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Influence of organic-inorganic nutrient management practices on growth and yield of sweet orange var. Nucellar (*Citrus sinesis* L. Osbeck)

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Abstract
To know the response of sweet orange to integrated nutrient management, a field experiment was conducted at the experimental farm of Sweet orange Research Station, Badnapur, Vasantrao Naik Marathwada Agricultural University, Parbhani for the year 2015-16. The experiment was laid out in Randomized Block Design (RBD) comprised of ten treatments having various combinations of inorganic fertilizers (urea, SSP and MOP), FYM, vermicompost and green manures. Amongst different INM-based treatments, the treatment receiving 75% RDF + 25% FYM + Green manuring recorded significantly highest plant height, Girth of stem, plants spread and canopy volume as compare to other treatments. Application of 75% RDF + 25% vermicompost + Green mannuring recorded significantly maximum number of fruits/ tree. The fruit yield was recorded significantly higher with application of 75% RDF + 25% vermicompost + Green mannuring

Keywords: INM, sweet orange, FYM, Green manuring, Vermicompost, Canopy volume

Introduction
Citrus is one of the most important fruit crops grown in many tropical and subtropical countries. Citrus occupies an important place in the fruit industry, but yield levels of citrus orchards are still very low. Out of many factors, poor nutrient status of soil as well as malnutrition is considered to be the major factors responsible for citrus decline and low yield. The protection of natural resources base for which the intensification of integrated nutrient management in fruit production has become important because it is directly related to the soil and water resources. Therefore we must adopt the most appropriate land investment practices.

Application of inorganic nutrients plays an important role on the yield attributes as well as uptake of nutrients at the same time. Further, the inorganic fertilizers are expensive and continuous use of these chemical fertilizers leads to the problem of soil deterioration. Organic manures alone are not able to supply all nutrients required for plant growth. However, use of proper proportion of organics along with inorganic nutrients not only helps in increasing the yield of the crop but also act as store house of nutrients besides it improves physical condition of soil Tayade *et al.* (2012) [17]. Inorganic fertilizers are one of the most expensive inputs in orchard management. Besides, continuous application of huge amount of chemical fertilizers hampers the quality, soil health and soil productivity. These problems draw the attention of scientists to search some other alternative not dependent solely on chemical fertilizers. Extensive use of chemicals and fertilizers with low doses of organic manures has resulted in deterioration of soil fertility and soil health as well.

The adequate fertilization, regular application of nutrients or alternatively use of nutrient enriched organic manures and biofertilizers in integrated nutrient management results in quality citrus production (Srivastava, 2012) [15]. Biological routes of improving soil fertility and health for optimum crop production form vital component of integrated nutrient management. These routes are operated through the use of FYM, vermicompost, green manuring and biofertilizer along with chemical fertilizers. The attractive fruit having superior quality, maintaining consumer appeal in taste, appearance and storability can be obtained only by following the concept of integrated nutrient management in sweet orange. Thus, the optimized standards of fertilizer application are of great importance to enhance fruit quality.

Therefore, integrated application of inorganic fertilizers, organic and biological sources of nutrients in an efficient way would not only reduce the sole dependence on inorganic fertilizers but also reduce fruit cracking and enhance fruit quality as well as minimize environmental hazards.

In recent years, the quick and substantial response to fruit production due to mineral fertilizers eclipsed the use of organic manures. An integrated nutrient management (INM) is one of most effective alternatives which involve use of chemical fertilizers, organic manure and biofertilizers for the maintenance of long term soil fertility and productivity along with sustainable production of crops. Ranjan and Gosh (2006) [16] and Mahendra *et al.* (2009b) [7] reported that application of organic manures, biofertilizers with NPK increased growth yield and quality. However, scanty information are available in this area; therefore, by Considering the above facts, an attempt was made to identify the suitable integration of different sources of nutrients with respect to plant growth and yield.

Materials and methods

A field trial was conducted at research farm of Sweet Orange Research Station, Badnapur, Vasantrao Naik Marathwada Agricultural University, Parbhani. The experiment was laid out in Randomized Block Design with eight treatments and three replications. The treatments were as follows: T1: 100 % RDF (800 gm N- 400 gm P and 400 gm K) + 50kg FYM, T2: 75% RDF + 25% FYM, T3: 50% RDF + 50% FYM, T4: 75% RDF + 25% FYM + Green mannuring, T5: 50% RDF+ 50% FYM + Green mannuring, T6: 75% RDF+25% vermicompost, T7: 50% RDF + 50% vermicompost, T8: 75% RDF + 25% vermicompost + Green mannuring, T9: 75% RDF + Green mannuring (Sunhemp) and T10: 50% RDF + Green mannuring.

Method of application of nutrients

The chemical fertilizers (SSP and MOP) along with FYM were applied at the mid of December except N (urea) which was applied in two split dozes *i.e.* first during spring before flowering and remaining half one month after first application. vermicompost was used one month after chemical fertilizers application. The seeds of sunhemp were sown during June. Observations on plant height, stem girth, plant spread, tree canopy volume, number of fruits per tree, weight of fruit and fruit yield were recorded.

The height and tree spread of each selected tree was measured with the help of calibrated bamboo stick. To get a tree spread (canopy diameter) two observations, one each on east-west and north-south sides of selected tress were recorded. The circumferential measurement was taken 5 cm above the bud union in the budded plants for stem girth. For computing the number of fruits per plant, weight of fruit and yield of fruits per plant, the matured fruits were harvested and weighed and yield was expressed in kg per tree.

The data was analyzed statistically as per Annova table given by Panse and Sukhatme (1985) [9] for interpretation of results and drawing conclusions.

Research findings and discussion

The results obtained from the present investigation are summarized below:

Effect on growth parameters

The results of the present investigation (Table 1) revealed that INM increased the growth parameters of sweet orange trees. Amongst different INM- based treatments, the treatment receiving 75% RDF + 25% FYM + Green manuring recorded significantly highest plant height, Girth of stem, plants spread and canopy volume as compare to other treatments.

This might also be attributed to the improved nutrient use efficiency with the balanced use of organic and inorganic sources of nutrients. Application of organic manures with chemical fertilizers improved the soil physical properties which might have helped the plant root development and enhanced uptake of nutrients resulting into faster cell division and cell elongation and consequently increased the plant height, spread and stem girth. These observations were correlated with the findings of Villasurda (1990) [19] and Yadav *et al*., (2012) [20].

Similar results were obtained by Gautam *et al.* (2012) [4] who reported maximum vegetative growth with application of FYM and green manuring along with chemical fertilizers. This might be due to the increased photosynthetic rate and carbohydrate accumulation as a result of multiferous role of FYM and green manuring to allow most favorable conditions of soil with increased availability of plant nutrients responsible for better plant growth (Sharma and Bhutani, 2000; Tiwari *et al.*, 1999; Dutta *et al*., 2009) [14, 18, 3]; Goswami *et al.* (2012) [5] and Pathak and Ram (2005) [10] also observed improved vegetative growth in guava with the application of different fertilizers, organic manures and biofertilizers. This increase in tree height, spread, volume, shoot length and number of shoot emergence per branch might be attributed to the stimulative activity of microflora in the rhizosphere leading to increased nutrient availability and hence, vigorous plant growth (Singh *et al*., 2000; Aseri *et al*., 2008) [13, 1].

Effect on yield

Data revealed that integrated nutrient management practices influenced significantly the physical characters of fruits and fruit yield.

Application of 75% RDF + 25% vermicompost + Green mannuring recorded significantly maximum number of fruits/ tree and fruit yield. Weight of fruit found significantly maximum with application of 75% RDF + 25% FYM + Green manuring.

These findings indicated that integrated application of inorganic fertilizers, vermicompost and green manures was successful in maintaining higher levels of sweet orange productivity. The present findings of increasing fruit yield by combined application of organic manures with inorganic fertilizers are in congruence with the findings of Singh *et al.* (2000) [13] who reported maximum fruit yield per plant of aonla with the standard doze of NPK + vermicompost. The increase in the yield was mainly attributed to relative increase in the availability of nutrients and better solute uptake by the plants. These findings are in accordance with the results of Korwar *et al*. (2006) [6] and Pathak *et al.* (2005) [11]. The effectiveness of inorganic fertilizers was greatly enhanced when it was applied along with vermicompost, green manuring and FYM. This might have resulted due to better retention of urea in root zone (Mistsui *et al*., 1960; Chin and Kroonje, 1963) [8, 2] and better availability of phosphate and potash to the plants by organic matter (Raychoudhuri, 1976) [12].

Conclusion

On the basis of obtained experimental findings, it can be concluded that among different treatments of integrated nutrient management, the treatment receiving 75 percent recommended dose of fertilizers along with 25 percent farm

yard manure and green manuring of sunhemp gave best results with respect to vegetative growth and yield. Hence application of 75 percent recommended dose of fertilizers along with 25 percent farm yard manure and green manuring of sunhemp is highly recommended to enhance growth of trees and consequently produce high yield of good quality fruits followed by application of 75 percent RDF + 25 percent vermicompost + green manuring.

Table 1: Response of INM- based treatments on growth parameters

Treatments	Height (m)	Plant spread (m)		Girth of stem (cm)	Canopy volume (m3)	No. of fruits / tree	Weight of fruit (g)	Fruit yield (kg) / tree
		E-W	N-S					
T1	4.51	4.16	4.30	41.73	25.71	279.67	241.00	67.40
T2	4.83	4.07	4.08	38.56	24.09	227.67	247.67	56.40
T3	4.34	4.04	3.91	39.26	22.12	242.67	238.00	57.75
T4	4.92	4.83	4.64	45.73	32.02	269.67	256.67	69.21
T5	4.81	4.23	4.09	41.06	26.70	307.67	219.33	67.49
T6	4.79	4.37	4.38	41.16	29.94	298.33	211.67	63.14
T7	4.68	4.01	4.01	42.18	23.94	258.67	239.33	61.91
T8	4.49	4.28	4.57	42.60	30.92	340.00	235.33	80.02
T9	4.19	4.07	4.12	39.30	25.07	259.67	219.33	56.95
T10	4.29	4.15	4.52	43.17	27.58	227.00	249.67	56.69
SE ±	0.027	0.023	0.027	0.33	0.156	2.77	2.12	0.90
CD at 5%	0.082	0.067	0.08	0.987	0.467	8.29	6.35	2.71

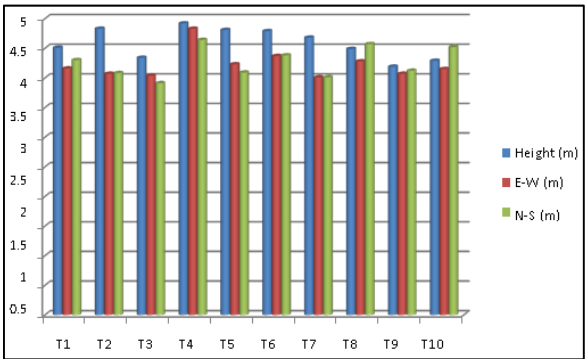

Fig 1: Effect of INM- based treatments on plant height and plant spread

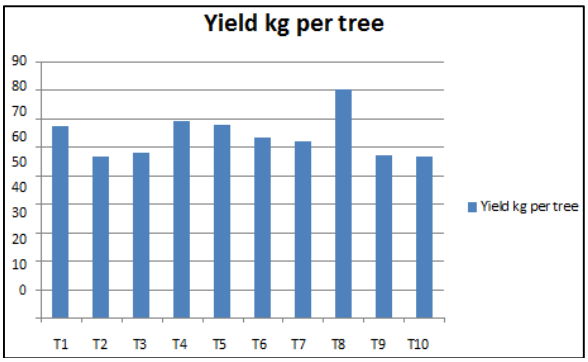

Fig 2: Effect of INM based treatments on plant yield

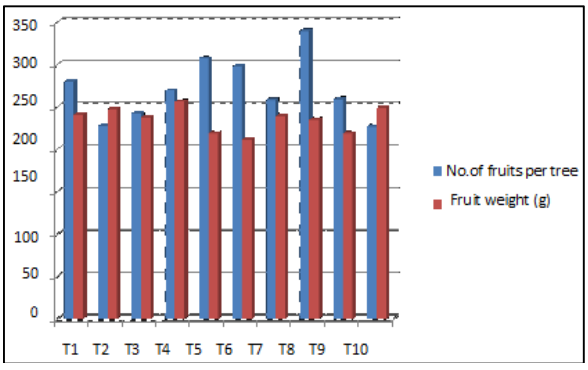

Fig 3: Effect of INM based treatments on number of fruits per tree and fruit weight.

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