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Effect of fresh cow dung slurry soil application on growth and quality parameters of okra (*Abelmoschus esculentus* L. Moench) fruits

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Abstract
The objective of this study was to determine the effect of fresh cow dung on growth and quality parameters and nutrient content of okra. The field experiment comprised of eight treatments and conducted in randomized block design with three replications. Treatments consist of (T_1) Control, Recommended dose of fertilizer N:P: K (150:50:00 kg/ha) (T_2), 75% RDF + 1000 kg cow dung/ha as basal (T_3), 75% RDF + 1000 kg cow dung/ha (50% as basal and 50% at 30 days after sowing) (T_4), 75% RDF + 1500 kg cow dung/ha as basal (T_5), 75% RDF + 1500 kg cow dung/ha (50% as basal and 50% at 30 days after sowing) (T_6), 75% RDF + 2000 kg cow dung/ha as basal (T_7) and 75% RDF + 2000 kg cow dung/ha (50% as basal and 50% at 30 days after sowing) (T_8). The result indicated that treatment T_6 [75% RDF + 1500 kg cow dung/ha (50% as basal and 50% at 30 days after sowing)] gave minimum days to 50% flowering (42.00), minimum days to first picking (47.00), maximum plant height (194.34 cm), maximum number of branches/plant (3.11). While, maximum days to last picking (106.67) was noted in T_8 [75% RDF + 2000 kg cow dung/ha (50% as basal and 50% at 30 days after sowing)], maximum chlorophyll content (SPAD) (50.18), minimum crude fiber (30.74%) and maximum ascorbic acid (16.44 mg/100 g). In chemical analysis maximum fruit nutrient content (2.88% N, 0.62% P, 1.44% K) and maximum plant nutrient content (1.60% N, 0.37% P, 2.03% K) also obtained in T_6 [75% RDF + 1500 kg cow dung/ha (50% as basal and 50% at 30 days after sowing)].

Keywords: Okra, fresh cow dung, growth characters, chlorophyll content, ascorbic acid, crude fiber, nutrient content

Introduction
Vegetable is common in our diet. A meal without vegetable supposed to be incomplete. For balance diet the daily consumption of vegetables is essential. Vegetables are important part of healthy eating and provide many nutrients, including potassium, fiber, folic acid and vitamins A, E and C. Hence, vegetables are called as "Health capsules" as well as "Mines of minerals". Indian subcontinents are capable for producing higher horticultural and field crops due to vast diversity of land, soil, climatic conditions etc. After green revolution, different improved cultural practices or scientific technologies should be adopted, which will lead to increase the vegetable production. Hence, the vegetable area, production or productivity increase year after year. India ranks second in vegetable production, after china. The contribution of vegetables remains highest (59-61%) in horticultural crops over the last five years (Yadav *et al*., 2020) [24]. Several vegetables are consumed in India. Among them okra is considered as a one of them most popular vegetables. All parts of okra like fresh leaves, buds, flowers, pods, stems and seeds can be used for different purposes and hence it is a multipurpose crop in terms of its uses (Gemede, 2015) [13]. It is one of the most important consumable crops of the India; immature and tender pods can be consumed as the boiled and fried vegetables or could be utilized as it may be added to soups and stews. In India, the major okra growing states are West Bengal, Gujarat, Bihar, Odisha, Jharkhand, Uttar Pradesh, Chhattisgarh, Madhya Pradesh, Andhra Pradesh etc. In India, okra is cultivated in area of 5.13 lakh ha and 6.17 million MT production with 12.24 MT/ha productivity (Yadav *et al*., 2020) [24]. Gujarat state ranks second position in okra production throughout India. Composition per 100 g of edible portion of okra contains, calories 35.0 mg, calcium 66.0 mg, moisture 89.6 g, iron 0.35 mg, carbohydrates 6.4 g, potassium 103.0 mg, protein 1.9 g, magnesium 53.0 mg, fat 0.2 g, copper 0.19 mg, fiber 1.2 g, riboflavin 0.01 mg, minerals 0.7g, thiamine 0.07 mg, phosphorus 56.0 mg, nicotinic acid 0.06 mg, sodium 6.9 mg, vitamin C 13.10 mg, sulphur 30.0 mg and oxalic acid 8.0 mg (Gopalan *et al.*, 2007) [14].

Crop removes large quantity of plant nutrients from soil, particularly the removal of NPK nutrients at the present level of crop production has been estimated at 125 kg/ha/annum whereas the annual addition is not more than 75 kg resulting in depletion of the nutrient reserve of soil. The excessive reliance on chemical fertilizers and the negligence shown to the conservation and use of organic sources of nutrients have not only caused the exhaustion of soil of its nutrient reserves but also resulted in soil health problems not conducive to achieving consistent increase in agricultural production. Moreover, Indian soils are poor in organic matter and in major plant nutrients. Soil organic matter is the key to soil fertility and productivity. In the absence of organic matter, the soil is a mixture of sand, silt and clay. Organic matter induces life into this inert mixture and promotes biological activities (Chandra, 2005) [6]. Therefore, organic amendments such as crop residues, animal manures or compost have been widely recognized as a vital agricultural fertilizer resource to improve the soil health and grain yield in Indian agro-ecosystem. Cow manure is a sustainable method for efficient nutrient usage which enhances efficiency of the chemical fertilizers and also can improve the properties of soil. Fresh cow dung slurry is a most important source of organic liquid manure which enhances productivity in long term with maintained the soil health and enhances the microbial population. Beside it, application of fresh cow dung slurry in proper and sustainable way can enhance not only productivity but also minimizes the chances of bacterial and fungal pathogenic diseases. Nutrient content in cow dung slurry is 0.7% N, 0.285% P2O5, and 0.231% K2O (Devakumar *et al*., 2014) [9]. It also contains 24 various minerals like nitrogen, potassium along with trace amount of sulphur, iron, magnesium, copper, cobalt and manganese. The indigenous Indian Cow also contain higher amount of calcium, phosphorus, zinc and copper than the crossbreed cow (Garg and Mudgal, 2007) [12]. C:N ratio in cow dung manure is an indication that it could be a good source of protein for the microbes which involved in decomposition of organic matter. (Adegunloye *et al*., 2007) [1].

Materials and Methods

The present investigation was carried out at Educational Farm, Polytechnic in Horticulture, JAU, Junagadh during *kharif* season in the year of 2021. Junagadh is situated in Saurashtra region of Gujarat state. Geographically, this place is situated at 20.310 N Latitude and 70.360 E Longitude with an altitude of 60 meters above the mean sea level and 80 km away from Arabian Sea coast on western side at the foothill of mount Girnar. The climate of this area is typically subtropical, characterized by fairly hot summer, moderate cold winter and humid warm monsoon. The annual precipitation range between 800 to 900 mm in normal year and exceeds 1000 mm during next year. In general monsoon commences during the second week of June and ends by the second fortnight of September. However, pre-monsoon rains in the last week of May and first week of June are not uncommon. The rainfall during the monsoon season of year 2021 was regular.

The field Experiment comprised of 8 treatments with control and conducted in randomized block design with three replications. There were total eight treatments, i.e., control without any treatment (T_1), Recommended dose of fertilizer N:P:K (150:50:00 kg/ha) (T_2), 75% RDF + 1000 kg cow dung/ha as basal (T_3), 75% RDF + 1000 kg cow dung/ha (50% as basal and 50% at 30 days after sowing) (T_4), 75% RDF + 1500 kg cow dung/ha as basal (T_5), 75% RDF + 1500 kg cow dung/ha (50% as basal and 50% at 30 days after sowing) (T_6), 75% RDF + 2000 kg cow dung/ha as basal (T_7) and 75% RDF + 2000 kg cow dung/ha (50% as basal and 50% at 30 days after sowing) (T_8). The land was brought to a fine tilth through ploughing and tillage. Irrigation channels and bunds were prepared according to layout. The seeds were sown in the field directly. Fresh cow dung was applied in plots as per the treatment at the time of sowing by making slurry with water @ 1:3. The recommended dose of fertilizers for okra was N, P2O5 and K2O @ 150: 50: 00 kg/ha applied in the form of urea and diammonium phosphate (DAP). Nitrogen is applied in two splits *i.e.*, 50% at sowing and 50% at 30 days after sowing. While full dose of P2O5 was applied as basal @ 50 kg/ha P2O5 in all treatments (except T_1). To keep field weed free intercultural operation and manual weeding were done throughout life span of okra crop. Observations were recorded on growth characters. Chlorophyll content of leaves recorded by SPAD in leaves of randomly selected plants. It was estimated by simple damping the device over leaf tissue at 45 DAS. For estimation of ascorbic acid volumetric method is used. The fiber content from green pods was determined by using method given by (Annon. 1960) [4]. Estimation of nitrogen content in leaves and fruit was carried out by microkjeldahl's method as described by Kanwar and Chopra (1967) [17]. Phosphorus was determined by venedomolybdo phosphoric yellow colour method as described by Olsen *et al.* (1954) [20]. Potassium was determined by flame photometer method (Jackson, 1974) [16]. The experimental data was analysed as per the RBD described by Panse and Sukhatme (1985) [21] and interpretation of result was based on 'F' test

Result and Discussions

Growth parameters

Days to 50% flowering

From the experiment it was observed that the minimum days to 50% flowering (42.00) was noted in T_6 treatment [75% RDF + 1500 kg cow dung/ha (50% as basal and 50% at 30 days after sowing)], whereas the maximum days to 50% flowering (50.33) was observed in T_1 treatment [Control]. The earliness in flowering could be attributed due to the faster enhancement of vegetative growth and storing sufficient reserved food materials for differentiation of buds into flower buds whereas maximum number of days was required to flower where no dose of fertilizer was applied (Control); probably due to the nutrient stress resulting in extended vegetative phase of the plant and cause late flowering. Similar results were found by Muqtadir *et al.* (2019) [19] and Ibrahim *et al.* (2020) [15] in okra.

Days to first picking

The data of Table 1 concluded that fresh cow dung had produced significant effect on days to first picking of okra. The minimum days to first picking (47.00) was noted in T_6 treatment [75% RDF + 1500 kg cow dung/ha (50% as basal and 50% at 30 days after sowing)], might be due to inputs like fresh cow dung and chemical fertilizers encouraged the differentiation of bud resulting in earlier flowering ultimately leads to early first picking. The first harvest might be due to difference in fruit maturing period. Similar results were found Muqtadir *et al.* (2019) [19], Ibrahim *et al.* (2020) [15] and Devanda *et al.* (2021) [10] in okra.

Days to last picking

The result of present investigation showed that significantly maximum days to last picking (106.67) was noted in T_8

treatment [75% RDF + 2000 kg cow dung/ha (50% as basal and 50% at 30 days after sowing)], this might be due to the cow dung release the nutrients slowly and steadily into the system and enables the plant to absorb nutrients and vigorously activated the vegetative development of plants. The beneficial effect of application of organic manures along with inorganic increasing the vegetative growth.

Plant height (cm)

The significantly maximum plant height (194.34 cm) of okra plant at final harvest was observed in treatment T_6 [75% RDF + 1500 kg cow dung/ha (50% as basal and 50% at 30 days after sowing]. These results are conformity with the finding of Benson and Tanee (2016) [5], Muqtadir *et al*. (2019) [19], Adekiya *et al.* (2020) [2], Devkota *et al*. (2022) [8] and Mondal *et al*. (2022) [18] in okra. This result might be due to the combined impact of recommended dose of fertilizers and fresh cow dung as organic matter release nutrient very slowly and steadily into the system and enables plant to absorb nutrients. The addition of manure to soil leads to a better environment for the growth of the roots. This enhances the utilization of soil nutrients, as a consequence rapid cell division and cell elongation in meristematic region of the plant of which increase the plant height.

Table 1: Effect of fresh cow dung on growth parameters of okra

Treatment No.	Days to 50% flowering	Days to first picking	Days to last picking	Plant height (cm)	Number of branches/ plant
T_1	50.33	55.33	89.00	154.33	1.89
T_2	48.33	53.33	90.33	163.67	2.00
T_3	49.00	54.00	92.33	169.13	2.33
T_4	45.33	50.33	98.00	180.87	2.67
T_5	47.33	52.67	93.67	174.00	2.56
T_6	42.00	47.00	100.67	194.34	3.11
T_7	47.67	53.00	95.67	173.33	2.44
T_8	42.67	47.67	106.67	185.00	2.89
S.Em. ±	1.73	1.82	3.49	7.04	0.14
C. D. at 5%	5.31	5.51	10.59	21.34	0.42
C.V.%	6.51	6.09	6.31	6.99	9.63

Number of branches/plants

The Table 1 clearly indicated that maximum number of branches per plant (3.11) of okra was observed in treatment T_6 [75% RDF + 1500 kg cow dung/ha (50% as basal and 50% at 30 days after sowing)]. Similar results were reported by Ibrahim *et al.* (2020) [15], Mondal *et al.* (2022) [18] and Devkota *et al.* (2022) [8] in okra. This result might be due to the combined impact of recommended dose of fertilizers, cow dung as organic matter. Usually, the cow dung releases the nutrients slowly and steadily into the system and enables the plant to absorb nutrients. This might be due to the fact that N in readily available from vigorously activated the vegetative development of plants. The beneficial effect of application of organic manures along with inorganic increasing the vegetative growth.

Quality parameters

Chlorophyll content (SPAD)

The result given in (Table 2) clearly indicated that chlorophyll content significantly influenced by various organic treatments. Different treatments of fresh cow dung had produced significant effect on chlorophyll content (SPAD) of okra. The maximum chlorophyll content (50.18) was noted in T_6 treatment [75% RDF + 1500 kg cow dung/ha (50% as basal and 50% at 30 days after sowing)] which was statistically at par with T_8 treatment. This might be due to supply of essential nutrients such as nitrates, phosphates and potassium by the cow dung. Since cow dung is an organic matter that is rich in these major nutrients which are necessary for chlorophyll synthesis. Nitrogen is a major component of nucleic acid and chlorophyll while phosphorus is involved in many metabolic processes essential for normal growth, such as photosynthesis. Potassium is also essential for photosynthesis because it activates many enzymes involved in the process of photosynthesis. These elements exert influence on stability of the chlorophyll molecule. The low chlorophyll content in the control might be due to reduction of these essential elements. Benson and Tanee (2016) [5] in okra, Salam *et al.* (2011) [22] in tomato and Chinthapalli *et al.* (2015) [7] in faba bean and pea reported similar findings.

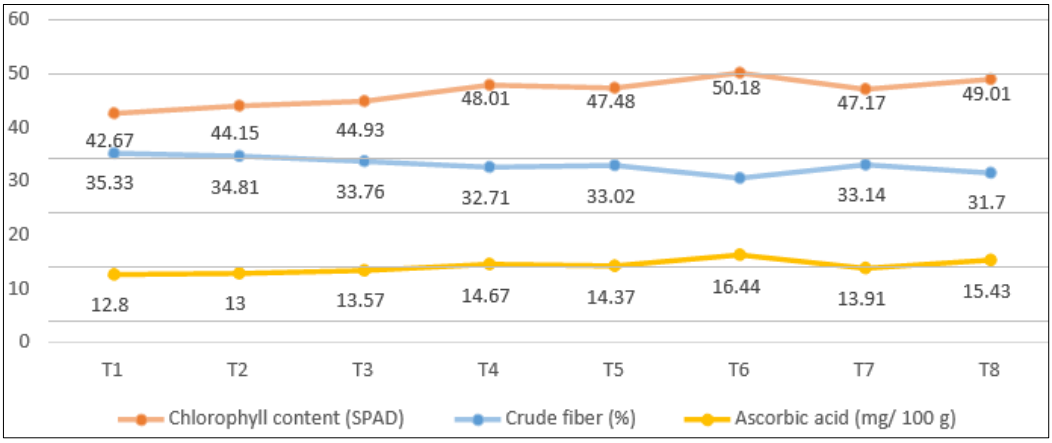

Fig 1: Effect of fresh cow dung on quality parameters of okra fruit

Table 2: Effect of fresh cow dung on quality parameters of okra

Treatment No.	Chlorophyll content (SPAD)	Crude Fiber (%)	Ascorbic acid (mg/100 g)
T_1	42.67	35.33	12.80
T_2	44.15	34.81	13.00
T_3	44.93	33.76	13.57
T_4	48.01	32.71	14.67
T_5	47.48	33.02	14.37
T_6	50.18	30.74	16.44
T_7	47.17	33.14	13.91
T_8	49.01	31.70	15.43
S.Em. ±	0.70	0.58	0.25
C. D. at 5%	2.12	1.76	0.77
C.V.%	2.60	3.02	3.09

Crude fiber (%)

The data found that adoption of different rate and split application of fresh cow dung minimize crude fiber content in fruit. The minimum crude fiber (30.74%) was observed in treatment T_6 [75% RDF + 1500 kg cow dung/ha (50% as basal and 50% at 30 days after sowing)], This might be due to the easy availability of nitrogen organic carbon leading to balance C:N ratio, enhancing the vegetative growth resulting in high photosynthetic activity. Addition of organic manure and consortium tended to produce tender fruits with least fiber content due to the action of organic acids secreted by microbes. Similar results were found by Devanda *et al.* (2021) [10] in okra.

Ascorbic acid (mg/100 g)

The data given in (Table 2) exposed that highest ascorbic acid (16.44 mg/100 g) was noted in T_6 treatment [75% RDF + 1500 kg cow dung/ha (50% as basal and 50% at 30 days after sowing)] whereas the minimum ascorbic acid (12.80 mg/100 g) was noted in T_1 [Control]. It might be due to the fact that when a plant is exposed to with more nitrogen, it increases protein production and reduces carbohydrate concentration. Similar results were found by Devkota *et al.* (2022) [8] in okra and Salam *et al.* (2011) [22] in tomato.

Nutrient content in crop

During the research, the impact of fresh cow dung on the nutritional content of fruit and plant, *i.e.*, N, P, and K (Table 3) content, was found significant. It was investigated that T_6 [75% RDF + 1500 kg cow dung/ha (50% as basal and 50% at 30 days after sowing)] outperformed than all other treatment combinations. The fact that organic manures and NPK fertilizer increased okra mineral contents compared with the control was attributed to increased availability of the nutrients in soil as a result of the mineralization of the manures leading to increased uptake by okra plants and fruits. Akande *et al.* (2008) [3] and Adekiya *et al.* (2020) [2] in okra, Frank *et al.* (2020) [11] in fluted pumpkin and Tshikalange *et al.* (2022) [23] in spinach all reported similar findings.

Table 3: Nutrient content in crop

Treatment No.	Nutrient content plant (%)			Nutrient content fruit (%)		
	N	P	K	N	P	K
T1	1.32	0.22	1.64	2.47	0.44	1.16
T2	1.41	0.28	1.79	2.53	0.49	1.20
T3	1.38	0.25	1.70	2.49	0.46	1.18
T4	1.54	0.33	1.89	2.78	0.58	1.34
T5	1.47	0.32	1.85	2.70	0.56	1.31
T6	1.60	0.37	2.03	2.88	0.62	1.44
T7	1.44	0.32	1.80	2.62	0.54	1.28
T8	1.57	0.34	1.93	2.82	0.60	1.40
S. Em. ±	0.06	0.02	0.08	0.09	0.03	0.06
C. D. at 5%	0.18	0.05	0.23	0.29	0.08	0.17
C.V. %	6.91	9.85	7.19	6.15	8.28	7.61

Conclusion

On the basis of results found from the present experiment, it can be concluded that the application of T_6 [75% RDF + 1500 kg cow dung/ha (50% as basal and 50% at 30 days after sowing)] well responded in terms of growth and quality parameters of okra. Nutrient content of nutrient in plant and fruit also obtained higher in the treatment T_6 [75% RDF + 1500 kg cow dung/ha (50% as basal and 50% at 30 days after sowing)].

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