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Effect of different organic sources of nitrogen on growth parameters and yield attributes of amaranth (*Amaranthus Spp*.) Cv. Arka Suguna

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Abstract
An experiment was conducted to examine the response of five different organic manures *viz.*, Farmyard manure, Vermicompost, Castor Cake, Poultry manure, Neem cake as a source of nitrogen with or without chemical fertilizers in randomised block design with four replications during the kharif season of the year 2016. The results revealed that the significantly minimum days taken for first cutting at 20 cm height (23.25) and third subsequent cutting (44.00) at 20 cm height was recorded with treatment 20% N from Castor Cake + 20% N from Vermicompost + 30% N from Poultry manure + 30% N from FYM(T_9). The significant minimum days taken for fourth subsequent cutting (57.75) at 20 cm height was recorded with both treatments20% N from Castor Cake + 20% N from Vermicompost + 30% N from Poultry manure + 30% N from FYM(T_9) and 25% N from Poultry manure + 25% N from Neem cake + 25% N from FYM + 25% N from Vermicompost (T_8).Whereas, the effect of different sources of organic nitrogen was not found significant difference with respect to days taken for second cutting. The total number of cuttings is equal in all the treatments. The significantly maximum yield of first cutting (443.74g), second subsequent cutting (444.64g), third subsequent cutting (441.52g) and fourth subsequent cutting (442.97g) at 20 cm height was recorded with treatment 20% N from Castor Cake + 20% N from Vermicompost + 30% N from Poultry manure + 30% N from FYM(T_9). The maximum yield per plot (1.773 kg) and yield per hectare (101.02q) was recorded with treatment 20% N from Castor Cake + 20% N from Vermicompost + 30% N from Poultry manure + 30% N from FYM (T_9).

Keywords: Arka Suguna, amaranth, organic manure, nitrogen, growth, yield

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) [11] 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) [10].

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.

To sustain soil health and benign environment there is a need for standardization the conjunctive use of organic and inorganic sources of nutrition in order to increase the productivity and alternately improving the soil health. The concept of use of organic sources to nitrogen management is gaining considerable momentum today but negligible study has been conducted so, the present investigation was planned on amaranth.

Materials and methods

The investigation was conducted at College of Horticulture, Sardarkrushinagar Dantiwada Agricultural University, Jagudan. 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. The experiment was laid out in a randomized block design with nine treatment were employed and replicated four time.

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
T_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) [8]. The soil status of experimental field as follows

Physico-chemical properties of the experimental soil

Sr. No.	Properties		Soil depth (15-30cm)	Method employed
[A]	Physical			
	(a)	Sand (%)	74.83	International Pipette method (Piper, 1950)
	(b)	Silt (%)	19.21	
	(c)	Clay (%)	5.56	
	(d)	Textural classes	Loamy sand	
[B]	Chemical			
	(a)	Soil pH	7.9	Potentiometric method (Jackson, 1973)

		(1:2.5, soil: water ratio)		
	(b)	Electrical conductivity (dSm^{-1}) (1:2.5, soil: water ratio)	0.30	Schofield method (Jackson, 1973)
	(c)	Organic carbon (%)	0.33	Walklely and Black's rapid titration method (Jackson, 1973)
	(d)	Available N (Kg ha^{-1})	181	Alkaline permanganate method (Subbiah and Asija, 1956)
	(e)	Available P_2O_5 (Kg ha^{-1})	38	Olsen method (Jackson, 1973)
	(f)	Available K_2O (Kg ha^{-1})	345	Flame photometer method (Jackson, 1973)

Results and Discussion

Effect of different organic sources of nitrogen on growth parameters

1. Days taken for first cutting at 20 cm height

Effect of different organic sources of nitrogen on days taken for first cutting are presented in table 1 and graphically depicted in Fig 1.

Data showed that effect of different organic sources of nitrogen on days taken for first cutting was found significant, which were in range of 23.25 to 28.25 days. Significantly minimum days taken for first cutting (23.25) was recorded in treatment 20% N from castor cake + 20% N from vermicompost + 30% N from poultry manure + 30% N from FYM (T_9) and it was at par with treatment of T_2 (100% N through FYM) whereas maximum days taken for first cutting (28.25) was recorded in control treatment (T_1).

2. Days taken for subsequent cutting at 20 cm height

2.1 Days taken for second cutting at 20 cm height

Effect of different organic sources of nitrogen on days taken for second cutting are presented in table 1 and graphically depicted in Fig.1.

Data showed that effect of different organic sources of nitrogen was found not significant with respect to days taken for second cutting which were in range of 35.50 to 39.25 days. minimum days taken for first cutting (35.50) was recorded under treatment 20% N from castor cake + 20% N from vermicompost + 30% N from poultry manure + 30% N from FYM (T_9) and also in treatment 25% N from poultry manure + 25% N from neem cake + 25% N from FYM + 25% N from vermicompost (T_8), whereas maximum days taken for first cutting (39.25) was recorded in control treatment (T_1). These finding are similar to Raghuwanshi *et al* (2016) [9] in fenugreek.

2.2 Days taken for third cutting at 20 cm height

Effect of different organic sources of nitrogen on days taken for third cutting are presented in table 1 and graphically depicted in Fig. 1.

Data pertaining to the effect of different organic sources of nitrogen on days taken for third cutting was found significant, which were in range of 44.00 to 47.75 days. Significantly minimum days taken for first cutting (44.00) was observed under treatment 20% N from castor cake + 20% N from vermicompost + 30% N from poultry manure + 30% N from FYM (T_9) and it was at par with application of T_2, T_3, T_4, T_5, T_6 & T_7, whereas, maximum days taken for first cutting (47.75) was recorded in control treatment (T_1).

2.3 Days taken for fourth cutting at 20 cm height

Effect of different organic sources of nitrogen on days taken for fourth cutting was found significant which is presented in Table 1.

Data showed that effect of different organic sources of nitrogen on days taken for fourth cutting was found significant, which were in range of 57.75 to 62.25 days. Significantly minimum days taken for fourth cutting (57.75) was found with treatment 20% N from castor cake + 20% N from vermicompost + 30% N from poultry manure + 30% N from FYM (T_9) and also under treatment 25% N from poultry manure +25% N from neem cake + 25% N from FYM + 25% N from vermicompost (T_8). It was at par with application of T_2, T_3, T_4, T_5, T_6 & T_7. Whereas, maximum days taken for first cutting (62.25) was recorded in control treatment (T_1).

The application of nitrogen through organic manure which also provided other essential micronutrients and minerals in integrated way. It might be encouraged the vigorous growth of root system which ultimately helped in better absorption and utilization of nutrients from soil solution as a results of high dry matter accumulation took place and their translocation in plant parts, which in turn reflected in batter plant growth. These results are similar to the findings of Parmar and Patel (2009) [5] and Kavitha *et al.* (2013) [4] in amaranthus.

3. Total number of cutting

The effect of different organic sources of nitrogen on total number of cutting are presented in table 1.

It was observed that number of cutting was not influenced by any treatment. The number of cuttings remain same in all the treatment. So nothing can be concluded from data.

Effect of different organic sources of nitrogen on yield attributes

1. Yield of first cutting at 20 cm height (g)

Effect of different organic sources of nitrogen on yield of first cutting are presented in table 2 and graphically depicted in Fig. 2.

The data showed significant difference for yield of first cutting (g) among different organic sources of nitrogen Significantly maximum yield of first cutting (443.74 g) was recorded with treatment 20% N from castor cake + 20% N from vermicompost + 30% N from poultry manure + 30% N from FYM (T_9), whereas lowest yield of first cutting was (332.44 g) observed in control treatment (T_1).

2. Yield of subsequent cutting at 20 cm height (g)

2.1 Yield of second cutting at 20 cm height (g)

Effect of different organic sources of nitrogen on yield of second cutting are presented in table 2 and graphically depicted in Fig. 2.

The data showed significant difference for yield of second cutting (g) among different organic sources of nitrogen. Significantly the highest yield of second cutting (444.64 g) was recorded with the treatment 20% N from castor cake + 20% N from vermicompost + 30% N from poultry manure + 30% N from FYM (T_9), while least yield of second cutting (336.27 g) was observed in control treatment (T_1).

2.2 Yield of third cutting at 20 cm height (g)

Effect of different organic sources of nitrogen on yield per plot of third cutting are presented in table 2 and graphically depicted in Fig. 4.2.

The data pertaining significant difference for yield of third cutting (g) among different organic sources of nitrogen. Significantly the highest yield of third cutting (441.52 g) was recorded with treatment 20% N from castor cake + 20% N from vermicompost + 30% N from poultry manure + 30% N from FYM (T_9), whereas, the lowest yield of third cutting (342.19 g) was recorded in control treatment (T_1).

2.3 Yield of fourth cutting at 20 cm height (g)

The Effect of different organic sources of nitrogen on yield of fourth cutting are presented in table 2 and graphically depicted in Fig. 2.

Reported data showed a significant difference for Effect of different organic sources of nitrogen on yield of fourth cutting (g) which were in range from 336.77 g to 442.97 g. The highest yield of fourth cutting (442.97 g) was observed in treatment 20% N from castor cake + 20% N from vermicompost + 30% N from poultry manure + 30% N from FYM (T_9), while the least yield of fourth cutting (336.77 g) was observed with control treatment (T_1).

Due to the application of nitrogen through different organic sources, plants received sufficient amount of other essential elements throughout their growth period and nourished properly which improved the green leaves yield in first cutting as well as in subsequent cuttings (2nd, 3rd, and 4th). These results are similar to findings of Adekayode (2004) [1] and Akaparobi (2009) [3] in amaranthus.

2.3 Total yield per plot (kg)

Total yield per plot as influenced by Effect of different organic sources of nitrogen are summarized in Table 2 and graphically depicted in Fig 4.3.

Inspection of data showed significant difference for yield per plot among different organic sources of nitrogen. Significantly maximum total yield per plot (1.773 kg) was recorded in treatment 20% N from castor cake + 20% N from vermicompost + 30% N from poultry manure + 30% N from FYM (T_9), whereas minimum yield per plot (1.348 kg) was recorded in control treatment (T_1). These finding similar to Adekayode (2004) [1] and Akaparobi (2009) [3] in amaranthus.

2.4 Yield per hectare (q)

Yield per hectare as influenced by Effect of different organic sources of organic are summarized in Table 2 and graphically depicted in Fig 3.

Inspection of data showed significant difference for yield per hectare (q) among different organic sources of nitrogen. Significantly maximum yield per hectare (101.02 q) was recorded in treatment 20% N from castor cake + 20%N from vermicompost + 30% N from poultry manure + 30% N from FYM (T_9), whereas minimum yield per hectare (76.79 q) was recorded with control treatment (T_1). These results are similar to findings of Adewole, M. B. and Dedeke, O. A. (2012) [2] in amarathus.

Table 1: Effect of different organic sources of nitrogen on days taken for first and subsequent cutting at 20 cm height and total number of cutting

Treatments		Days taken for first cutting at 20 cm height	Days taken for second subsequent cutting at 20 cm height	Days taken for third subsequent cutting at 20 cm height	Days taken for fourth subsequent cutting at 20 cm height	Total number of cutting
T_1	Control	28.25	39.25	47.75	62.25	4.00
T_2	100% N through FYM	26.75	38.00	47.25	63.50	4.00
T_3	100% N through Vermicompost	25.50	37.75	47.00	61.25	4.00
T_4	100% N through Castor cake	25.75	37.75	47.00	61.75	4.00
T_5	100% N through Poultry manure	25.25	37.50	46.00	61.00	4.00
T_6	100% N through Neem cake	26.25	38.00	47.25	61.75	4.00
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	25.00	37.00	45.50	60.25	4.00
T_8	25% N from poultry manure +25% N from neem cake+ 25% N from FYM+ 25% N from vermicompost	23.75	35.50	44.50	57.75	4.00
T_9	20% N from castor cake + 20% N from vermicompost + 30% N from poultry manure + 30% N from FYM	23.25	35.50	44.00	57.75	4.00
	S.Em±	0.56	0.81	0.84	1.16	-
	C.D. at 5%	1.65	NS	2.84	3.40	-
	C. V.%	4.42	4.33	3.64	3.83	-

Table 2: Effect of different organic sources of nitrogen on yield per plot of first and subsequent cutting at 20 cm height (g), yield per plot (kg) and per hectare (q)

Treatments		Yield of first cutting at 20 cm height (g)	Yield of second subsequent cutting at 20 cm height (g)	Yield of third subsequent cutting at 20 cm height (g)	Yield of fourth subsequent cutting at 20 cm height (g)	Yield per plot (kg)	Yield per ha (q)
T_1	Control	332.44	336.27	342.19	336.77	1.348	76.79
T_2	100% N through FYM	352.07	346.56	344.95	350.09	1.394	79.41
T_3	100% N through Vermicompost	364.75	358.82	360.13	356.19	1.440	82.04
T_4	100% N through Castor cake	359.21	351.61	351.85	354.65	1.417	80.76
T_5	100% N through Poultry manure	367.46	358.61	361.51	358.39	1.446	82.39
T_6	100% N through Neem cake	350.62	348.59	350.47	350.57	1.400	79.78
T_7	20% N from FYM + 20% N from vermicompost + 20% N from	379.15	367.16	364.26	362.04	1.473	83.91

	castor cake + 20% N from poultry manure + 20% N from neem cake						
T8	25% N from poultry manure + 25% N from neem cake+ 25% N from FYM+ 25% N from vermicompost	379.95	366.29	367.02	363.73	1.477	84.16
T9	20% N from castor cake + 20% N from vermicompost + 30% N from poultry manure + 30% N from FYM	443.74	444.64	441.52	442.97	1.773	101.02
	S.Em±	19.13	19.12	18.31	18.70	0.05	2.71
	C.D. at 5%	55.85	55.82	53.44	54.58	0.14	7.90
	C. V.%	10.34	10.50	10.03	10.28	6.49	6.49

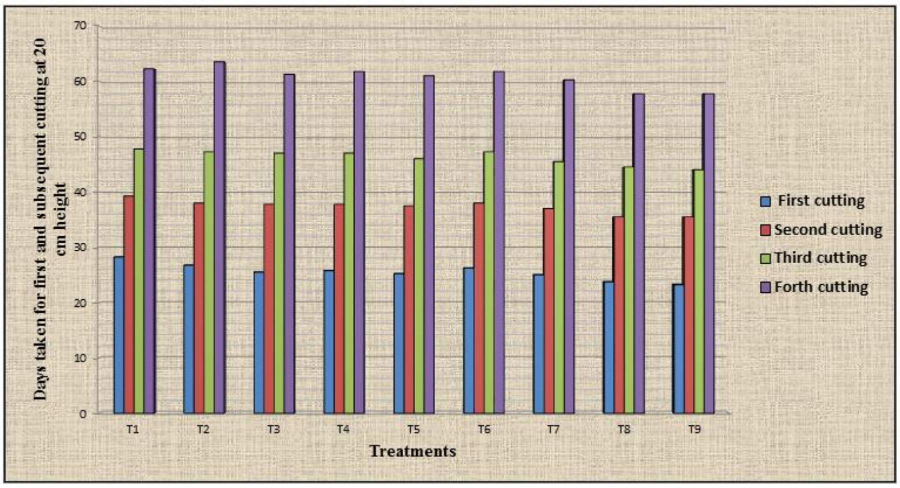

Fig 1: Effect of different organic sources of nitrogen on days taken for first and subsequent cutting at 20 cm height

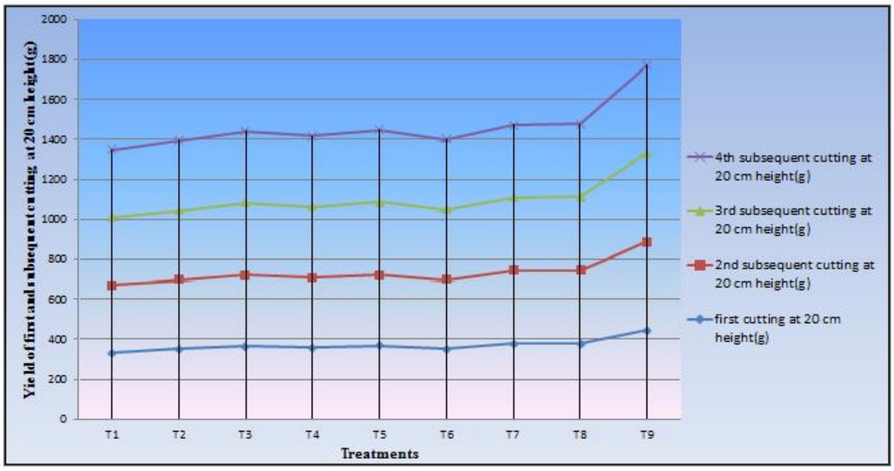

Fig 2: Effect of different organic sources of nitrogen on yield of first and subsequent cutting at 20 cm height (g)

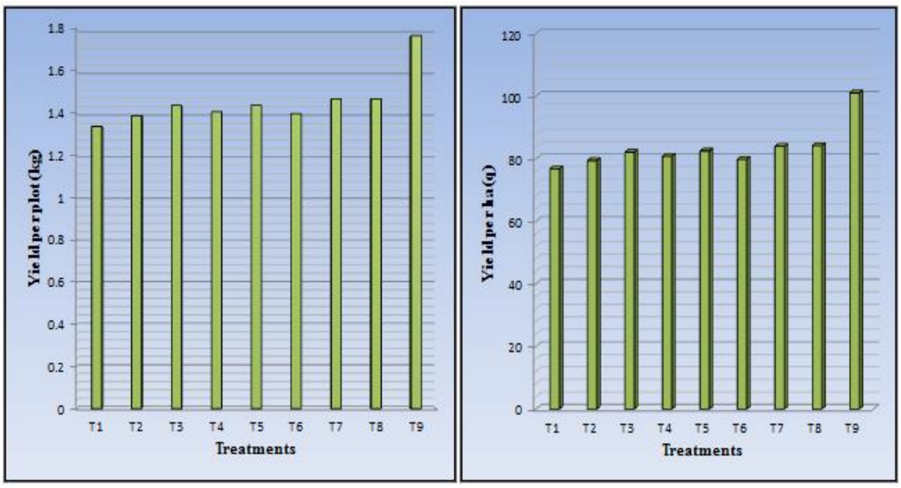

Fig 3: Effect of different organic sources of nitrogen on yield per plot (kg) and per hectare (q)

Conclusion
In view of the results obtained from present investigation, it is concluded that application of 20% N from castor cake + 20% N from vermicompost + 30% N from poultry manure + 30% N from FYM should be applied to obtain the better growth parameters and maximum yield of amaranth under the North Gujarat condition.

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