Impact of Integrated Nutrient Management on Growth, Yield, Quality and Economics of Grain Amaranth

ABSTRACT

The investigation entitled, "Impact of Integrated Nutrient Management on Growth, Yield, Quality and Economics of Grain Amaranth" was conductedduring *rabi*seasons of 2022-23 and 2023-24 at College Farm, Navsari Agricultural University, Navsari. Nine treatments consisted of integrated nutrient management treatments were applied to grain amaranth crop in *rabi* season and replicated three times in randomized block design.Almost all the growth attributes, yield attributesand qualitywere significantly improved due to combination of organic manures and inorganics.Significantly higher grain yield (1371 kg/ha) and stover yield (2916 kg/ha) were recorded under the application of vermicompost 5 t/ha + 100% RDN through inorganic fertilizer (T_6). However, this yield was at par with the application of biocompost 5 t/ha + 100% RDN through inorganic fertilizer (T_4) and application of FYM 5 t/ha + 100% RND through inorganic fertilizer (T_2) in pooled analysis of 2022-23 to 2023-24.Application ofbiocompost 5 t/ha + 100% RDN through inorganic fertilizer (T_4)gave maximum profitably higher net returns (₹ 65768) and BCR (2.67)among all the treatments.

KEYWORD: Grain amaranth, Growth, Yield attributes, Yield, Quality and Economics.

INTRODUCTION

Amaranthus or pigweed belongs to the family *Amaranthaceae*. The word *Amaranthus* is basically derived from a Greek word "Anthos" which means ever-lasting or un-wilting. At present time, it is also called as a third millennium crop. Amaranth varies in flower, leaf and stem colour with range of striking pigment from the spectrum of maroon to crimson and can grow longitudinally from 1 to 2.5 metertall with a cylindrical, succulent, fibrous stem. It is believed to have originated from Central and South America, it is an important part of diet in areas of Latin America, Africa and Asia (Grubben and Von Sloten, 1981).The genus Amaranthus consists of up to 70 species, either as cosmopolitan weeds or cultivated plants, and is widely spread across all tropical and subtropical regions of the world. They are grown as leafy vegetables, grains, or ornamental plants, while others exist as weeds (Srivastva, 2011), *Amaranthuscruentus* Linn and *Amaranthushypochondriacus* Linn, are the best grain producers.Amaranth is C_4 plant that germinates quickly when sod temperature reaches 15˚C to 18˚C. Seedling rate should be increased to compensate for lower emergence rates when soil temperatures are less than 15˚C (Webb *et al.*, 1987). Grain amaranth can be grown several times a year and ittolerates to drought, heat stress, high soil acidity and salinity.It has potential for increased production due to low cost of inputs and its adaptation to a wide range of agro-ecological zones.

Amaranth is widely distributed throughout the old and new world. In Asia-Pacific regions covering India, China, Manchuria, Nepal, Bhutan, Afghanistan, Indonesia, Japan, Thailand and Israel, thiscrop is cultivated as a minor crop.In India, grain amaranth was primarily cultivated in hill regions but of late in 1990s, its cultivation gained momentum in Central and Western Plateau regions.Now-a-days, this crop is being promoted globally as a nutritive food crop or potential crop of the future. This crop is still not in the main stream cultivation practices in India and the world.In some of the Indian languages, it is known as rajgira (king of seeds) in Gujarati, ramdana (seed sent by god) in Bihar, Odisha and Uttar Pradesh, chuka in Bengal, kalaghesa, chumera and ganhar in Central India and bathu in Himachal Pradesh. Presently amaranth is grown in Himachal Pradesh and on hills of Uttar Pradesh and Uttaranchal for grain and leafy vegetable purpose. It is mainly grown for grainin Uttarakhand, Maharashtra and in some parts of Gujarat. Being a profitable crop the area under amaranth is increasing day by day where irrigation facilities exist (Neeraja, 2013).

MATERIALS AND METHODS

The study took place at the Agronomy Instructional Farm, situatedatthe College Farm, N. M. College of Agriculture, Navsari Agricultural University, Navsari during the *rabi*season 2022-23 and 2023-24. The soil of south Gujarat is locally known as “Deep Black Soil”. The soils of Navsari campus are classified under the order, ‘*Inceptisols*’. The soil analysis reveal that soil of experimental plot was clay in texture, low in organic carbon (0.49% and 0.43%) and available nitrogen (206.10 kg/ha and 196.23 kg/ha), medium in available phosphorus (36.30 kg/ha and 40.10 kg/ha) and high in available potassium (290.2 kg/ha and 298.36 kg/ha).

The treatment consisted of integrated nutrient management *viz.*, T_1: 25% Nthrough FYM + 75% RDN through inorganic fertilizer, T_2: FYM 5 t/ha + 100% RDN through inorganic fertilizer, T_3: 25% N through Biocompost + 75% RDN through inorganic fertilizer, T_4: Biocompost 5 t/ha + 100% RDN through inorganic fertilizer,T_5: 25% N through Vermicompost + 75% RDN through inorganic fertilizer, T_6:Vermicompost 5 t/ha + 100% RDN through inorganic fertilizer, T_7: FYM 5 t/ha, T_8:Biocompost 5 t/ha and T_9: Vermicompost 5 t/ha were applied to grain amaranth crop in *rabi* season and replicated three times in randomized block design.For this experiment, the grain amaranth used was Grainamaranth2, and it was sown with a spacing of 45 cm × 10 cm.

RESULTS AND DISCCUSION

Effect on growth parameters

According to pooled results of 2 years (Table 1) integrated nitrogen management treatments exhibited significant effect on plant height (except at 30 DAS) , stem girth, dry matter per plant and 50% days to flowering. Application of vermicompost 5 t/ha + 100% RDN through inorganic fertilizer (T_4) recorded significantly higher plant height at 60 DAS and at harvest and dry matter (g/plant) which were remained at par with application of biocompost 5 t/ha + 100% RDN through inorganic fertilizer (T_4) and FYM 5 t/ha + 100% RDN through inorganic fertilizer (T_2). Whereas significantly higher stem girth and more number of days to 50% flowering of grain amaranthin pooled study was found at par with all treatments except application of 25% N throughFYM + 75 % RDN through inorganic fertilizer (T_1), vermicompost 5 t/ha (T_9), biocompost 5 t/ha (T_8) and FYM 5 t/ha (T_7).Significantly lower plant height, stem girth, dry matter and 50% days to flowering were observed with application of FYM 5 t/ha (T_7).

Significantly higher plant height, stem girth, 50% days to flowering and dry matter were observed by combined application of organic and inorganic sources of nitrogen, it might be due to application of nitrogen and phosphorus through chemical fertilizer which enhanced its availability which resulted in increased photosynthetic activity and translocation of photosynthates from source to sink which helpedin achieving higher plant height, stem girth, dry matter (g/plant). At the same time, effect of organic sources (vermicompost, biocompost and FYM) as a source of plant nutrient and humus improved the soil physical conditions by increasing its capacity to absorb and store water, improving aeration and favouring the beneficial microbial activity which helped in improving growth parameters. The increased growth parameters are also a function of cell division and cell enlargement, which depends upon availability of nutrients in balanced form especially N and P. Similar results were reported byJangir *et al.* (2019), Srujan *et al.* (2021) and Bartwal *et al.*(2022).

Effect on yield parameters

Length of spike, length of spikelet and no. of spikelets/spike were significantly affected by different treatments of integrated nutrient management. Application ofvermicompost 5 t/ha + 100% RDN through inorganic fertilizer (T_6) showed significantly higher spike length and length of spikelet and no. of spikelets/spike of grain amaranth at harvest which was statistically at par with application of biocompost 5 t/ha + 100% RDN through inorganic fertilizer (T_4)and application of FYM 5 t/ha+ 100% RDN through inorganic fertilizer (T_2) in pooled analysis.

Test weight of grain amaranth (volume basis) was not significantly influenced bydifferent treatmentsin pooled study.Length of spike, length of spikelets and no. of spikelets/spike were noted significantly lower with the treatment T_7 (FYM 5 t/ha).

It was emphasized that use of inorganic fertilizer and organic source bring about significant improvement in overall growth of the crop by providing needednutrient from initial stage. Increased supply of macro as well as micro nutrient inmore synchronized way in the treatment receiving integrated supply of nutrient fromorganic manure along with inorganic fertilizer resulting in increased photosyntheticefficiency. Thus, greater availability of photosynthates, metabolites and nutrients todevelopreproductive structures seems to have resulted in increased length of spikelet, length of spikelet and no. of spikelets/spike in amaranth crop. The results were in agreement with the findings of Kushare *et al.* (2010), Keraliya *et al*. (2017), Jangir (2019) and Patel *et al.* (2022) in grain amaranth.

Effect on yield

The treatment receiving vermicompost 5 t/ha + 100% RDN through inorganic fertilizer (T_6) recorded significantly higher grain yield and straw yield (1371and 2916 kg/ha) remained at par with application of biocompost 5 t/ha + 100% RDN through inorganic fertilizer (T_4) (1341and 2796 kg/ha) and application of FYM 5 t/ha + 100% RDN through inorganic fertilizer (T_2) (1280and 2728 kg/ha) in pooled analysis. Further, results indicated that the treatment T_5 (25% N through vermicompost + 75% RDN through inorganic fertilizer), treatment T_3(25% N through Biocompost + 75% RDN through inorganic fertilizer) and, treatment T_1 (25% N throughFYM + 75% RDN through inorganicfertilizer) found at par with one other in pooled analysis.

Significantly lower grain and straw yields were recorded in treatment T_7 (FYM 5 t/ha) (788 and 1893 kg/ha) in pooled results.

An increase in the grain and straw yield with vermicompost, biocompost and FYM served as reserves of macro and micro nutrients which are released during process of mineralization. Among the treatments, the combined use of organic and inorganic fertilizers, as well as solely inorganic fertilizers, resulted in higher grain yield compared to treatments receiving nutrients only through organic manures. This is likely due to the optimal supply of nutrients at the right time to meet crop requirements. Grain amaranth responds well to fertilizer application, which promotes more extensive root growth. This enhanced root development leads to better absorption of moisture and nutrients from the soil, facilitating effective dry matter production and the translocation of photosynthates from the leaves to the spikelets, resulting in improved grain development. The results were in agreement with the findings of Parmar and Patel (2009), Gunjal (2011),Neeraja and Patel (2015), Keraliya *et al.* (2017), Jangir *et al.* (2019) and Patel *et al.* (2022) in grain amaranth.

Effect on Quality

Significantly higher protein content and protein yield were noted under the application of vermicompost 5 t/ha + 100% RDN through inorganic fertilizer (T_6) which was statistically at par with application of biocompost 5 t/ha + 100% RDN through inorganic fertilizer (T_4) and application of FYM 5 t/ha + 100% RDN through inorganic fertilizer (T_2) in pooled analysis of the experimental results.

The variation in protein yield was observed because uptake of nitrogen associated with its levels of supply as well as plant potential to absorb and utilize for growth as well as accumulation of protein in grain under adequate N supply through inorganic fertilizers or combination of organics and inorganics might be accounted to continuous availability of nitrogen for protein synthesis. The protein yield is correlated with protein content in grain and grain yield of crop.This could be due to the higher grain yield under corresponding treatment.These results are in accordance with the findings of Jangir *et al.* (2021) and Patel (2022) in grain amaranth.

Economics

Maximum net monetary return of ₹ 65768 and BCR of 2.67 was recorded by the treatment of biocompost 5 t/ha + 100% RDN through inorganic (T_4) followed by treatment of 25% N through biocompost + 75% RDN through inorganic fertilizer (T_3) with net monetary return of ₹ 51323 and BCR of 2.42 and T_2 (FYM 5 t/ha + 100% RDN through inorganic fertilizer) with ₹ 48815/ha and BCR 1.94. Whereas, the lowest net monetaryreturn of ₹ 1922 with BCR of 1.03 was recorded with the treatment T_9(Vermicompost 5t/ha).

The highest net monetary return under treatment T_4 (Biocompost 5 t/ha + 100% RDN through inorganic fertilizer) might be due to low cost of biocompost as compared to other organic manure used under study which resulted in low cost of cultivation coupled with higher grain yield turned in higher net monetary return and BCR.Similar results were also reported by Keraliya *et al.* (2017), Salmankhan *et al.* (2023), Bartwal (2022) and Patel (2022).

CONCLUSION

Based on two years of experimentation, it can be concluded that the application of biocompost 5 t/ha combined with 100% recommended dose of nitrogen (60 kg N/ha) and Phosphorus (40 kgP_2O_5/ha) from inorganic fertilizers enhances the growth parameters, yield attributes, yield,quality, net returns and BCR of grain amaranth.

Future line of work

Research should investigate the long-term impacts of integrated nutrient management on soil health, crop productivity, and environmental sustainability. Additionally, studies should explore the potential benefits of combining different organic amendments with inorganic fertilizers across various crops and agro-climatic conditions to optimize nutrient use efficiency and enhance overall agricultural sustainability.

Table 1. Effect of integrated nutrient management on plant height, stem girth, 50% days to flowering and dry matter of grain amaranth

Treatments		Plant height (cm)			Stem girth (cm)	50% days to flowering	Dry matter (g/plant)	
		At 30 DAS	At 60 DAS	At harvest			At 60 DAS	At harvest
T_1: 25% N throughFYM + 75% RDN through inorganic fertilizer		19.19	95.88	122.20	3.57	51.83	33.06	40.75
T_2: FYM 5 t/ha + 100% RDN through inorganic fertilizer		20.12	113.50	142.17	3.80	54.17	39.67	47.91
T_3: 25% N through Biocompost + 75% RDN through inorganic fertilizer		19.28	98.87	125.59	3.68	53.17	35.05	42.39
T_4: Biocompost 5 t/ha + 100% RDN through inorganic fertilizer		20.69	118.67	151.88	3.86	55.00	42.55	51.30
T_5: 25% N through Vermicompost + 75% RDN through inorganic fertilizer		19.54	104.04	127.23	3.77	53.50	37.93	43.61
T_6: Vermicompost 5 t/ha + 100% RDN through inorganic fertilizer		21.19	120.25	153.01	4.03	56.50	43.93	52.87
T_7: FYM 5 t/ha		17.89	81.18	100.38	2.93	44.67	27.15	33.28
T_8: Biocompost 5 t/ha		18.39	81.82	101.17	3.08	49.17	28.88	35.32
T_9: Vermicompost 5 t/ha		18.69	83.87	102.70	3.28	50.17	30.51	37.19
	SEm ±	0.79	3.94	4.97	0.14	1.51	1.48	1.73
	CD (P=0.05)	NS	11.34	14.31	0.41	4.35	4.25	4.98
	CV (%)	10.01	9.66	9.72	9.74	7.11	10.21	9.90
Y	**SEm ±**	0.375	1.856	2.341	0.067	0.712	0.696	0.814
	CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS
Y × T	**SEm ±**	1.124	5.567	7.024	0.200	2.136	2.088	2.443
	CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS

Table 2. Effect of integrated nutrient management on length of spike, spikelet, No. of spikelets/spike, grain yield, straw yield, protein content and protein yield of grain amaranth (pooled data 2022-23 & 2023-24)

Treatments		Length of spike (cm)	Length of spikelet (cm)	No. of spikelets/ spike	Test weight (g) (Volume basis 10mL)	Grain yield (kg/ha)	Straw yield (kg/ha)	Protein content	Protein yield
T_1: 25% N throughFYM + 75% RDN through inorganic fertilizer		51.36	14.29	56.96	6.133	1078	2333	12.35	133.10
T_2: FYM 5 t/ha + 100% RDN through inorganic fertilizer		57.72	15.89	67.19	6.330	1280	2728	13.47	172.63
T_3: 25% N through Biocompost + 75% RDN through inorganic fertilizer		53.16	14.95	60.10	6.187	1106	2468	12.98	143.85
T_4: Biocompost 5 t/ha + 100% RDN through inorganic fertilizer		61.73	16.15	73.21	6.317	1341	2796	14.07	188.78
T_5: 25% N through Vermicompost + 75% RDN through inorganic fertilizer		53.43	15.19	61.73	6.220	1146	2488	13.15	151.02
T_6: Vermicompost 5 t/ha + 100% RDN through inorganic fertilizer		62.96	17.28	73.62	6.400	1371	2916	14.15	193.89
T_7: FYM 5 t/ha		46.43	12.16	46.12	5.967	788	1893	11.46	90.20
T_8: Biocompost 5 t/ha		50.01	13.96	48.93	6.022	830	1972	11.73	97.71
T_9: Vermicompost 5 t/ha		50.77	14.17	50.85	6.037	924	2073	11.81	109.35
	SEm ±	2.12	0.57	2.50	0.102	41.89	94.4	0.24	6.72
	CD (P=0.05)	6.12	1.63	7.21	NS	120.68	272.0	0.70	19.35
	CV (%)	9.60	9.31	10.24	4.029	9.36	9.6	4.65	11.56
Y	**SEm ±**	1.001	0.267	1.180	0.048	19.748	44.503	0.115	3.166
	CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS
Y × T	**SEm ±**	3.004	0.801	3.539	0.144	59.245	133.510	0.344	9.497
	CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS

Table 3: Economics of grain amaranth as influenced by different treatments of integrated nutrient management (Average of 2022-23 and 2023-24)

Treatments	Yield (kg/ha)		Cost of cultivation (₹ /ha)			Gross returns (₹ /ha)	Net returns (₹ /ha)	BCR
	grain	Straw	Fixed Cost	Treatment Cost	Total			
T_1: 25 % N throughFYM + 75% RDN through inorganic fertilizer	1078	2333	31160	17099	48259	84849	36590	1.76
T_2: FYM 5 t/ha + 100% RDN through inorganic fertilizer	1280	2728	31160	20635	51795	100610	48815	1.94
T_3: 25 % N through Biocompost +75% RDN through inorganic fertilizer	1106	2468	31160	4927	36087	87410	51323	2.42
T_4: Biocompost 5 t/ha + 100% RDN through inorganic fertilizer	1341	2796	31160	8135	39295	105064	65768	2.67
T_5: 25 % N through Vermicompost + 75% RDN through inorganic fertilizer	1146	2488	31160	16071	47231	90276	43045	1.91
T_6: Vermicompost 5 t/ha + 100% RDN through inorganic fertilizer	1371	2916	31160	43135	74295	107667	33372	1.45
T_7: FYM 5 t/ha	788	1893	31160	17500	48660	62853	14193	1.29
T_8: Bio compost 5 t/ha	830	1972	31160	5000	36160	66164	30004	1.83
T_9: Vermi compost 5 t/ha	924	2073	31160	40000	71160	73082	1922	1.03

Note: Selling price of grain (₹ 68and ₹ 70 /kg) and straw (₹ 4.5 /kg)in 2022-23 and 2023-24,respectively.

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