spacing (S)										
S_1 : 30 cm x 15 cm	141.29	43.69	107.15	68.76	5.03	2373	5549	15.4	79029	5.23
S_2 : 30 cm x 30 cm	144.92	42.1	105.79	70.86	5.28	2424	5715	15.7	81238	5.37
S_3 : 45 cm x 15 cm	150.76	40.97	103.95	73.90	5.56	2520	5762	16.0	85059	5.57
S_4 : 45 cm x 30 cm	154.48	45	112.82	67.28	4.50	2240	5309	15.0	73709	4.97
S.Em. ±	3.23	1.03	2..22	1.64	0.11	61.32	116.71	NS	-	-
C.D. at 5%	9.40	NS	6.44	4.76	0.32	178.94	338.70		-	-
Interaction										
D x S	NS	NS	NS	NS	NS	Sig.	Sig.	NS	-	-
C.V. %	7.57	6.05	7.16	8.10	7.68	8.89	7.24	5.99	-	-

Effect of date of sowing

The data presented in [Table-1] showed that, among the date of sowing, date of sowing 7th November recorded significantly the highest grain yield (2657 kg ha^{-1}). The increase in stover yield of date of sowing 7th November recorded significantly the higher in D_1 (7th November) and D_2 (17th November) were at the extent of 22.7 and 13.36 percent, respectively as compared to D_3 (27th November). which was at par D_2 (17th November). The higher grain and stover yield of date of sowing 7th November sowing, might be due to under this sowing date favorable temperature and weather conditions throughout the crop might have resulted in higher rate of photosynthesis as well as higher translocation of photosynthates from various plant organs to the development and ultimately and ultimately higher values of growth and yield attributes *viz*., plant height, panicle weight, number of panicles plant^{-1}, length of panicle and spikelet length which resulted in higher stover yield. These findings are akin to those reported by Anon., (1994), Anon., (1995), Patel, (2003), Troiani, *et al*., (2004) [4-7]. The result showed that the date of sowing D_1 (7th November) recorded significantly the higher plant height at 60 DAS and at harvest (146.83 cm) and (156.57 cm) respectively, Panicle length (74.76 cm), spikelet length (13.77 cm), least number of days required to 50 % flowering (40.56 days) and maturity (103.46 days), highest number of panicles (5.95), panicles weight plant^{-1} (159.34 g), grain yield plant^{-1} (23.97 g), test weight (0.91 g) and highest lodging percent (19.61%). It might be due to Early sowing of the crop on 7th November resulting in early maturity might be due to early emergence of crop with favourable optimum conditions of temperature (25-35^{0}C) at the time of seed germination and during crop growth period and development, accelerate the growth process and increased the photosynthetic rate, ultimately enhanced maturity. The results collaborate with the findings of Modhavadia, *et al*., (2007) and Chaudhari, *et al*., (2009) [8,9].

Effect of spacing

The data presented in [Table-1] showed that, the effect of spacing on grain and stover yields were observed in spacing S_3 (45 cm x 15 cm) recorded significantly the highest grain yield (2520 kg ha^{-1}). In case of stover yield S_3 (45 cm x 15 cm) recorded also significantly higher yield (5762 kg ha^{-1}). It might be due to advantages of better utilization of moisture and nutrients as well as solar radiation due to better orientation of the leaves which in turn resulted in greater amount of photosynthesis leading to increase in the value of growth and yield parameters *viz*., length of panicle, length of spikelets, panical weight plant $^{-1}$, panicles palnt^{-1} and thereby resulted in higher stover yield. Similar result is also reported by Bhaskar, (1996), Malligawad and Patil, (2001), Arya and Singh, (2004), Patel, *et al*., (2011), Kumar and Yassin, (2013) and Oluwatonyi, (2015) [10-15]. The result showed that the spacing S_3 (45 cm x 15 cm) recorded significantly higher Panicle length (73.90 cm), spikelets length (13.78 cm), number of panicles plant^{-1} (5.26), panicles weight plant^{-1} (153.39 g). However, it was at par with S_2 (30 cm x 30 cm). Spacing S_3 (45 cm x 15 cm) recorded significantly the highest number of panicles plant^{-1} (5.36) and test weight (0.87 g). In case of panicle weight (30.47 g), lodging percent (15.33%) and grain yield plant^{-1} (31.60 g) S_4 (45 cm x 30 cm) recorded significantly higher value than other spacing. Same finding also reported by Malligawad and Patil, (2001) [16]. The interaction effect between date of sowing and spacing brought significant variations in grain yield. Treatment combination of D_1S_3 (2952 kg ha^{-1}) recorded significantly higher grain yield, but it was found statistically at par with D_1S_2. The interaction effect between date of sowing and spacing brought significant variations in stover yield. Treatment combination of D_1S_3 (6234 kg ha^{-1}) recorded significantly higher grain yield, but it was found statistically at par with D_1S_1, D_1S2, D_1S_4, D_2S_1 and D_2S_3.

Economics of different treatments

Economics play important role in deciding the adoption of particular treatment by the farmers. Therefore, the gross realization, net realization and benefit cost ratio (B.C.R.) were calculated for date of sowing and spacing.

Effect of date of sowing

The data on economics [Table-1] revealed that Maximum gross (` 109339 ha$^{-1}$) and net realization (` 90736 ha^{-1}) with maximum BCR value of 5.88 were obtained under D1 (7th November) sowing date.

Effect of spacing

Maximum gross (`103681 ha$^{-1}$) and net realization (`85059 ha^{-1}) with maximum BCR value of 5.88 were obtained 5.57 were realized under S1 (45 cm x 15 cm) spacing,

Conclusion

In light of results obtained from this investigation, it is concluded that for securing maximum grain yield and higher net return, the grain *amaranthus* crop in *rabi* season should be sown on 7th November either with a combination of 45 cm x 15 cm inter and intra row spacing or with a combination of 30 cm x 30 cm inter and intra row spacing on loamy sand soil of middle Gujarat.

Research Category: Agronomy

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