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Nutritional quality of okra as affected by tank silt and organic manures

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Abstract

To evaluate the efficiency of tank silt with organic manures, pot culture experiment was conducted at Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal on Sorakudy soil series using okra as test crop with 13 treatments. Wherein, absolute control and application of 100% recommended dose of fertilizer (RDF) was compared with the application of tank silt (TS) alone @ 2 t ha^{-1} and different organic manures *viz.*, press mud (PM), sewage sludge (SS), water hyacinth compost (WHC), FYM and spent wash (SW). The same set of treatments were repeated with 100% RDF. The results revealed that fruit yield was higher with TS+PM+ remaining through fertilizer (RTF) and it was comparable with RDF, TS+RTF, TS+SS+RDF and TS+PM+RDF. With regard to the quality of fruits, the chlorophyll and ascorbic acid content was higher in TS+WHC+RDF and TS+PM+RDF, respectively. The mucilage content was more with TS+SW+RDF. The absolute control treatment recorded the highest crude fibre content and physiological loss in weight (PLW). The study revealed that addition of this organo mineral amendments could positively influence the yield and quality of okra when applied over and above the 100% RDF rather than accounting their nutrient contribution during fertilization.

Key words: Tank silt, organic manures, okra, *Abelmoschus esculentus*, INM, chlorophyll, mucilage, starch, protein, crude fibre, quality.

Introduction

Vegetables are important in the human diet as protective food. They not only adore the dining table but also enrich the diet. India is a leading vegetable producing country, accounting for 11.4 percent of the world's vegetable production (Rai and Pondey, 2012). Presently vegetable production occupies 6.09 m ha with an annual production of 84.8 million tones, accounting 30 per cent of the cultivable area in the country. However, the current per capita availability of vegetable in our country is only 210 g day^{-1} as against the dietary recommendation of 285 g. It is estimated that by 2020, the country's vegetable demand would be 250 million tonnes (Sridhar *et al.*, 2014). To meet the perpetual demand, efforts need to be undertaken to increase the use of balanced fertilizers and their use efficiency by integrating them with organic manure and bio-fertilizers. Okra, commonly known as lady's finger, is grown popularly throughout India on commercial scale. Being a short duration vegetable crop, its growth, yield and quality are largely influenced by the application of fertilizers. The potential yield is still not achieved because of various reasons including imbalanced use of inorganic fertilizers with more of N, less P and K, and virtual absence of micronutrients. It has been experimentally proved that no single source of fertilizer is capable of supplying all the plant nutrients in adequate amount and at a balanced proportion. Integration of organic and inorganic sources of nutrients is a viable option which not only supply the balanced nutrition but also increases the nutrient use efficiency and soil fertility, thus enhancing the productivity as well as the quality of the produce.

Tank silt, a deposited suspended matter or eroded soil in tank, which comes along with surface runoff caused due to intensive rainfall, invariably contains higher nutritive value over their respective cultivated catchment soil. Therefore, it can be used preferably in the fields of respective catchment to build up their productivity. While many attempts have been made to prove the advantages of different organic manures on soil health and that of the tank silt application in order to modify the soil textural deficiencies (Shankaranarayana, 2001; Annadurai *et al.,* 2001; Binitha, 2006; Bhanavase *et al.*, 2011 and Tiwari *et al.*, 2014), there were no specific attempts to blend these two sources. While there cannot be any standard values for the content of nutrients in organic manures, whichever may be the source, it is proved beyond doubt that they can supply essential nutrient elements like C, N, P, S and certain micronutrients depending on the material. In the case of tank silt they are known to possess such of those essential mineral nutrients which are known to be related with mineral fraction of soil like K, Ca, Mg, S, Cu *etc*. Therefore, it was hypothesized that blending the tank silt with any one of the organic manures may may be used as manurial formulation which could result in better crop growth with an additional advantage of improving the soil health. Keeping these views in mind, the present study has been carried out to investigate the impact of tank silt and organic manures either alone or in combination on nutritional quality and performance of okra.

Materials and methods

The experiment was carried out during April to July, 2013 in the pot culture yard of Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal. Soil collected from the C_7 field, eastern farm of the campus, belonging to the soil Sorakudy series (*Fluventic Haplustept*) was sieved through 8 mm sieve and each pot was filled with 18 kg of soil. The experimental site was having sandy loam texture with almost neutral pH (7.29), EC of 0.095 dS m^{-1} and medium range in organic carbon (5.30 g kg^{-1}). The available N, P and K of the experiment soil was 214, 29.7 and 204.2 kg ha^{-1} respectively.

The experiment was conducted in CRD with three replications. The treatments were as follows. T_1: control, T_2: 100% RDF, T_3: Tank silt @ 2 t ha^{-1}+Remaining through fertilizer, T_4: Tank silt @ 1 t ha^{-1}+Pressmud @ 1 t ha^{-1} +Remaining through fertilizer, T_5: Tank silt @ 1 t ha^{-1}+Sewage sludge @ 1 t ha^{-1}+Remaining through fertilizer, T_6: Tank silt @ 1 t ha^{-1}+Water hyacinth compost @ 1 t ha^{-1} +Remaining through fertilizer, T_7: Tank silt @ 1 t ha^{-1}+FYM @ 1 t ha^{-1}+Remaining through fertilizer, T_8: Tank silt @ 1 t ha^{-1}+Spent wash @ 1 t ha^{-1} +Remaining through fertilizer, T_9: Tank silt @ 1 t ha^{-1}+Pressmud @ 1 t ha^{-1}+100% RDF, T_{10}: Tank silt @ 1 t ha^{-1}+Sewage sludge @ 1 t ha^{-1}+100% RDF, T_{11}: Tank silt @ 1 t ha^{-1} +Water hyacinth compost @ 1 t ha^{-1}+100% RDF, T_{12}: Tank silt @ 1 t ha^{-1}+FYM @ 1 t ha^{-1} +100% RDF, T_{13}: Tank silt @ 1 t ha^{-1}+Spent wash @ 1 t ha^{-1}+100% RDF.

Okra (Mahyco No. 64) was selected as test crop and sown at the rate of 2 seeds per pot. The tank silt and organic manures used in the study were analyzed for their NPK content for calculating the manure and fertilizer application. N application as urea was taken up in two equal splits according to the treatments *viz.*, 50% as basal and remaining 50% at 30 DAS. In case of application of N through tank silt and organic manures, the entire organic manures and tank silt was applied basally. After calculating the N added through manures and tank silt, remaining nitrogen required if any was applied either basally and/or top dressed at 30 DAS through urea. After working out the P and K contents of added organic manures, the remaining P and K was applied through SSP and MOP basally.

Plant analysis: Fruit samples were collected at 5th, 15th and last picking and used for analysis. Quality parameters *viz.*, chlorophyll, starch, protein, ascorbic acid and crude fibre content was determined with the procedure suggested by Sadasivam and Manickam (1992). For mucilage content, fresh fruit was grinded using distilled water and kept for 24 hours. The content was then filtered using muslin cloth and 50 mL of alcohol was added to the filtrate. Filtrate was then filtered through a pre weighed filter paper. Filter paper along with the residue was dried and mucilage content was expressed in %. PLW was measured as suggested by Sankaran (1999). Immediately after harvest, the fruit was weighed. The weight was recorded daily until complete loss of freshness and weight loss was taken as PLW.

The analytical data was subjected to statistical scrutiny. Correlation and regression analysis were also carried out to determine the strength of relationship among different soil and quality parameters as well as to quantify the extent of contribution of soil properties and prediction towards quality.

Results and discussion

Fruit yield: The fruit yield of okra crop as influenced by different treatments is presented in Table 1. The results indicated that the higher fruit yield was associated with the pots received TS+PM+RTF, which was statistically on par with 100% RDF, TS+RTF, TS+SS+RDF and TS+PM+RDF. The above trend of results could be attributed to the contents of nutrients in tank silt, particularly K, Ca, Mg and S. It could also be attributed to the release of micronutrients which might have been linked with the organic carbon (9.90 g kg^{-1}). Similar results of higher yield with addition of tank silt was reported by Binitha (2006) and Bhanavase *et al.* (2011). It was reported by many authors that the tank silt addition could result in the increased availability of nutrients, particularly nitrogen (Binitha, 2006), phosphorus (Kumar and Gowda, 2010) and other nutrients (Shankaranarayana, 2001 and Annadurai *et al.,* 2001).

Table 1. Effect of tank silt and organic manures on fruit yield (g pot^{-1}) of okra

Treatments	Fruit yield
T_1: Control	114.5
T_2: 100 % RDF	224.4
T_3: TS+ Remaining through fertilizer	222.9
T_4: TS+PM+ Remaining through fertilizer	241.3
T_5: TS+SS+ Remaining through fertilizer	185.7
T_6: TS+WHC+ Remaining through fertilizer	156.3
T_7: TS+FYM+ Remaining through fertilizer	169.4
T_8: TS+SW+ Remaining through fertilizer	200.3
T_9: TS+PM+100 % RDF	202.9
T_{10}: TS+SS+100 % RDF	213.4
T_{11}: TS+WHC+100 % RDF	195.7
T_{12}: TS+FYM+100 % RDF	156.4
T_{13}: TS+SW+100 % RDF	183.7
S. Ed	19.4
C.D (0.05)	39.9

Quality parameters: While the yield of crop is the ultimate goal of farmers, the quality of the product, particularly vegetable is important to fetch higher price. The quality of fruit refers not only its richness with respect to starch and protein but also its keeping quality, crude fibre content and the greenness of fruits as measured by chlorophyll content. Each one of the above parameter is considered to be an important criterion to evaluate the efficiency of the added amendments. It is also true that there were ample evidences to show that the addition of organic manures could improve the quality of fruits.

The chlorophyll content was found to be higher due to the addition of tank silt along with water hyacinth compost or FYM and remaining through fertilizer and the lowest was in control (Table 2). This could be attributed to the supply of essential nutrients through the addition of tank silt and organic manures, which might have improved the synthesis of chlorophyll. It is also worth mentioning that when organic manures are applied with inorganic fertilizers comprising N, P and K it could serve as a major source of N, whereas when it was blended with tank silt, the additional advantage of Mg was realized (2.41% total Mg, 71.42 mg kg^{-1} NH_4OAc-Mg). In particular, the nutrients like N and Mg could favourably induce the chlorophyll synthesis and therefore the fruits look green and fresh. It was also reported by Kuppusamy (2008) and Sanni and Adesina (2012) that the higher chlorophyll content due to the addition of organic manures might be due to the release of nitrogen and magnesium from the added sources.

The mucilage content of the okra fruit was found to be higher in the pots which received tank silt amended with spent wash or water hyacinth compost (Table 2). The interaction of treatment with stages had shown that in all stages the TS+SW+100% RDF had resulted in higher mucilage content and the least was in control. Higher mucilage content was considered to be

Table 2. Quality parameters of okra as influenced by tank silt and organic manures

Treatments	Chlorophyll (mg g^{-1})	Mucilage (%)	Starch (%)	Protein (%)	Crude fibre (%)	Ascorbic acid (mg $100g^{-1}$)	PLW (%)
T_1	0.144	1.802	3.310	0.735	18.83	11.49	26.55
T_2	0.298	2.845	4.897	1.082	14.37	13.00	19.24
T_3	0.259	2.355	4.218	1.040	12.45	12.23	20.40
T_4	0.261	2.473	4.145	0.972	10.93	12.08	16.42
T_5	0.415	2.267	3.580	0.982	11.09	11.98	21.25
T_6	0.504	3.027	4.390	0.928	13.20	12.34	21.99
T_7	0.472	2.182	4.883	1.063	16.27	12.25	23.44
T_8	0.303	2.120	5.270	1.060	15.21	11.86	18.72
T_9	0.252	2.630	4.877	1.072	12.28	13.68	23.92
T_{10}	0.204	2.227	4.052	0.998	15.81	12.68	20.89
T_{11}	0.259	2.505	4.840	0.923	14.73	12.90	17.09
T_{12}	0.229	2.863	4.940	0.969	13.85	13.45	17.26
T_{13}	0.194	3.252	5.260	0.940	11.38	12.60	18.69
S. Ed	0.017	0.065	0.117	0.055	0.52	0.41	0.73
C.D (0.05)	0.035	0.131	0.237	0.111	1.05	0.82	1.45

a favourable quality since it is considered to be a medicinal value of okra fruit. It was reported by Sanni and Adesina (2012) that higher mucilage content of okra fruit due to addition of organic manures could be due to supply of micronutrients and traces of some secondary metabolites which act as stimulant for mucilage synthesis. It was also reported by the same authors that since mucilage consists of acidic polysaccharides and the mucilage of okra in particular is composed of galacturonic acid, galactose, rhamnose and glucose which were all the products of carbohydrate metabolism and therefore any treatment which could improve the starch synthesis could also result in increased mucilage content. Mucilage and crude fibre are both derivatives of carbohydrate and if the photosynthetic C is utilized for mucilage synthesis, the crude fibre content will get decreased. In other words, fruits with better mucilage content contain less crude fibre content and therefore considered to be of better quality.

Starch content was significantly higher in TS+SW+RTF and TS+SW+RDF which were comparable (Table 2). Though spent wash is not a good source of nutrients its advantage is its acidic pH, which might have solubilized the native nutrients and thereby influencing the quality. Similar results of higher starch content with addition of organics was reported by Kuppusamy (2008) and Nibin *et al.* (2016). With the advancement of crop growth, the starch content increased.

As regards the protein content, numerically higher value was associated with the treatments which received RDF and it was on par with the treatments which included TS+PM+RDF, TS+FYM+RTF, TS+SW+RTF, TS+RTF, TS+SS+RDF, TS+SS+RTF and TS+PM+RTF (Table 2). The possible reason might be the supply of N and S which forms an integral part of amino acids. Similar results were also reported by Raj and Kumari (2001), Yadave *et al.* (2006) and Kuppusamy (2008). The multiple regression analysis had shown that the protein content of fruit could be significantly altered by the soil properties recorded (R^2=0.632*) with significant contribution from pH and EC of soil.

The content of crude fibre is an important quality parameter of fruit as it directly reflects the quality of cooked vegetable. It is also preferable in the case of okra fruit to contain lower crude fibre content. In the present investigation, the control pots produced fruits with higher crude fibre content and the pots which received pressmud, sewage sludge or spent wash along with tank silt produced fruits with lowest crude fiber (Table 2). As discussed earlier, when the photosynthetic C is utilized for synthesis of mucilage the content of crude fibre gets reduced (Raj and Kumari, 2001). As the addition of organic manures had positive influence on the nutrient supply resulting in higher uptake, enhanced photosynthesis and higher starch production, it is understandable that such treatments would record lower crude fibre content.

The ascorbic acid content was also found to be positively influenced by addition of tank silt with either one of the organic manure *viz.,* pressmud, FYM or water hyacinth compost (Table 2). As ascorbic acid is the form of carbohydrates and any factor which could induce the synthesis of carbohydrates would also improve the ascorbic acid content. Application of organic manures not only supplied major and micro nutrients which favour photosynthetic activity but also resulted in higher sugar content which duly accompanied by increase in ascorbic acid content. The above findings were also reported by Kuppusamy (2008) and Nibin *et al.* (2016). The multiple regression analysis had revealed that 74.4% of variation in ascorbic acid content could be attributed to different soil properties with significant contribution from pH, EC and NH_4OAc-K which again confirms that the added tank silt and organic manures altered the soil properties and favoured the plant growth.

The PLW is yet another quality parameter which indicates the loss in weight during storage which could be related to the mucilage content. In the present investigation highest loss in weight was noticed in control and the lowest was in the pots which received tank silt with pressmud, water hyacinth compost or FYM (Table 2). As stated above addition of these organic manures had resulted in higher mucilage content and lower crude fibre content and therefore had retained more moisture during storage. It was reported by Nanthakumar and Veeraragavathatham (1999) that the lower PLW could be attributed to the accumulation of Ca and P when organic manures were applied and in the present investigation the tank silt was a good source of Ca (2.56 %) and therefore the supply of Ca and P from these sources had increased the cell wall turgidity so that the loss of water is reduced.

The study showed that amendments used in this investigation *viz.,* tank silt and organic manures which included pressmud, sewage sludge, water hyacinth compost, FYM and spent wash proved to be good source of nutrients. However, results obtained from this investigation had shown that the tank silt could definitely be used as a source of mineral element and the organic manures as a source of N, P, S and trace elements. Among the combination of tank silt with various organic manures, combining tank silt with pressmud was found to be a better option followed by FYM, sewage sludge, water hyacinth compost and spent wash. It was also noticed that addition of this organo mineral amendments could positively influence the yield and quality of okra when they are applied over and above the 100% RDF rather than accounting their nutrient contribution during fertilization. Further investigations are required in order to optimize the ratio with which these amendments could be blended by considering their availability, cost of material and ease with which they can be blended.

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