Indian Journal of Agricultural Sciences **90** (7): 1267–70, July 2020/Article

Improving sustainable yield index in guava (*Psidium guajava*) through organic and inorganic inputs

TARUN ADAK*[1], KAILASH KUMAR[2], S K SHUKLA[3] and G PANDEY[4]

ICAR-Central Institute for Subtropical Horticulture, Rehmankhera, Lucknow, Uttar Pradesh 226 101, India

Received: 15 April 2019; Accepted: 03 October 2019

ABSTRACT

Improvement of sustainable yield index (SYI) in fruit crop is the most important aspect of orchard sustainability and economic enhancement of fruit growers for which an investigation was laid out to improve SYI in guava (*Psidium guajava* L.) cv Shewta under different integrated nutrient management systems. Higher SYI was obtained using organic + inorganic systems (0.66) followed by NPK fertilization in soil (0.67) or foliar application of micronutrients (0.71) as compared to control (0.45) or adoption of sole organic sources of nutrition (0.45). A range of variation in SYI from 0.44 to 0.77 was recorded across treatments and seasons. The Reference ET_0 and pan evaporation was varied between 0.82 to 5.33 mm/day and 1.30 to 7.0 mm/day respectively during reproductive stages of guava. Changes in soil physical properties were recorded across three depths (0-10, 10-20 and 20-30 cm); water holding capacity and porosity varied across the depths and treatments; 19.53 to 24.48% and 39.92 to 50.20 % respectively. Improvement in these two parameters might have contributed towards better SYI in guava. The co-efficient of variation (CV%) of guava productivity based on yield stability indicated lower the variation (1.2 to 4.9) higher is the stability. The dynamic variations in total fruit yield 31.4 to 72.5 kg/tree indicated immediate need for precise soil management to enhance yield potentiality. Conclusively for better SYI in guava, the nutrient requirement through organic (FYM, *Azotobacter*, PSM, organic mulching *Trichoderma* etc.) and inorganic (NPK, micronutrients) sources are essentially required in soils of inherently low or poor fertility status.

Key words: Guava, Soil management, Sustainable yield index, Yield stability analysis

Sustainability of any fruit orchard ecosystem is the most essential part as the livelihood of growers is dependent on it (Kumar *et al.* 2017). Nutritional and economic securities are inter-dependent and best orchard management practices reducing the gap between potential and observed productivity of fruit orchard under varied agri-horti system. Hence, the most important priority to enhance farm productivity employing good management practices for the better fruit quality control measures both soil and tree health (Sharma *et al.* 2005, Adak *et al.* 2013). The input and output ratio, if economically viable and feasible to produce more quality produce per unit of applied inputs, resulting into the system becomes more robust. Apart from efficient farm management practices employing integrated nutrient management through integrated nutrient sources, during the critical phenological stages of fruit crop is also an important issue to look upon very cautiously under present day's climatic variation phenomenon. The reference evapotranspiration and higher pan evaporation often suggests for life saving irrigation at critical stages; fruit setting and development phases (Singh *et al.* 2007). Apart from offsetting this weather aberrations lasting across seasons, the Nutrition through soil or foliar application or even in different combinations involving organic and inorganic nutrients determines the effectiveness of the orchard management system even in offsetting weather aberrations lasting across the season of particular fruit crop.

Guava being rich in minerals, nutrients, Vitamin C and other anti-oxidants are equally capable of providing the same quantum to the nutritional requirement of human body and helpful in reducing the malnutrition problem (Adak and Pandey, 2018). However, soil management system plays critical role in sustaining the productive ecosystem. The aim of this experiment was thus to assess the effectiveness of different nutrient management modules to improve the sustainable yield index in guava. This is particularly important in the areas of having low soil fertility status and constrains in production system.

MATERIALS AND METHODS

The field experiment was conducted on 8-9 years old guava cv. Shewta plantation using 9 treatments combinations (Table 1) at ICAR-CISH, Rehmankhera experimental farm during 2012-15 Lucknow, UP, India. The inputs

*Corresponding author: tarunadak@gmail.com

[1]Senior Scientist (tarunadak@gmail.com), [2]Retired Principal Scientist (kailash1952@gmail.com), [3]Principal Scientist (skshuklacish@gmail.com), [4]Head and Principal Scientist (pandeyhorti@yahoo.co.in). ICAR-Central Institute for Subtropical Horticulture, Rehmankhera, Lucknow, India.

Table 1 Treatments composition for improving the SYI in guava cv. Shewta

T_1	10 kg FYM + 120, 60, 50 g NPK/tree/year of age (Recommended dose)
T_2	10 kg FYM + 120, 60, 50 g NPK/tree/year of age + *Azotobacter* + PSM + *Trichoderma harzianum* + organic mulching (10 cm thick)
T_3	120, 60, 50 g NPK/tree/year of age + *Azotobacter* + PSM + *Trichoderma harzianum* + organic mulching (10 cm thick)
T_4	120, 60, 50 g NPK/tree/year of age + Foliar application of Zn, B, Mn and Cu.
T_5	120, 60, 50 g NPK/tree/year of age + Soil application of Zn, B, Mn and Cu.
T_6	5 kg FYM + 120, 60, 50 g NPK/tree/year of age + *Azotobacter* + PSM + *Trichoderma harzianum* + organic mulching (10 cm thick)
T_7	10 kg FYM + *Azotobacter* + PSM + *Trichoderma harzianum* + organic mulching (10 cm thick)
T_8	10 kg FYM + 60 g N + 30 g P + 25 g K/tree/year of age + *Azotobacter* + PSM + *Trichoderma harzianum* + organic mulching (10 cm thick)
T_9	Control

were applied each year within the tree basin following the standard recommended package of practices. Uniform tree canopy was maintained to some extent. Tree health was given priority and nutrients were applied in soil and foliar application of micronutrients during fruit set to development stages. Biofertilizer and organic mulching were used for regulating the microclimate within the tree basin. Regular mowing was done through tractor to avoid weed infestation; however, time to time intercultural operation was carried out in tree basin to avoid weed population. Soil samples (undisturbed core) were collected each year before treatment application and after fruit harvesting at 0-10, 10-20 and 20-30 cm soil depths. Core samples were processed as per standard methodology in the laboratory for estimating the water holding capacity (WHC), porosity, bulk density (BD) and particle density (PD). Pooled data of two years was used for graphical presentation and statistical analysis. The sustainable yield index (SYI) was estimated as suggested by Singh *et al.* (1990) and yield stability was inferred from the coefficient of variation (CV %) as per Hu and Geng (1993). The study was related with winter season guava crop for SYI during both the years. Dynamics of yield variability across seasons and treatments were graphically presented and conclusion was drawn based on scattered diagram. The reference ET_0 was calculated using Allen *et al.* (1998) and pan evaporation dynamics during guava growing season from October to March was graphically presented.

RESULTS AND DISCUSSION

Soil and atmospheric analysis:

The prevailing atmospheric conditions during the crop growing season are presented by the analysis of existed reference ET_0 and variations in pan evaporation. Data showed reference ET_0 varied between 0.95 to 5.33 and 0.82 to 4.84 mm/day during the two crop seasons while pan evaporation from 1.30 to 7.00 mm/day. The reference ET_0 at different phenological stages, *viz*. flowering, fruit setting, fruit development and maturity was varied between the years (Fig 1). The analysis clearly showed lower dry situations during the fruit development stage might be very favourable for any climatic aberrations to avoid forced fruit maturity without much effects on fruit quality and total fruit production. Addition of different substrates in the form of nutrient management modules greatly influences the soil physical properties. It was recorded that the water holding capacity was meagrely higher in treatments having organic substrate; WHC ranged between 21.07 to 24.48, 20.42 to 21.87 and 19.53 to 20.95 % across the treatments at 0-10, 10-20 and 20-30 cm soil depth while porosity had a range of 44.31 to 50.20, 40.08 to 45.87 and 39.92 to 45.98% respectively (Fig. 2). Similarly the BD and PD varied from 1.26 to 1.48 g/cm^3 and 2.35 to 2.62 g/cm^3 respectively. Lower compaction resulting into high porosity might be responsible for higher fruit yield. Hence, to avoid any weather extremes during the fruiting season, farmers need to be sensitized for adoption of agro-advisory services for real time orchard management. This is particularly important for winter season crop to get more yields from per unit input applied. The positive response of soil moisture stress in winter guava cv. Allahabad safeda was observed for better fruit yield (Singh *et al.* 1997). Likewise adoption of drip fertigation at critical phenological stages enhanced growth and yield of guava cv. Khaja (Sharma *et al.* 2011). Thus, site-specific management options needs to be evolved for getting better response of crop-climate-soil interactions. Malhi *et al.* (2011) reported the effects on the organic C and other soil properties under long-term soil management. Similarly, in order to further précising the soil management, the importance of variability of soil were also suggested by Gosling and Shepherd (2005), Camacho-Tamayo *et al.* (2008) and Dec and Dörner (2014) depending upon

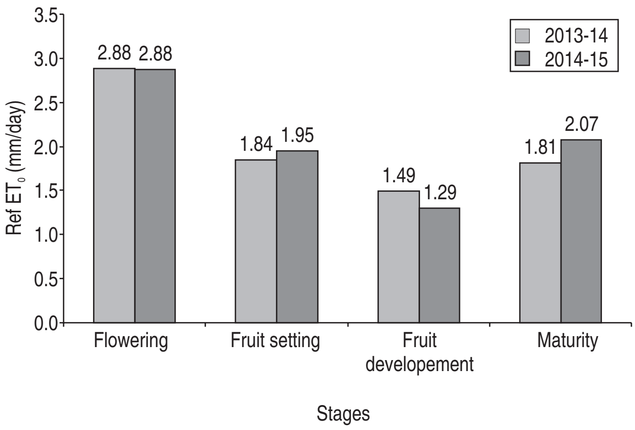

Fig 1 Variation in reference ET_0 at different phenological stages under nutrient management modules in guava cv. Shewta during winter crop season in 2012-15.

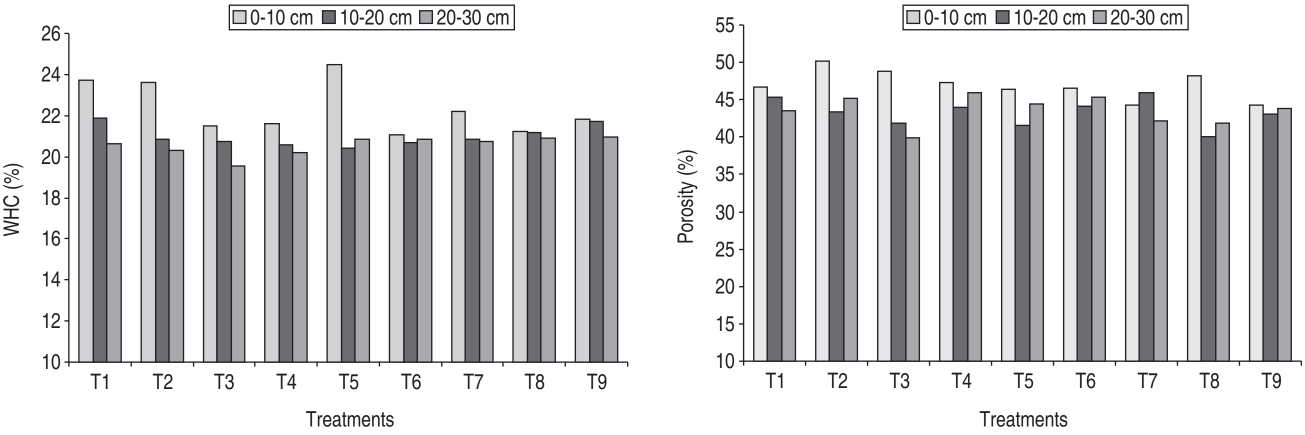

Fig 2 Water holding capacity and porosity among different nutrient management modules in guava cv. Shewta orchard soil.

the location and agro-climatic requirement. To economize further natural resources for higher input use efficiency, proper care should be taken (Adak *et al.* 2016).

Yield stability analysis and sustainability

Analysis of yield stability showed wider variations across various organic and inorganic substrate treated guava trees. The coefficient of variation (CV%) indicated lower value in soils applied with NPK + soil or foliar application of micronutrients (Fig 3); thus high yield stability could be obtained with these treatments at farmers field. Tree supplemented with only organic substrate also showed lower CV% but yields are not sustainable. The yield gap analysis is the best way for planners/growers to choose the ways to improve yield sustainability and finally total economic returns. Beneficial effects of organic substrate along with fertilizer for obtaining better sustainable yield in different crops is being reported by researchers like Manna *et al.* (2005). The SYI approach inferred the fact, that farmers may adopt some of these treatments in their guava orchard for higher economic return. The SYI in the treatments T_2, T_4 and T_5 was 0.55 to 0.67, 0.58 to 0.76 and 0.65 to 0.77 while it was 0.44 to 0.45, 0.45 to 0.45 and 0.48 to 0.61 in T_9, T_7 and T_1 respectively during both the years (Fig 3). Adak *et al.* (2018) reported higher SYI by application of NPK + micronutrient in mango. Similarly, drip fertigated Dashehari mango trees recorded higher SYI, when the fertigation is applied at the critical crop phenological stages (Adak *et al.* 2018). In fact in guava, fruit bud differentiation plays a major role towards the yield variations. Quality of shoots alongside shoots emerged during April and July months contributed towards winter harvested fruit as observed by Singh *et al.* (1999). Not only quality of flushes but also the cropping pattern and density of planting system contribute towards major shifts in productivity at farmers' field. Singh *et al.* (1996) reported the effect of cropping pattern on quality attributes of guava while accommodating of more number of plants per unit area could lead to quality fruit production (Singh *et al.* 2012). In fact such system also needs special management system for enhancing the observed yield. There was a huge gap between observed vs potential yield and in order to overcome such gap, precision farming or adoption of integrated nutrient management system is required in different soil ecosystem for the betterment of farming community. Hazarika *et al.* (2015) also reported sustaining fruit yield following integrated nutrient management options in Banana. The role of effective orchard management for obtaning higher productivity and improved input use

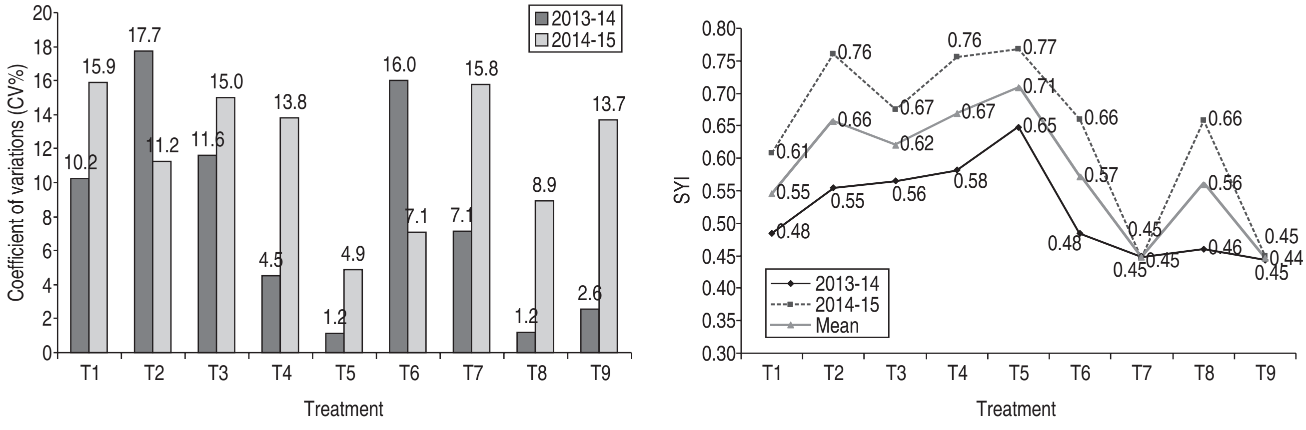

Fig 3 Analysis of coefficient of variations of productivity and sustainable yield index in guava cv Shewta under different nutrient management modules.

efficiency was also evidenced by Meshram *et al.* (2018) in pomegranate and Kumar *et al.* (2018) in apple cv. *Mollies delicious*.

Field experiemntaion showed higher SYI following integarted approach system along with addition of micronutrients in soil or foliar spray. Yield stability index should be considered for recommending to the growers based on soil, tree and climatic interactions. Analysis of atmospheric conditions need to be given priority for yield stability analsyis and agroadvisory servcies should also be followed to aviod abiotic stress. The analysis of SYI suggested to follow the integrated approach system along with addition of micronutrient through foliar and basal application in guava growing soil in India. Hence, the regular application of recommended dose of fertilizer along with organic sources of nutrition, soil and foliar spray of micronutrient is very much essential to reduce the future negative yield trends. moeover, canopy managemet through pruning should be practiced as it is very selective and crucial for guava production. The cause of yield decline are mostly location specific but depletion of soil organic carbon and associate nutrients to be a general cause. Presently the SYI of guava followed the order of 0.66, 0.67 and 0.71.

REFERENCES

Adak T and Pandey G. 2018. Soil Management of Horticultural Crops for Food and Nutritional Security of Farm Women. *(In) Training Manual on Model Training Course Food and Nutritional security of farm women through horticulture based interventions*, ICAR-CISH Lucknow India, November 13-20, pp 111-114.

Adak T, Kumar K and Singh V K. 2016. Annual variations in weather parameters, thermal indices, heat and water use efficiency in mango. *(In) Proceedings of International Conference on Climate Change and its Implications on Crop Production and Food Security*, BHU Varanasi, Nov 12-13, p 19.

Adak T, Kumar K and Pandey G. 2018. Enhancing sustainable yield index in fertigated Mango cv. Dashehari. *GERF Bulletin of Biosciences* **9**(2):1-6.

Adak T, Kumar K and Singh V K. 2018. Sustainable yield index and soil properties in mango under different nutrient management strategy. *Indian Journal of Horticulture* **75**(4): 605-12.

Adak T, Singha A, Kumar K and Singh V K. 2013. Impact of different substrates on spatial variations of soil organic carbon, soil moisture and dehydrogenase activity in guava soil. *(In) Proceedings of First International Conference on Bio-resource and Stress Management*, Kolkata India, February 6-9, p 46.

Allen R G, Pereira L S, Raes D and Smith M. 1998. Crop evapotraspiration, guideline for computing crop water. *FAO Irri. Drain. Paper 56*, FAO Rome, Italy, 300 p.

Camacho-Tamayo J H, Luengas C A, Leiva F R. 2008. Effect of agricultural Intervention on the spatial variability of some soils chemical properties in the eastern plains of colombia. *Chilean Journal of Agricultural Research* **68**: 42-55.

Dec D and Dörner J. 2014. Spatial variability of the hydraulic properties of a drip irrigated andisol under blueberries. *Journal of Soil Science and Plant Nutrition* **14**(3): 589-01.

Gosling P and Shepherd M. 2005. Long-term changes in soil fertility in organic arable farming systems in England, with particular reference to phosphorus and potassium. *Agriculture Ecosystems and Environment* **105**:425-432.

Hazarika T K, Nautiyal B P and Bhattacharyya R K. 2015. Sustainable banana (*Musa* spp) production through integrated plant nutrition system – A review. *Indian Journal of Agricultural Sciences* **85**(8): 987-95.

Hu B M and Geng X. 1993. Methods for crop stability analysis. Science Press, Beijing.

Kumar K, Adak T and Singh VK. 2017. Green manuring and nutrient management impacting soil properties and sustainability of mango orchard. *Journal of Soil and Water Conservation* **16**(1): 72-8.

Kumar M, Jamwal M, Kumar V, Charak A and Rai A P. 2018. Effect of orchard management practices in high density of apple cv. *Mollies delicious* under temperate condition. *Journal of Soil and Water Conservation* **17**(3):288-93.

Malhi S S, Nyborg M, Solberg E D, McConkey B, Dyck M and Puurveen D. 2011. Long-term straw management and N fertilizer rate effects on quantity and quality of organic C and N and some chemical properties in two contrasting soils in Western Canada. *Biology and Fertility of Soils* **47**:785-800.

Manna M C, Swarup, A, Wanjari R H, Ravankar H N, Mishra B, Saha M N, Singh Y V, Sahi D K and Sarap P A. 2005. Long term effect of fertilizer and manure application on soil organic carbon storage, soil quality and yield sustainability under subhumid and semi-arid tropical India. *Field Crops Research* **93**: 264-80.

Meshram D T, Gorantiwar S D, Lad S A and Pal R K. 2018. Effect of organic mulches on yield, quality and WUE of Pomegranate (*Punica granatum* L.). *Indian Journal of Soil Conservation* **46**(1):101-8.

Sharma K L, Mandal U L, Srinivas K, Vittal K P R, Mandal B, Grace J K and Ramesh V. 2005. Long-term soil management effects on crop yields and soil quality in a dryland Alfisol. *Soil and Tillage Research* **83**(2): 246-59.

Sharma S, Patra S K and Ray R. 2011. Effect of drip fertigation on growth and yield of guava cv. Khaja. *Environment and Ecology* **29**: 34-8.

Singh A K, Singh C P and Pandey G. 2012. Effect of high density planting system on growth, yield and quality of mango (*Mangifera indica* L), *viz*; Dashehari. *Annals of Horticulture* **5**(2): 173-8.

Singh A K, Singh G, Pandey D and Rajan S. 1996. Effect of cropping pattern on quality attributes of guava (*Psidium guajava*) fruits. *Indian Journal of Agricultural Sciences* **66**(6): 348-2.

Singh B K, Tiwari K N, Chourasia S K and Mandal S. 2007. Crop water requirement of guava (*Psidium guajava* L.) cv. KG/KAJI under drip irrigation and plastic mulch. *Acta Horticulturae* **735**: 399-5.

Singh G, Rajan S and Singh A K and Pandey D. 1999. Fruit bud differentiation and contribution of different flushes towards annual yield of guava (*Psidium guajava* L.). *Journal of Applied Horticulture* **1**(1):19-3.

Singh G, Rajan S, Pandey D and Singh A K. 1997. Effect of soil-moisture stress on water relation by plant and cropping behaviour in guava (*Psidium guajava*). *Indian Journal of Agricultural Sciences* **67**(7): 303-06.

Singh R P, Das S K, Bhaskar Rao U M and Narayana Reddy M. 1990. Towards Sustainable Dryland Agricultural Practices. CRIDA, Hyderabad, India.