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Enhancement in Yield Parameters of Guava (*Psidium guajava* L.) cv. Lalit through Foliar Application of Nano Urea and chelated Zinc under Western Uttar Pradesh conditions

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ABSTRACT: The present investigation was carried out at Horticultural Research Centre of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut. The experiment titled "A study on yield attributes of guava (*Psidium guajava* L.) cv. Lalit affected by foliar application nano urea and chelated zinc" was laid out in a Factorial Randomized Block Design (FRBD) and the number of treatments were 16 *viz.*, T_1- control, T_2- nano N 1.5 ml, T_3- nano N 3.0 ml, T_4-nano N 4.5 ml, T_5- chelated Zn 0.4%, T_6- nano N 1.5 ml + chelated Zn 0.4%, T_7- nano N 3.0 ml + chelated Zn 0.4%, T_8- nano N 4.5 ml + chelated Zn 0.4%, T_9- chelated Zn 0.8%, T_{10}- nano N 1.5 ml + chelated Zn 0.8%, T_{11}- nano N 3.0 ml + chelated Zn 0.8%, T_{12}- nano N 4.5 ml + chelated Zn 0.8%, T_{13}- chelated Zn 1.2%, T_{14}- nano N 1.5 ml + chelated Zn 1.2%, T_{15}- nano N 3.0 ml + chelated Zn 1.2% and T_{16}- nano N 4.5 ml + chelated Zn 1.2%, each replicated thrice. Because horticulture crops mostly rely on chemical fertilisers, precise nutrient management of these crops is a significant challenge on a global scale. Traditional fertilisers can be hazardous to people and the environment in addition to being expensive for the producer. Due to this, people are looking for environmentally acceptable fertilisers, especially ones that are highly nutrient-efficient, and nanotechnology is emerging as a possible substitute. Out of the 16 treatment applied, the results revealed that treatment T_{12} recorded the highest number of fruits per tree (179.67 and 180.33), maximum fruit yield per tree (18.53 and 18.59 kg) and yield per hectare (205.90 and 206.50 q/ha). Among nano urea and chelated zinc doses, T_4 and T_9 were found to be best.

Keywords: Guava, Nano Urea, Chelated Zinc, Yield Attributes, Foliar Application, Nutrient Management, Nanotechnology and Environmental Sustainability.

INTRODUCTION

Guava (*Psidium guajava* L.) is an important commercial and hardy fruit crop grown across the various tropical and subtropical regions of the world (Negi *et al*., 1998). Belonging to myrtle family (Myrtaceae), guava is believed to have originated from Tropical America i.e., from Mexico to Peru, and possess a chromosome number of 2n = 22 (Menzel, 1985; Boora, 2012). However, the triploid species of guava which are seedless possess a chromosome number 2n = 33 (Raman *et al*., 1971). Being a staple fruit of the tropics and serving a variety of uses, it is often referred to as "Apple of Tropics" and mostly enjoyed as a fresh fruit (Webber, 1944; Menzel, 1985). As per National Nutrient Database released by United States Department of Agriculture (USDA) in 2018, 100 g of guava fruit contains 14.3 g carbohydrates, 5.4 g total dietary fibre, 8.92 g sugar and 2.55 g protein. Beside this, it is also abundant in vitamin C (228 mg), vitamin A (31 µg), potassium (417 mg), phosphorus (40 mg), magnesium (22 mg), calcium (18 mg) and iron (0.26 mg) (Anonymous, 2018). The guava fruit is also a rich source of pectin (0.78%), which is an important component of jelly (Dhingra, 1979). Among the various fruit crops cultivated in India, guava ranks fifth in area after mango, citrus, banana, and apple occupying about 354 thousand hectares area, while it also ranks fifth in production after banana, mango, citrus and papaya with about an annual production of 5.53 million metric tonnes. The major guava producing states are Uttar Pradesh, Madhya Pradesh, Bihar, Andhra Pradesh, Haryana, Punjab, etc. Uttar Pradesh ranks first in both area and production with an annual production of 983.59 thousand metric tonnes from an area of 52.25 thousand hectares accounting for a total market of 21.78% followed by Madhya Pradesh, Bihar, Andhra Pradesh etc. The average national productivity of guava is estimated to be 15.41 MT/ha (Anonymous, 2021). Uttar Pradesh is known to produce the highest quality guava and Allahabad region of Uttar Pradesh possesses a distinct reputation for producing the best guava in the country as well as in the world.

Fertilizers have long been used in the agricultural sector to support crops, but the issue with conventional fertilisers is that they remain in the soil for an extended duration, leaving the soil barren. Plants are therefore, deficient in vital nutrients. Nano fertilisers offer the ideal way to solve this issue due to their site-specificity, demand-release, efficiency, and ease of solubility (Butt and Naseer 2020). Nano fertilizers are often referred to as "Smart Fertilizers" due to their ability to enhance the nutrient use efficiency and reduce the adverse impact on environment, consequently lowering the cost of environment protection (Manjunatha *et al*., 2016). Micronutrients play a significant role in crop productivity due to their importance in plant metabolism and the detrimental effects that result from their deficiency. They have an important role in influencing the quality and shelf life of harvested produce, a phenomenon that has received less attention in the past (Raja, 2009). Both basal and foliar applications of nutrients can provide the plant with nutrients. However, in recent years, foliar application of nutrients has gained importance over soil application due the fact that a higher quantity of nutrients is required to be applied in the soil because some of it gets leached down while a part of it becomes unavailable to the plants due to the complex reactions in soil. The principle behind foliar application is that nutrients are rapidly absorbed by leaves and transported to various parts of the plant to meet the functional need for nourishment. Foliar application of micronutrient is crucial for enhancing quality and are considerably more successful for hastening plant recovery in high pH environments as micronutrients are rendered unavailable under such conditions (Yadav *et al*., 2014). However, the deficiency of nutrients persists in our soils today, causing many physiological processes to malfunction. Considerable research work has been done in the country on various aspects such as varieties, propagation, irrigation, training and pruning, etc. to increase the yield and quality of guava fruits. But poor yield and quality of fruits is still a matter of common experience (Badal and Tripathi 2021). It would be therefore worthwhile to improve the yield by use of micronutrients and nano-fertilizers. Thus, the outcome of the study can lead to improvement in the yield without hampering the properties of soil. Considering the above facts, yield attributes of guava (*Psidium guajava* L.) cv. Lalit was examined in relation to foliar application nano urea and chelated zinc.

MATERIALS AND METHODS

The present investigation entitled "A study on yield attributes of guava (*Psidium guajava* L.) cv. Lalit affected by foliar application nano urea and chelated zinc" was carried out at Horticultural Research Centre of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, U. P., India during the year 2021-22 and 2022-23. Geographically, experimental field is located at 29°04′ North latitude, 77°42′ East longitude and at an altitude of 237.75 meter above the mean sea level. The variety Lalit was selected for study. Plants are spaced at a distance of 3 × 3 m and uniform cultural practices were followed throughout the experimental period. Observations taken during the period were number of fruits per tree, fruit yield per tree (kg), fruit yield per hectare (q/ha). The trial was laid out in a Factorial Randomized Block Design (FRBD) and the number of treatments were 16 (Table 1), each replicated thrice. the yield parameters that were recorded were number of fruit per plant, fruit yield per tree (kg) and fruit yield per hectare (q/ha).

Table 1: Treatment details.

Treatment no.	Treatment combination	Dose
T_1	N_0Z_0	Control
T_2	N_1Z_0	Nano N 1.5 ml
T_3	N_2Z_0	Nano N 3.0 ml
T_4	N_3Z_0	Nano N 4.5 ml
T_5	N_0Z_1	Chelated Zn 0.4%
T_6	N_1Z_1	Nano N 1.5 ml + Chelated Zn 0.4%
T_7	N_2Z_1	Nano N 3.0 ml + Chelated Zn 0.4%
T_8	N_3Z_1	Nano N 4.5 ml + Chelated Zn 0.4%
T_9	N_0Z_2	Chelated Zn 0.8%
T_{10}	N_1Z_2	Nano N 1.5 ml + Chelated Zn 0.8%
T_{11}	N_2Z_2	Nano N 3.0 ml + Chelated Zn 0.8%
T_{12}	N_3Z_2	Nano N 4.5 ml + Chelated Zn 0.8%
T_{13}	N_0Z_3	Chelated Zn 1.2%
T_{14}	N_1Z_3	Nano N 1.5 ml + Chelated Zn 1.2%
T_{15}	N_2Z_3	Nano N 3.0 ml + Chelated Zn 1.2%
$\mathbf{T_{16}}$	N_3Z_3	Nano N 4.5 ml + Chelated Zn 1.2%

Number of fruits were calculated by counting the fruits after each harvesting and the total was summed up. The total fruits obtained per tree were weighed after each harvesting and was summed up and yield per tree was calculated. The fruit yield per hectare (q/ha) was calculated by multiplying fruit yield per tree × 11.11. The parameters were statistically analysed by adopting appropriate model of analysis of variance (ANOVA) as per the procedure described by Panse and Sukhatme (1985). The significance of treatments effect was computed with the help of 'F-test' (variation ratio).

RESULTS AND DISCUSSION

A. Number of fruits per tree

During both the years, application of nano urea, chelated zinc and their combination significantly influenced the number of fruit per tree as depicted in Table 2 and Fig. 1. Highest number of fruits per tree with the application of nano urea and chelated zinc singly and their combination was recorded in treatment T_4 i.e. nano urea@ 4.5 ml/tree (161.67 and 162.67), treatment T_9 i.e. chelated zinc @ 0.8% (163.67 and 164.67) and treatment T_{12} i.e. nano urea@ 4.5 ml/tree + chelated zinc @ 0.8% (179.67 and 180.33) in both the years, respectively while, the lowest number of fruits per tree was recorded in T_1 - control i.e. 143.67 and 142.33, respectively. Treatment T_{11}, T_{15} and T_{16} were found to be at par with treatment T_{12} in the first year, while only T_{11} and T_{16} were found to be at par with treatment T_{12} in the second year. The results are partially consistent with findings of El-Aidy *et al.* (2022) in orange, Davarpanah *et al.* (2017); Davarpanah *et al.* (2016) in pomegranate, Sarrwy *et al.* (2012) in mandarin. The reason for increase in number of fruits per tree can be explained by physiological and metabolic functions of nitrogen in the process of flowering and fruiting. The role of nitrogen is crucial in supplying carbohydrates that is necessary at various stages of plant such as flower bud growth, initiation and development of flower, lifespan of ovule and effective pollination and fertilization.

B. Fruit yield per tree (kg)

During both the years, application of nano urea, chelated zinc and their combination significantly influenced the fruit yield per tree as depicted in Table 3 and Fig. 1. Highest fruit yield per tree with the application of nano urea and chelated zinc singly and their combination was recorded in treatment T_4 i.e. nano urea@ 4.5 ml/tree (16.11 and 16.35 kg), treatment T_9 i.e. chelated zinc @ 0.8% (16.27 and 16.33 kg) and treatment T_{12} i.e. nano urea@ 4.5 ml/tree + chelated zinc @ 0.8% (18.53 and 18.59 kg) in both the years, respectively. The lowest yield per tree in both the years was recorded in T_1 - control i.e. 13.03 and 12.95 kg, respectively. Treatment T_{11} and T_{16} were found to be at par with treatment T_{12} in the first year only. The results are consistent with the findings of El-Aidy *et al.* (2022) in orange, El-Rahman and Abd-Elkarim (2022) in date palm, Saied (2018) in mango, Davarpanah *et al.* (2017) in pomegranate, Sarrwy *et al.* (2012) in mandarin, Hassan *et al.* (2010) in plum and Dawood *et al.* (2000) in orange. The increase in fruit yield per tree with foliar application nano urea and chelated zinc may be ascribed to increase in the fruit retention on the tree consequently reducing the fruit drop percentage (Bisen *et al.*, 2020).

Table 2: Influence of foliar application of nano urea and chelated zinc on number of fruit per tree of guava (*Psidium guajava* L.) cv. Lalit under western Uttar Pradesh conditions.

	2021-22					2022-23				
	Control (Z_0)	**Zn 0.4% (Z_1)**	**Zn 0.8% (Z_2)**	**Zn 1.2% (Z_3)**	**Mean**	**Control (Z_0)**	**Zn 0.4% (Z_1)**	**Zn 0.8% (Z_2)**	**Zn 1.2% (Z_3)**	**Mean**
Control Nano-N (N_0)	143.67	149.67	163.67	157.33	153.58	142.33	147.00	164.67	158.67	153.17
Nano-N 1.5 ml/tree (N_1)	152.67	155.67	174.33	168.33	162.75	151.33	154.67	173.67	169.67	162.33
Nano-N 3.0 ml/tree (N_2)	158.33	166.33	178.33	175.33	169.58	160.33	167.00	178.67	175.33	170.33
Nano-N 4.5 ml/tree (N_3)	161.67	171.33	179.67	177.67	172.58	162.67	172.67	180.33	177.33	173.25
Mean	154.08	160.75	174.00	169.67		154.17	160.33	174.33	170.25	
	N	**Z**	**N×Z**			**N**	**Z**	**N×Z**		
C. D.	1.726	1.726	3.451			1.785	1.785	3.570		
S. E. (d)	0.841	0.841	1.682			0.870	0.870	1.739		

Table 3: Influence of foliar application of nano urea and chelated zinc on fruit yield per plant of guava (*Psidium guajava* L.) cv. Lalit under western Uttar Pradesh conditions.

	2021-22					2022-23				
	Control (Z_0)	**Zn 0.4% (Z_1)**	**Zn 0.8% (Z_2)**	**Zn 1.2% (Z_3)**	**Mean**	**Control (Z_0)**	**Zn 0.4% (Z_1)**	**Zn 0.8% (Z_2)**	**Zn 1.2% (Z_3)**	**Mean**
Control Nano-N (N_0)	13.03	14.22	16.27	15.15	14.67	12.95	13.96	16.33	15.39	14.66
Nano-N 1.5 ml/tree (N_1)	14.14	14.89	17.47	16.45	15.74	13.97	14.87	17.46	16.48	15.69
Nano-N 3.0 ml/tree (N_2)	15.63	16.45	18.23	17.76	17.02	15.79	16.46	18.22	17.86	17.09
Nano-N 4.5 ml/tree (N_3)	16.11	17.35	18.53	18.19	17.55	16.35	17.42	18.59	18.11	17.62
Mean	14.73	15.73	17.63	16.89		14.76	15.68	17.65	16.96	
	N	**Z**	**N×Z**			**N**	**Z**	**N×Z**		
C. D.	0.185	0.185	0.370			0.187	0.187	0.374		
S. E. (d)	0.090	0.090	0.180			0.091	0.091	0.182		

C. Yield per hectare (q/ha)

During both the years, application of nano urea, chelated zinc and their combination significantly influenced the yield per hectare as depicted in Table 4 and Fig. 1. Highest yield per hectare with the application of nano urea and chelated zinc singly and their combination was recorded in treatment T_4 i.e. nano urea @ 4.5 ml/tree (178.98 and 181.61 q/ha), treatment T_9 i.e. chelated zinc @ 0.8% (180.76 and 181.43 q/ha) and treatment T_{12} i.e. nano urea @ 4.5 ml/tree + chelated zinc @ 0.8% (205.90 and 206.50 q/ha) in both the years, respectively. The lowest yield per hectare in both the years was recorded in T_1 - control i.e. 144.80 and 143.87 q/ha, respectively. Treatment T_{11} and T_{16} were found to be at par with treatment T_{12} in the first year only. The results are consistent with the findings of partially consistent with Khan *et al*. (2019) in Red Delicious Apple.

Table 4: Influence of foliar application of nano urea and chelated zinc on yield per hectare of guava (*Psidium guajava* L.) cv. Lalit under western Uttar Pradesh conditions.

	2021-22					2022-23				
	Control (Z_0)	**Zn 0.4% (Z_1)**	**Zn 0.8% (Z_2)**	**Zn 1.2% (Z_3)**	**Mean**	**Control (Z_0)**	**Zn 0.4% (Z_1)**	**Zn 0.8% (Z_2)**	**Zn 1.2% (Z_3)**	**Mean**
Control Nano-N (N_0)	144.80	157.95	180.76	168.28	162.95	143.87	155.13	181.43	171.02	162.86
Nano-N 1.5 ml/tree (N_1)	157.06	165.46	194.09	182.72	174.83	155.17	165.17	193.98	183.13	174.36
Nano-N 3.0 ml/tree (N_2)	173.69	182.72	202.57	197.28	189.06	175.46	182.91	202.50	198.42	189.82
Nano-N 4.5 ml/tree (N_3)	178.98	192.72	205.90	202.09	194.92	181.61	193.57	206.50	201.17	195.71
Mean	163.63	174.71	195.83	187.59		164.03	174.20	196.10	188.44	
	N	**Z**	**N×Z**			**N**	**Z**	**N×Z**		
C. D.	2.055	2.055	4.109			1.935	1.935	3.869		
S. E. (d)	1.001	1.001	2.002			0.943	0.943	1.885		

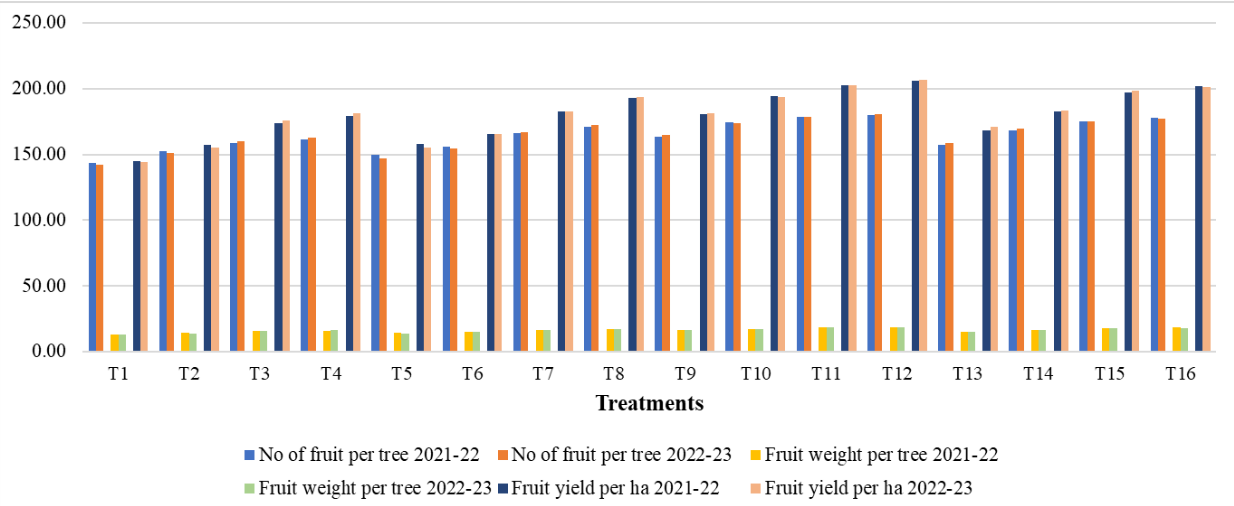

Fig. 1. Influence of foliar application of nano urea and chelated zinc on number of fruit per tree, fruit yield per plant and yield per hectare of guava (*Psidium guajava* L.) cv. Lalit under western Uttar Pradesh conditions.

CONCLUSIONS

Based on above investigation, it was observed that there was significant effect of nano urea and chelated zinc yield attributes of guava cv. Lalit. It can be concluded that guava plants sprayed with combination of nano urea@ 4.5 ml/tree and chelated zinc @ 0.8% recorded maximum number of fruits per tree, fruit yield per tree and yield per hectare. Among the doses of nano urea applied, nano urea@ 4.5 ml/tree performed the best and nano urea@ 3.0 ml/tree was also found to be at par. Also, the single doses of chelated zinc applied, chelated zinc @ 0.8% recorded the best findings and chelated zinc @ 1.2% was found to be at par with it. Therefore, it can be recommended that under western Uttar Pradesh conditions, guava trees when sprayed with combination of nano urea (4.5 ml/tree) and chelated zinc (0.8%) thrice, starting from one month before flowering, at full bloom and at fruit set, along with recommended cultural practices increases the yield attributes of guava.

FUTURE SCOPE

The prospects of the study hold significant and positive impacts on the yield attributes of guava plants leading to a boost in the fruit industry. These innovative agricultural practices harness nanotechnology and advanced nutrient delivery systems to enhance plant growth, nutrient uptake, and overall yield. Nano urea and chelated zinc formulations can promote greater nutrient absorption and utilization by guava plants. This enhanced nutrient availability can lead to increased fruit production and overall yield, contributing to higher economic returns for farmers.

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Conflict of Interest. None.

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