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The scientific approach for organic Langra production under Subtropical Climate

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ABSTRACT

Organic fruit production is becoming a serious concern due to enhanced awareness of health issues and ever-increasing demands for organic fruit supply. The nation's priority on environmental sustainability *vis-à-vis* agricultural sustainability is to be confirmed. Keeping this in mind, scientific approaches were started to produce mango fruits organically under subtropical climatic conditions. Encouraging results from field experimentation (2021 and 2022 fruiting season) on mango cv, Langra suggested that it was possible to produce organic Langra and make it available to the market. Analyzed data indicated soil organic carbon ranged between 0.43 to 0.66 percent; soil available P and K between 20.02 to 37.84 and 238.04 to 326.04 kg/ha across 0-30 and 30-60 cm soil depths. The variations among soil available Zn, Cu, and Fe were 0.56 to 1.58, 1.34 to 5.04, and 2.18 to 3.72 mg/kg, respectively. Histographic distribution showed variability of all these parameters across different content classes and maximum frequency levels. Lower content in higher frequency distribution indicated the need for scientific management to improve soil health conditions. Overall, farm efficiency indicated low yield as low as <47.3 kg/tree and improvement after organic management to as high as 80.3 to 90.4 kg/tree. Recent field experimentation was thus highly recommended to continue the organic farming study to enhance farm efficiency levels for the benefit of growers.

Keywords: Soil parameters, fruit yields, organic management, langra mango, subtropical climate

INTRODUCTION

The environment is crucial for achieving agricultural sustainability, and management of orchards of subtropical climate through a scientific approach is important for securing economic security. Daily demand for organic produce is increasing, and the supply of organic fruits is in huge demand in domestic and export markets. As per the recent report, India contributes significantly to exporting fresh mangoes, and it was noticed that around 52.8, 49.2, 46.51, and 49.66 thousand metric tons of fresh mangoes were exported to different foreign countries. However, in 2021 and 2022, approximately 21.03 and 27.87 thousand M.T. were exported from India. A sizeable amount of 4.06, 4.0, 2.72, and 2.79 billion Indian rupees was earned between 2019 and 2022, respectively. UAE, U.K., Qatar, Saudi Arabia, The Netherlands, and many other countries enjoyed Indian mangoes. Moreover, mango pulp was also exported to different countries. Langra mango contributes foreign exchange earnings and organic fruit may further provide scope for the ever-increasing export regime. Therefore, there is a need for the organic production of mangoes scientifically and systematically. Maintaining orchard ecology in subtropical climates is a challenging job wherein soil and tree health are prioritized.

Improving orchard sustainability is the sole criterion wherein organic sources of nutrition play a significant role (Adak *et al.,* 2020), and to ensure the quality of mango under subtropical climatic conditions, boron nutrition practices should also be made mandatory (Shukla *et al.,* 2020). Garg *et al.* (2021) scientifically analyzed and showed that mango leaf compost had considerable macro and micronutrients and microorganisms of high degradative enzymatic potential. Therefore, growers may practise composting mango leaves for soil management under organic practices to maintain microbial diversity and soil physicochemical properties. Reddy *et al.* (2010) observed that FYM@10kg/plant or urban compost @ 7kg improved soil respiration (7.26 to 8.57 mg C kg^{-1}soil hr^{-1}) and microbial population like bacteria (139.6 to 141.8×10^{8}cfu g^{-1}), fungi (16.4 to 19.3×10^{4} cfu g^{-1}) and actinomycetes (16 to 17.8×10^{5}cfu g^{-1}) with papaya fruit yields of 30 to 36.5 t ha^{-1} in red loam soil. It was found that liming management in strong acidic soil (4.7) over the years promoted chemical properties *vis-à-vis* productivity of mango cc Keitt in Typic Haplustox soil (Almeida *et al.,* 2015). In organic ecosystems, soil ecology should be maintained at its optimum functional levels to sustain orchard efficiency. Sustainability through productivity and soil functionality were in synchrony for the betterment of the growers' community. Bhardwaj *et al.* (2011) expressed that ecosystem management could improve soil health *vis-à-vis* production capacity. Even under an arid ecosystem wherein soils were poor in organ carbon, other nutrients, microbial populations, and enzymatic activities, a combination of potassium solubilizing bacteria and natural K-feldspar improved the nutrient contents, dehydrogenase activity by 54 percent, alkaline phosphatase enzymes by 52 percent along with 23 percent fruit yield of mango in sandy soil (Wang *et al.,* 2022). Thus, the scope of organic management across agroecologies was tremendous, and farmers may adopt systematic practices. There was a concern about whether growers could be satisfied with organic farming. In a scientific study with a probit model, Mzoughi (2014) opined that farmers were more confident with the income and profitability of organic agriculture than conventional farming. Moreover, it was expected that organic group certification of small fruit and vegetable farmers might be beneficial in the long term for recognition of organic food suppliers (Solfanelli *et al.,* 2021). Since lack of information on soil aspects, flowering, and fruiting in organic management in Langra mango was lacking under subtropical conditions, recent field experimentation was thus started to address resource management issues.

MATERIALS AND METHODS

The location of the present field experimentation was at the Telibagh campus, Raebareli Road, ICAR-CISH, Lucknow (Figure 1). The area is 6 km from Lucknow (Charbagh) railway station and 10.4 km from Lucknow airport. Field experimentation was

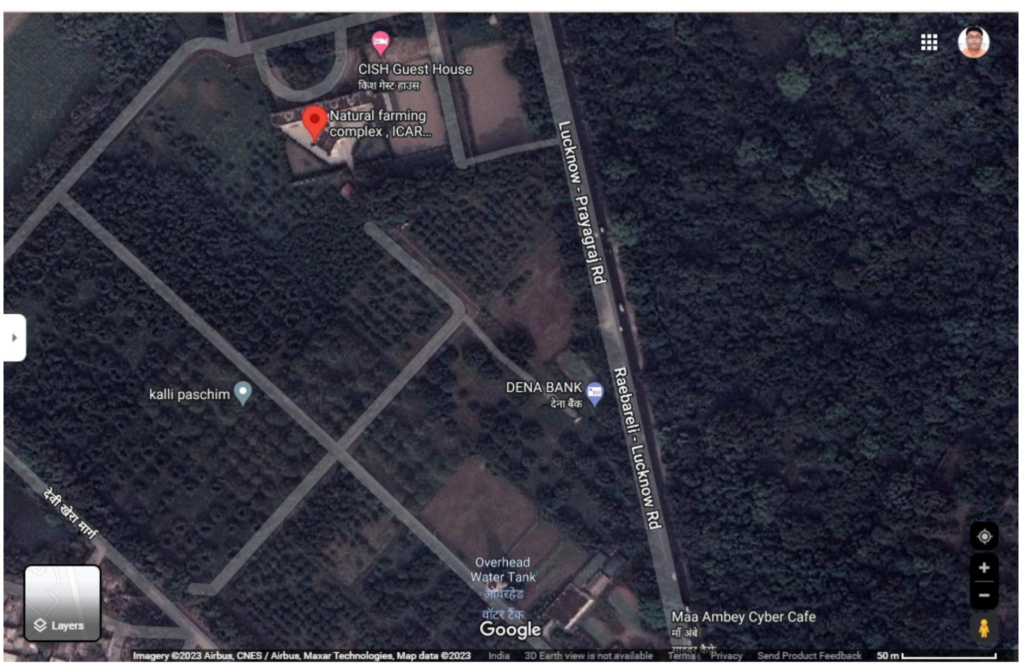

Fig. 1. Location of organic farming in Langra mango orchards at ICAR-CISH, Telibagh campus, Raebareli Road, Lucknow, UP

laid out during 2021 and 2022 fruiting seasons in mango cv Langra trees planted at a spacing of 10×10 having 35 to 40 years of age. Treatments consisting of different organic modules implemented on Langra trees. Organic mulching in tree basins, application of jeevamrit, neemastra, brahmastra, agnyastra, and Dashparni ark, etc, were performed. Two sprays (*Neemastra* @ 3%, *Agnyastra* @3%, and *Dashparni Ark* @ 3% and two with cow urine @ 10%) were done at 7-day intervals during panicle emergence and development stages. Other important practices like canopy management, polythene banding, glue traps, and solar traps for pest control were also performed. The crop was successfully protected from thrips and hoppers by one spray of Agrospray oil 97% E.C. (1%) followed by one spray with neem oil emulsion (0.3%) 7 days after the first.

Later, one spray with vermiwash, cow urine, and gliricidia-based liquid manure was also done. Flowering and fruit yields were recorded for each tree, and they have also been depicted in photographs. Representative soil samples were collected from tree basin areas at 0 to 30 and 30 to 60 cm soil depths. Samples from north to south and east to west within the tree canopy at basin area were collected. Thus, exhaustive soil samples were collected to determine the soil fertility status in existing Langra mango orchards. All these representative samples were air-dried in the laboratory and prepared for chemical analysis. Soil organic carbon, soil available P, K, DTPA extractable Zn, Cu, and Fe were determined. Data were undergone statistical analysis, and a histographic distribution was created to indicate the frequency distribution of content intervals for each soil parameter. Graphs were presented to depict the exactness of distribution patterns. Univariate statistical analysis was performed to show the variability of soil parameters in mango orchards of Telibagh, Raebareli Road campus of ICAR-CISH, Lucknow.

RESULTS AND DISCUSSIONS

It was observed from the statistically analyzed data that the soil organic carbon varied between 0.60±0.08 and 0.50±0.07 percent in 0 to 30 and 30 to 60 cm soil depths (Table 1). Similarly, soil available P and K were in ranged from 27.56±3.63 and 28.60±8.51 283.36±40.64 and 274.94±35.23 kg/ha, respectively. It was noticed that the values of soil organic carbon, soil available P, and K ranged from 0.43 to 0.66 percent, 20.02 to 37.84 kg/ha, and 238.04 to 326.04 kg/ha, respectively, across the Langra orchard soils. The soil available Zn, Cu, and Fe had contents of 1.23±0.29, 1.00±0.34; 3.16±0.89, 3.23±1.7; and 3.35±0.39, 2.31±0.17 mg/kg respectively in 0-30 and 30-60 cm soil depth. A range of 0.56 to 1.58, 1.34 to 5.04, and 2.18 to 3.72 mg/kg was also observed.

Interestingly, it was inferred from the dataset that the soil organic carbon, P, and K had lower

Table 1. Univariate statistical analysis of soil fertility in Langra orchard under organic farming at ICAR-CISH, Telibagh campus, Lucknow

Soil depths	mean	sd	max	min	cv	Skewness	Kurtosis
			Soil organic carbon (%)				
0-30 cm	0.60	0.08	0.66	0.49	13.1	-1.46	1.99
30-60 cm	0.50	0.07	0.56	0.43	13.7	-0.01	-5.20
			Soil available P (kg/ha)				
0-30 cm	27.56	3.63	31.90	23.76	13.2	0.31	-2.31
30-60 cm	28.60	8.51	37.84	20.02	29.8	0.11	-4.33
			Soil available K (kg/ha)				
0-30 cm	283.36	40.64	326.04	243.76	14.3	0.08	-4.93
30-60 cm	274.97	35.23	322.63	238.04	12.8	0.87	1.70
			Zn contents in soil (mg/kg)				
0-30 cm	1.23	0.29	1.58	0.94	23.8	0.45	-2.48
30-60 cm	1.00	0.34	1.28	0.56	34.5	-0.69	-2.12
			Cu contents in soil (mg/kg)				
0-30 cm	3.16	0.89	4.08	2.28	28.2	0.06	-4.94
30-60 cm	3.23	1.70	5.04	1.34	52.8	-0.07	-3.50
			Fe contents in soil (mg/kg)				
0-30 cm	3.35	0.39	3.72	2.84	11.5	-0.85	-0.17
30-60 cm	2.31	0.17	2.56	2.18	7.4	1.76	3.31

coefficients of variations in the ranges of 12.8 to 29.8 percent, while soil micronutrients showed greater coefficients of variations in the ranges from 23.8 to 52.8 percent. Such wider variability indicated the need for more soil conservation practices to nullify the adverse effects of higher nutrient variability across Langra orchards. Histographic distribution showed maximum frequency levels of soil organic carbon, P, and K in the lower category of 0.4 to 0.5 percent, 20 to 25 kg/ha, and 250 to 275 kg/ha, respectively (Figure 4). In contrast, Zn had 1.0 to 1.5, Cu had 2.0 to 3.0, and Fe had 2.0 to 2.5 mg/kg ranges in maximum frequency levels, respectively (Figure 5). All these statistical distributions strongly suggest improving soil health conditions so that maximum frequency distribution lies in the maximum content ranges. The organic modules impacted the trees, particularly flowering and fruit-setting patterns. It was observed that after spraying of organic sources, Langra had considerable flowering, and, of course, a considerable fruit set was also noticed (Figures 2 and 3). Langra fruits started developing, and their size increased over time due to resource management practices like irrigation at the pea, marble, and egg stages. Mulching positively affected the moisture consideration *vis-à-vis* fruit development and increment in fruit size. Each tree's fruits were recorded, and it was found that a low yield of 47.3 kg/tree (Control) to 90.4 kg/tree was in organic-treated trees. The response of trees toward organically sprayed nutrient sources enhanced the researchers' confidence. Thus, it was felt that flowering and fruit load may be increased via resource conservation and management practices in subtropical climates. The new initiatives of organic farming may be fruitful to growers for economic benefits.

Fig. 2. Depiction of flowering in mango cv Langra under organic farming at ICAR-CISH, Telibagh campus, Lucknow

Fig. 3. Depiction of Fruit yields in mango cv Langra under organic farming at ICAR-CISH, Telibagh campus, Lucknow

Considering the resource constraints and management practices, the impacts of organic sources on soil and tree health *vis-à-vis* fruit yield and quality were envisaged. The performances of the same trees or similar varieties may be different in different hydrothermal regimes, and climatic changes may alter their response, too. Therefore, it

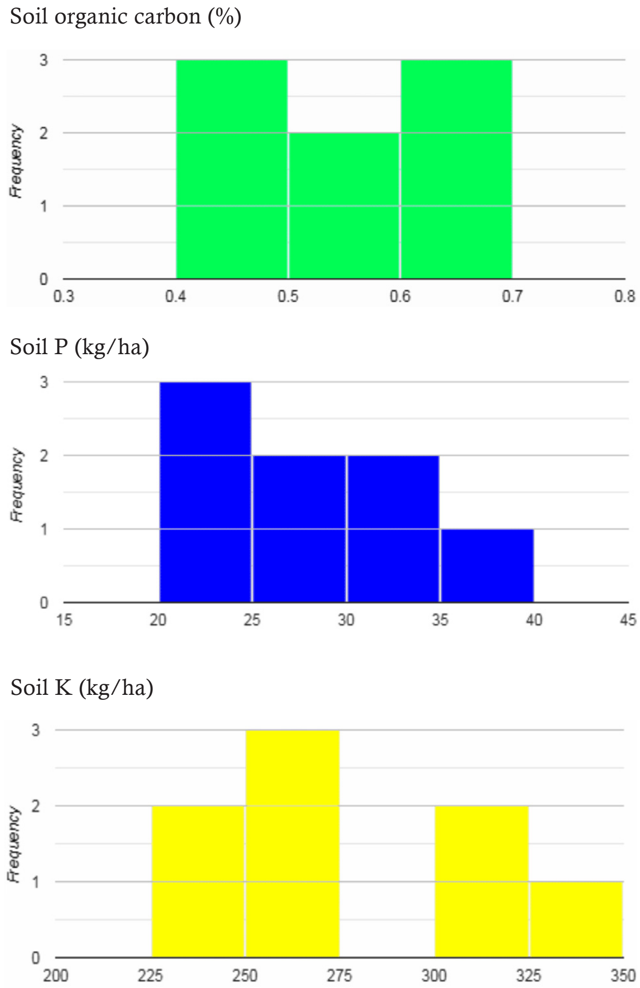

Fig. 4. Histographic distribution of soil organic carbon, soil P and soil K in mango cv Langra under organic farming orchards

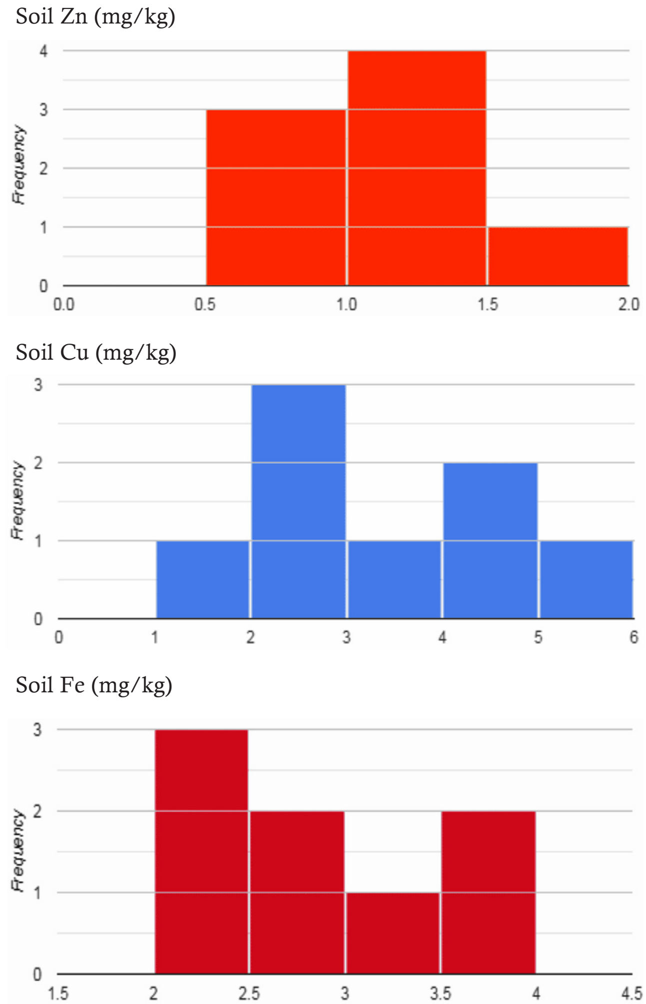

Fig. 5. Histographic distribution of soil Zn, soil Cu and soil Fe in mango cv Langra under organic farming orchards

is crucial to manage the orchard ecosystem scientifically and obtain requisite fruit yields. Adak *et al.* (2018) observed that Grower's Langra orchards under subtropical climates of the Malihabad area had 0.34±0.02 to 0.45±0.04 percent soil organic carbon across 0 to 30 cm soil depths. In contrast, available P and K status indicated 10.77±1.71 to 27.97±3.51 and 76.62±2.82 to 116.95±17.74 mg/kg, respectively, in these orchards. Some of the orchards were thought to be well managed, but others were low yielding, having the lowest Zn, Cu, and Fe contents of 0.64±0.23, 1.81±0.56 and 7.57±2.85 mg/kg, respectively, with fruit yield of <2.0 t ha^{-1}. Therefore, the thrust was given to resource conservation and management so that soil health improves and quality fruit yields can be harvested. Bhardwaj *et al.* (2020) emphasized research priorities and paradigm shifts for improving sustainability options. Moisture conservation should be maintained at critical pea, marble, and fruit maturity stages in Amrapali mango under hot, dry subtropical conditions to increase water productivity (Adak and Babu, 2022). Babu *et al*. (2022) discussed detailed technological strategies for enhancing production for small and marginal farmers. Organic sources like mulching improve the orchard soil condition. Garg *et al.* (2007) recorded that banana leaf mulch conserved soil moisture, had the highest bacterial and fungal counts and greater fruit yield of 11.8 kg/guava tree. It was further noticed that organic sources like organic mulching, FYM, *Azotobacter*, and *Trichoderma harzianum,* along with phosphate solubilizing microorganisms, improved tree response in subtropical guava orchards either alone or in combination with mineral fertilizers. Considerable yields of 48.8 kg/tree under 0.344%

SOC, 23.37 and 120.02 mg/kg P and K, 0.79, 0.63, and 3.37 mg/kg Zn, Cu and Fe were noted (Adak *et al.,* 2019). Orchard soils responded positively to quality improvement in fruits treated organically, like apples (Sharma *et al.,* 2001) and Kinnow mandarin (Bakshi *et al.,* 2017). Ram and Rajput (1998) found that organic (neem cake, mustard cake, sunhemp, Sesbania) and *Azospirillum* had a positive impact on ascorbic acid (200 to 205.76 mg/100g fruit), reducing sugars (4.85%) and acidity (1.14%) in guava. Thus, it was noted that organic farming statistically affected the soil health, yields, and quality of subtropical fruits. Not only soil and tree health is important, but controlling insects and diseases cost-effectively is equally important in the organic ecosystem. Daniels *et al.* (2017) recorded scientifically that losing three predators may produce hundred per cent black pears and cause significant economic loss. Thus, species richness and natural biodiversity are equally important in organic ecological production systems to sustain quality production economically. Under subtropical conditions, Ram (2021) advised that the first spray should be done with biodynamic liquid to control the mango hopper effectively. After that, 4-5% neem seed extract should be sprayed 4-5 times. In December-January, 250 g of *Beauveria bassiana* in the tree basin may control the mealy bug. In powdery mildew, foliar sprays of biodynamic preparation-501(13g/100 liter of water)/lime sulfur (2%) and 4-5 pheromone traps per acre significantly control fruit fly incidence. Thus, all these organic modules should be practiced systematically and sincerely to get the benefits of organic production.

CONCLUSION

The field experimentation was conducted to evaluate soil health and yield response in mango cv Langra under organic farming practices. The study confirmed positive responses across trees about flowering, fruit set, and fruit yields. Of course, there is a need to increase the soil's organic carbon and other nutrients. Results also suggested enhancing fruit yields further as we could get 80.3 to 90.4 kg of fruits/tree. The study's outcomes also indicated that it may be possible for farmers of other regions to implement organic farming practices in mangoes to get considerable flowering and fruiting with cost-effective local resources.

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