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Effect of different organic sources of nitrogen on quality parameters and economics of amaranth (*Amaranthus spp*.) Cv. Arka suguna

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Abstract
The present investigation entitled, "Effect of different organic sources of nitrogen on growth, yield and quality of amaranth (*Amaranthus spp*.) cv. Arka Suguna" was carried out during late *kharif* 2016 at the farm of College of Horticulture, Sardarkrushinagar Dantiwada Agricultural University, Jagudan (Gujarat). Experiment was laid out in randomised block design with nine treatments *viz*., Control (T_1), 100% Nitrogen through FYM (T_2), 100% Nitrogen through Vermicompost (T_3), 100% Nitrogen through Castor Cake (T_4),100% Nitrogen through Poultry manure(T_5), 100% Nitrogen through Neem cake(T_6), 20% N from FYM + 20% N from Vermicompost + 20% N from Castor Cake + 20% N from Poultry manure + 20% N from Neem cake(T_7), 25% N from Poultry manure + 25% N from Neem cake + 25% N from FYM + 25% N from Vermicompost (T_8) and20% N from Castor Cake + 20% N from Vermicompost + 30% N from Poultry manure + 30% N from FYM(T_9).
The results revealed that the maximum chlorophyll (15.04) through SPAD meter reading, carotenoids (2.80mg/g) and protein (3.33%) was recorded with treatment 20% N from Castor Cake + 20% N from Vermicompost + 30% N from Poultry manure + 30% N from FYM(T_9) and maximum iron (3.27mg/100g) was recorded with treatment25% N from Poultry manure + 25% N from Neem cake + 25% N from FYM + 25% N from Vermicompost (T_8)

Keywords: Arka suguna, amaranth, organic manure, nitrogen, quality parameters, economics

Introduction
Vegetable growing is the most remunerative enterprise as it is adopted on small and marginal holding with high production in short duration. Being a source of farm income, it creates impact on the agricultural development and economy of the country. Vegetables are cheaper source of minerals, vitamins and with high caloric values. There is an increasing demand of vegetables both for domestic as well as for export market, which can earn valuable foreign exchange for the country.
Amaranth (*Amaranthus spp*.) originated in America and it is one of the oldest food crops in the world, with evidence of its cultivation reaching back as far as 6700 BC. The genus *Amaranthus* consists of nearly 60 species; most of them are cultivated as leafy vegetables, grains or ornamental plants, while others are weeds. It is the most common leafy vegetable grown during summer and rainy season in India. The present production and consumption of vegetables in the country are very inadequate being only about one-fourth to one-third of requirement. The population being increased without check is the main handicap in our progress with the result of that food shortage, malnutrition and poverty occurs. Therefore, there is an urgent need to increase the vegetable production by bringing more area under vegetable cultivation and adoption of improved technologies. However, due to heavy pressure of industrialization and urbanization, there is literally no scope to increase the area under vegetables therefore the only way is to increase the production of vegetables per unit area by scientific cultivation.
Van Soest *et al*. (1991) [10] have reported leafy vegetables to contribute significant amount of vitamins and minerals to the human diet and are also excellent sources of protein, carotene (vitamin A), iron and ascorbic acid (vitamin C) and this group of vegetables are also referred to as 'mines of minerals'. It is in this backdrop that a field experiment was attempted to assess the performance of leafy vegetables. For maintaining proper physique, recommendation have been made by the dieticians is 300 g of total vegetables per day per person, out of which 125 g

of leafy, 100 g of roots and 75 g of other vegetables. Therefore, amaranth plays an important role for continuous supply of leafy vegetables in summer.

The leaves and tender stem of amaranth are rich in protein, minerals, carbohydrates, vitamin A and C. It is also a rich source of magnesium, phosphorus, sodium, riboflavin, potassium, sulphur and nicotinic acid. There are two varieties based on leafy colour *i.e.* green and red leaf. The most common amaranth popular in India are *A. tricolor*, *A. dubius* and *A. blitum*. amaranth leaves as well as the softest portions of the shoots are usually boiled in water and then cooked with onions, tomatoes, oil and other additives of modern culinary delights. Its leaves are combined with condiments to prepare soup. The flavour of raw and cooked vegetable amaranth was reported as equal to or better than spinach or other similar greens.

Organic fertilizers also had a positive effect on soil microbial population resulting in enhanced soil biomass, carbon, nitrogen content, and dehydrogenase activity. To compensate the short supply and to mitigate recent price hike in inorganic fertilizers, use of indigenous sources like farmyard manure, vermicompost, poultry manure, neem cake and castor cake, etc. should be necessary. Use of organic manures not only helps to sustain crop yields but also plays a key role in improving the physical, chemical and biological properties and also increases the efficiency of applied fertilizers (Singh and Biswas, 2000) [8].

FYM is principle source of organic matter in our country. Application of FYM alone or in combination with Bio-fertilizer helps in proper supply of nutrition and maintaining soil health. It supplies all the essential plant nutrients, which improve the physico-chemical properties, increases water holding capacity and encourages the soil microbial activities. FYM is also advantageous for its residual value. It contains about 0.42% N, 0.23% P_2O_5 and 0.51% K_2O.

Castor cake is produce by crushing castor seeds in expeller to extract oil from it in a control temperature with help of steam. It contains about 4.32% N, 1.81% P_2O_5 and 1.32% K_2O.

Vermicompost is adopted as organic manure produced by use of earth worms. Earth worms play an important role in organic farming by vermin technology is a cost effective method for converting all types of bio-wastes in to nutrient rich organic manure. It modified physical, chemical and bio-chemical properties of soil. It contains about 1.60% N, 2.20% P_2O_5 and 0.67% K_2O.

Poultry manure is nutrient rich organic manure, since in birds, liquid and solid excreta are excreted together resulting in a no urine loss. Poultry manure ferments very quickly. Poultry manure contains 2.87% N, 2.93% P_2O_5 and 2.35% K_2O.

Neem cake organic manure protects plant roots from nematodes, soil grubs and white ants probably due to its residual limonoid content. It also acts as natural fertilizer with pesticidal properties and also reduces alkalinity in soil, as it produces organic acids during decomposition. It is a potential source of organic manure, which contains 5.21% N, 1.02% P_2O_5 and 1.41% K_2O. Being totally neutral, it is compatible with soil microbes, improves and rhizosphere micro flora and hence ensures fertility of soil.

Therefore, looking to all these factor combination of different organic sources of nitrogen in amaranth is the need of the regional farmer. Keeping this view an experimental was conducted on "Effect of different organic sources of nitrogen on growth, yield and quality of amaranth (*Amaranthus spp*.) cv. Arka Suguna".

Materials and methods

The field experiments were conducted during kharif seasons of 2016 at College of Horticulture, Sardarkrushinagar Dantiwada Agricultural University, Jagudan. Jagudan is about 10 km away from Mehsana and it is located on 72^0 43' East longitude and 23^0 50' North latitude at an elevation of 87 meters above the Mean Sea Level. It represents the North Gujarat Agro-climatic zone.

This zone is typically characterized by semi-arid region with cool winter and quite hot and dry summer. Generally, monsoon commences in the middle of June and retreats by the middle of September. Most of the precipitation is received from South-West monsoon concentrating in the month of July and August. The winter season starts by the end of October and continuous till the last week of February. The minimum temperature of the year is usually in the month of December or January. The temperature starts rising from end of February and reaches maximum in the month of May. April and May are the hottest months of summer season.

The standard week wise meteorological data on maximum and minimum temperature, relative humidity, bright sunshine hours and rainfall pertaining to the period of this investigation as recorded at the Meteorological Observatory, Seed Spices Research Station, Sardarkrushinagar Dantiwada Agricultural University, Jagudan, District: Mehsana. The experiment was laid out in a randomized block design with nine treatment were employed and replicated four time. Seed of *Amaranthus* cultivar Arka Suguna were collected from Indian Institute Horticultural Research, Bangalore for conducting present study.

The five different organic manures *viz.*, Farmyard manure, Vermicompost, Castor Cake, Poultry manure, Neem cake as a source of nitrogen with or without chemical fertilizers were tested during kharif season of year 2016.

Treatments	Treatment details
T_1	Control (RDF FYM 25 t/ha and N:P:K 100:50:50 kg/ha)
T_2	100% Nitrogen through FYM
3	100% Nitrogen through Vermicompost
T_4	100% Nitrogen through Castor Cake
T_5	100% Nitrogen through Poultry manure
T_6	100% Nitrogen through Neem Cake
T_7	20% N from FYM + 20% N from Vermicompost + 20% N from Castor Cake + 20% N from Poultry manure + 20% N from Neem cake
T_8	25% N from Poultry manure + 25% N from Neem cake + 20% N from FYM + 25% N from Vermicompost
T_9	20% N from Castor Cake + 20% N from Vermicompost + 30% N from Poultry manure + 30% N from FYM

To raise the crop recommended package of practices were followed. The treatments were evaluated on the basis of growth, and yield performance from ten randomly selected tagged plants at different stages. The mean data were subjected to statistical analysis following analysis of variance technique (Panse and Sukhatme, 1985) [6]

Results and Discussion

Effect of different organic sources of nitrogen on quality parameters

1. Chlorophyll content (SPAD meter reading)

Effect of different organic sources of nitrogen on chlorophyll content are presented in table 1 and graphically depicted in Fig. 1.

Inspection of data showed significant difference for chlorophyll content (SPAD meter reading) among different organic sources of nitrogen. Significantly maximum chlorophyll content (15.04) was found in treatment of T_9 (20% N from castor cake + 20% N from vermicompost + 30% N from poultry manure + 30% N from FYM) and it was at par with application of T_7,T_8 whereas minimum chlorophyll content (12.99) was recorded under control treatment (T_1).

Significant variation among different sources of organic nitrogen on chlorophyll content might be due to involvement of nitrogen in chlorophyll formation. The results are accordance with Kavitha *et al*. (2013) [3] in *Amaranthus*.

2. Carotenoid content (mg/g)

Effect of different organic sources of organic nitrogen on carotenoid content are presented in table 1 and graphically depicted in Fig 2.

The data showed significant difference for carotenoid content (mg/g) among different organic sources of nitrogen. Significantly maximum carotenoid content (2.80 mg/g) was found under treatment of T_9 (20% N from castor cake + 20% N from vermicompost + 30% N from poultry manure + 30% N from FYM), whereas minimum carotenoid content (2.45 mg/g) was recorded with treatment of T_1 (control).

Carotenoid content with increase in the use of different organic manures might be due to positive correlation between chlorophyll content and carotenoid content. The resuls are accordance with the similar findings are accordance with Upadhyay *et al.* (2012) [9] in cabbage and Kavitha *et al.* (2013) [3] in *Amaranthus*.

3. Protein Content (%)

Data pertaining to Effect of different organic sources of nitrogen on protein content are presented in table 1 and graphically depicted in Fig 3.

Data pertaining to Effect of different organic sources of nitrogen on protein content (%) were found significant, which were in range of 2.88% to 3.33%. Significantly maximum protein content (3.33%) was recorded in treatment of T_9 (20% N from castor cake + 20% N from vermicompost + 30% N from poultry manure + 30% N from FYM) and it was at par with application of T_8 while minimum protein content (2.88%) was observed under control treatment (T_1).

Different organic sources has contain nitrogen in good level and nitrogen play good role in protein formation, so in this process by use of different organic sources is helpful to increase protein content because they contain good level of nitrogen. These results are similar to findings of Adekayode (2004) [1] and Naimuddin *et al*. (2013) [4] in *Amaranthus*.

4. Iron content (mg/100g)

Effect of different organic sources of nitrogen on iron content are presented in table 1 and graphically depicted in Fig 4.

Data pertaining to effect of different organic sources of nitrogen on Iron content (mg/100g) of amaranth were found significant, which were in range of 2.84 to 3.27 (mg/100g). Significantly maximum iron content (3.27mg/100g) was recorded in treatment 25% N from poultry manure + 25% N from neem cake + 25% N from FYM + 25% N from vermicompost (T_8) and it was at par with application of T_9, while minimum iron content (2.84 mg/100g) was recorded in control treatment (T_1).

Application of organic nutrient sources increased the quality parameters like iron because soil that has been managed organically has congenial environment for microorganisms which produce compounds that influence the plant to absorb more micronutrients from soil. These results are similar to findings of Kavitha *et al*. (2013) [3] in *Amaranthus* and Kumar *et al.* (2015) in cabbage.

Economics

The economics indicating cost of cultivation, gross return, net return and benefit: cost ratio under various levels of different organic sources of nitrogen are furnished in Table 2.

Results regarding economics i.e., cost of cultivation, gross returns, net return and Cost : Benefit Ratio are summarized in Table 2. The results indicated that treatment T_9 (20% N from castor cake + 20% N from vermicompost + 30% N from poultry manure + 30% N from FYM) recorded maximum gross return (₹ 202040/ha), net return (₹151854.20/ha) and Benefit Cost Ratio (4.02). While, the minimum Benefit Cost Ratio found under the treatment T_1 (Control).

Table 1: Effect of different organic sources of nitrogen on chlorophyll content at 2nd cutting (SPAD meter reading), carotenoid content at 2nd cutting (mg/g), protein content (%) at 2nd cutting and Iron content at 2nd cutting (mg/100g)

Treatments	Chlorophyll content at 2nd cutting (SPAD meter reading)	Carotenoid content at 2nd cutting (mg/g)	Protein content at 2nd cutting (%)	Iron content at 2nd cutting (mg/100g)
Control	2.45	2.88	2.84	12.99
100% N through FYM	2.47	2.90	2.86	13.07
100% N through Vermicompost	2.52	3.08	2.95	13.91
100% N through Castor cake	2.50	3.03	2.92	13.91
100% N through Poultry manure	2.55	3.15	2.98	14.44
100% N through Neem cake	2.47	2.94	2.87	13.85
20% N from FYM + 20% N from vermicompost +20% N from castor cake + 20% N from poultry manure + 20% N from neem cake	2.57	3.20	3.02	14.68
25% N from poultry manure +25% N from neem cake + 25% N from FYM + 25% N from vermicompost	2.63	3.32	3.27	14.82
20% N from castor cake + 20% N from vermicompost + 30% N from poultry manure + 30% N from FYM	2.80	3.33	3.26	15.04
S.Em±	0.04	0.04	0.04	0.16
C.D. at 5%	0.11	0.11	0.12	0.46
C. V.%	2.85	2.48	2.79	2.22

Table 2: Economics and benefit cost ratio of amaranth for different treatments

Treatments	Yield/ha (q)	Gross returns (₹/ha)	Cost of cultivation (₹/ha)	Net returns (₹/ha)	Benefit: Cost Ratio
T_1	76.791	153582.00	58245.92	95336.08	2.63
T_2	79.412	158824.00	51909.00	106915.00	3.05
T_3	82.046	164092.00	59350.00	104742.00	2.76
T_4	80.760	161520.00	45455.00	116065.00	3.55
T_5	82.392	164784.00	45500.00	119284.00	3.62
T_6	79.787	159574.00	54966.00	104608.00	2.90
T_7	83.911	167822.00	51440.30	116381.70	3.26
T_8	84.160	168320.00	52934.75	115385.25	3.17
T_9	101.020	202040.00	50185.20	151854.80	4.02

The selling price of amaranth was ₹ 20/kg.

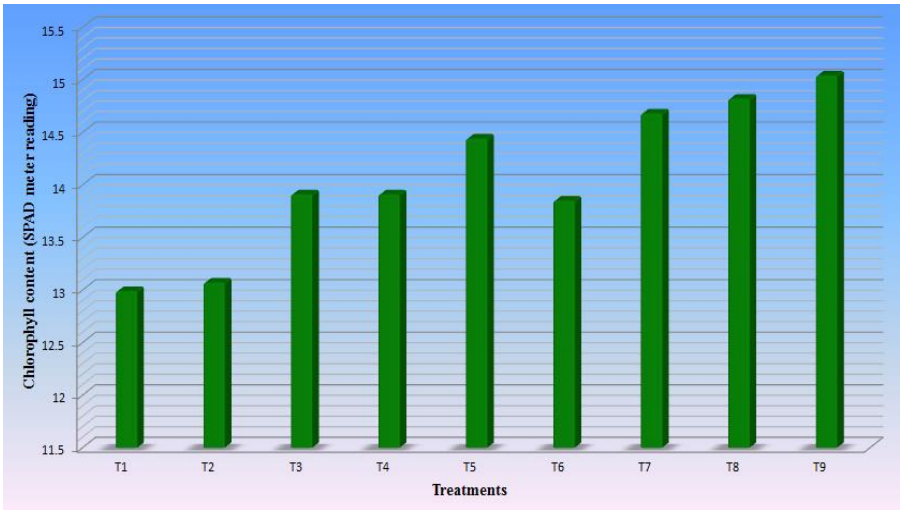

Fig 1: Effect different organic sources of nitrogen on chlorophyll content (SPAD meter reading)

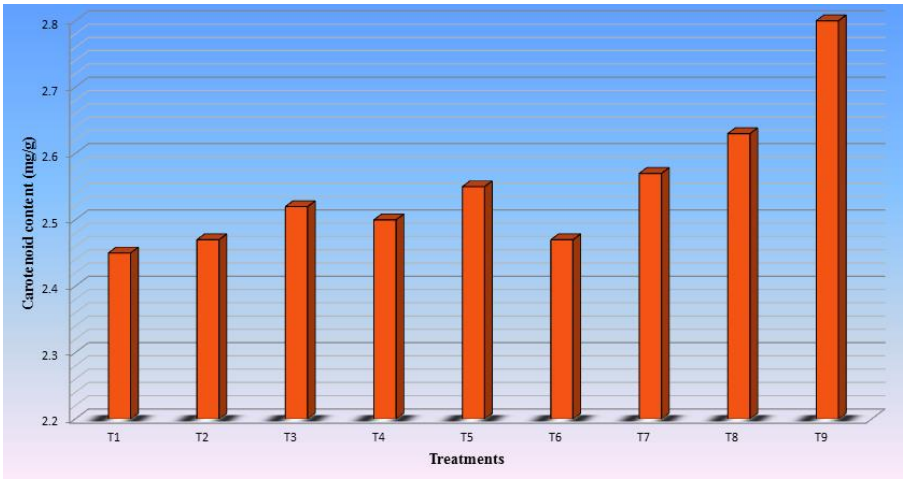

Fig 2: Effect of different organic sources of nitrogen on carotenoid content (mg/g)

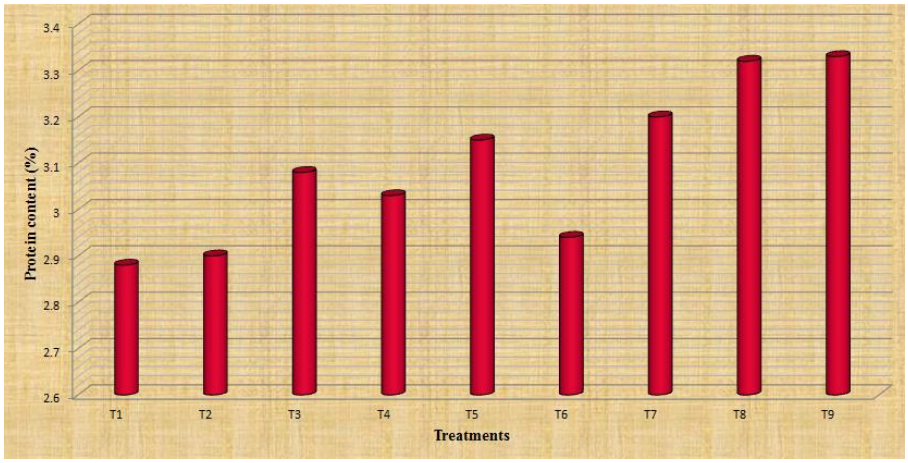

Fig 3: Effect of different organic sources of nitrogen on protein content (%)

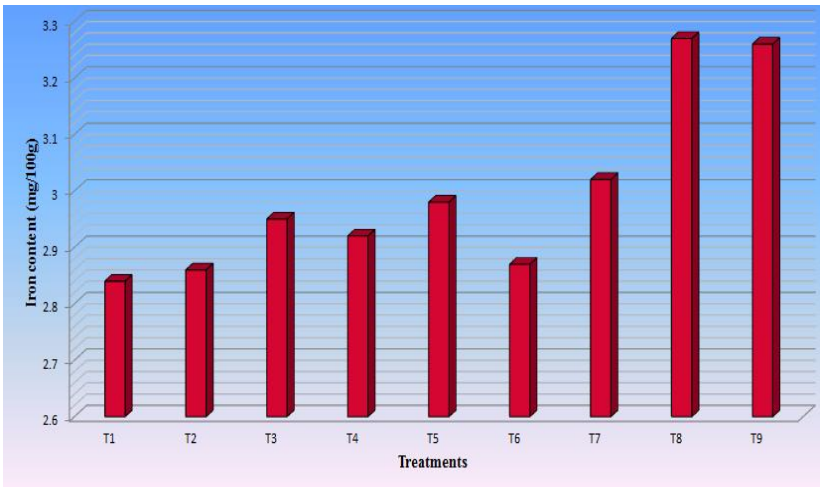

Fig 4: Effect of different organic sources of nitrogen on Iron content (mg/100g)

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