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Effect of different doses of urea and nano-urea on yield and quality of guava (*Psidium guajava* L.) CV. Lucknow-49

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Abstract

Field experiment was conducted at Fruit Research Station, Sakkarbaug Farm, Junagadh Agricultural University, Junagadh during the year 2022. As a result, number of fruits per plant (93.93), fruit yield per plant (16.22 kg), yield per hectare (12.01 tonnes) and reducing sugar (3.94%) were found in 100% RDN (U_1). Regarding nano-urea, maximum fruit set (75.33%), number of fruits per plant (102.58), fruit yield per plant (18.64 kg), fruit yield per hectare (13.81 tonnes) and minimum titratable acidity (0.35%) were registered in 0.1% nano-urea (N_1). Maximum non-reducing sugar (2.43%) and TSS (14.58 ˚Brix) were noted in 0.2% (N_2) and 0.4% nano-urea (N_3), respectively. For interaction effect, maximum number of fruits per plant (112.00), fruit yield per plant (18.66 kg) and yield per hectare (13.82 tonnes) were reported in 100% RDN + 0.1% nano-urea (U_1N_1). Likewise, maximum total sugar (6.73%), reducing sugar (4.09%) and non-reducing sugar (2.64%) were observed in 100% RDN + 0.2% N through nano-urea (U_1N_2). Accordingly, this investigation revealed that an application of 100% RDN with 0.1% nano-urea increased fruit yield and quality of guava.

Keywords: Guava, urea, nano-urea, yield, quality

Introduction

In the family Myrtaceae, Guava *(Psidium guajava* L.) is classified, and it has a chromosome count 2n=22. Myrtaceae family comprises about 103 genotypes and 150 species. The fruit commonly known as the "Apple of tropics" is highly prevalent and favored in India. Originally native to Tropical America, particularly Mexico, Guava is now commercially cultivated in various countries including India, the United States of America (USA), South America, Egypt, South Africa, and Thailand. Following mango, banana and citrus, guava claims to be the fourth most important fruit in area and production. In the state of Gujarat, guava cultivation is carried out on a large scale, making it the second most cultivated fruit after citrus. It covers an extensive area of 14,326 hectares, with an impressive annual production of 1.75 lakh MT (Anon., 2021) [3]. The area under commercial cultivation of guava is increasing day by day which requires the quality planting materials. It is only possible through multiplication of plants by different propagation methods. Among them, soft wood grafting is the good and fast method for the multiplication of healthy planting materials (Vasava, *et al.* 2023 and Anwarulhaq *et al.* 2021a) [29, 4]. It is a rich source of vitamin C (260 mg/100 g) which is the second after amla (600 mg/100 g). It is also rich in pectin. It is a fare source of vitamin A and good source of calcium and phosphorus. Raw guavas are eaten out of hand but are preferred seeded and served sliced as dessert or in salads. It can be used in preparation of jam marmalade and juice. Guava jelly is a widely recognized and popular product that can be preserved in sugar syrup or transformed into fruit butter. The juice of guava is commonly used in the creation of refreshing sherbets and delicious ice cream recipes.

Plant nutrition is crucial for agriculture production and crop quality and approximately 40 to 60% of the total world food production depends on the application of fertilizers. Regarding fruit crops, fertilization during fruit growth can improve harvest and postharvest quality (Roberts, 2009 and Anwarulhaq *et al.*, 2021b) [23, 5]. Nitrogen is deficient in most of the Indian soils particularly the light textured ones which is one of the basic plant nutrients. The recommended dose of nutrients for different crops were determined one to two decades ago but thereafter, the fertility status, crop varieties and other inputs have under gone a considerable change. Thus, there is an urgent need to give a fresh look to fertilizer requirement specially nitrogen under rainfed conditions.

Nano fertilizers are manufactured through different processes (chemical, physical, mechanical, or biological), either by reducing larger particles to nanoscale size (Top-Down) or by assembling smaller particles or molecules into nanoscale structures (Bottom-Up). They can be derived from botanical, microbial or animal sources having size between 1-100 nm. Nano-fertilizers will combine nano-devices in order to synchronize the release of fertilizer nitrogen with their uptake by crops, so preventing undesirable nutrient losses to soil, water and air via direct internalization by crops and avoiding the interaction of nutrients with soil, microorganisms, water and air (Derosa *et al*., 2010) [6]. Nanotechnology in nitrogen fertilizers allows for targeted release of nitrogen when crops need it, making it a promising solution for sustainable agriculture.

Materials and Methods

This experiment was conducted during 2022 located at Fruit Research Station, Sakkarbaug Farm, Junagadh Agricultural University, Junagadh. The experiment was laid out in factorial randomized block design with control vs rest concept and replicated thrice with the following treatments such as U_1-100% RDN and U_2-80% RDN as a factor A and N_1-0.1% Nano-urea, N_2-0.2% Nano-urea, N_3-0.4% Nano-urea, N_4-0.5% Nano-urea and N_5-0.6% Nano-urea as a factor B and RDF as a control with 3 replications. The age of tree is three years with spacing of 4.5 m × 3m. Different treatments were administered using foliar spray of nano-urea. These treatments were applied at three different stages: before flowering, at full bloom and two weeks after the second spray. Throughout the experiment, necessary observations were recorded. The recommended dose of fertilizers and other package of practices for guava were uniformly applied to all treatments, including the control.

Result and Discussion

Effect of different levels of urea and nano urea with their interaction effect and also control vs rest on yield and yield attributing parameters and quality parameters are tabulated in Table 1, 2 and 3.

Yield and Yield Attributing Parameters

Effect of urea

The investigation data demonstrated that the application of urea had a significant impact on the yield and yield attributing parameters, such as the number of fruits per plant, yield per plant and yield per hectare. However, there was no significant effect observed on fruit set and the percentage of fruit drop.

The 100% RDN (U_1) had significantly higher values for the number of fruits per plant (93.93), fruit yield per plant (16.22 kg) and yield per hectare (12.01 tonnes) followed by 80% RDN (U_2). Significantly maximum number of fruits per plant (93.93), fruit yield per plant (16.22 kg) and yield per hectare (12.01 tonnes) was noted in 100% RDN (U_1) followed by 80% RDN (U_2). The positive response to nitrogen fertilizer application can be attributed to the essential role of nitrogen in photosynthesis and carbohydrate formation. This finding is consistent with the results reported by Py and Teisson (1987) [19] in pineapple and Ramniwas *et al*. (2012) [22] and Parsana *et al.* (2023) [16] in guava.

Effect of nano-urea

The application of different treatments of nano-urea resulted in significant variations in yield and yield attributing parameters, including fruit set, fruit drop, number of fruits per plant, yield per plant and yield per hectare.

Significantly maximum fruit set (75.33%) and minimum fruit drop (24.67%) were observed in 0.1% nano-urea (N_1), which was at par with 0.2% nano-urea (N_2). Likewise, highest number of fruits per plant (102.58), fruit yield per plant (18.64 kg) and fruit yield per hectare (13.81 tonnes) was obtained in 0.1% nano-urea (N_1) followed by 0.2% nano-urea (N_2). The significant effects of nano-urea on fruit set and fruit drop can be attributed to its rapid absorption and translocation within the plants, resulting in increased photosynthesis and greater accumulation of dry matter. These findings align with previous studies by Tarafdar *et al.* (2014) [28] in pearl millet and Hafeez *et al*. (2015) [10] in wheat.

Interaction effect of urea and nano-urea

Similar trend of urea was also noted in interaction effect and variation due to different treatments was found significant in parameters like number of fruits per plant, yield per plant and yield per hectare. Meanwhile, fruit set and fruit drop per cent were found non-significant.

Maximum number of fruits per plant (112.00) was found in treatment combination of 100% RDN + 0.1% nano-urea (U_1N_1) followed by 100% RDN + 0.2% nano-urea (U_1N_2). Similarly, maximum fruit yield per plant (18.66 kg) and yield per hectare (13.82 tonnes) were also obtained in treatment combination of 100% RDN + 0.1% nano-urea (U_1N_1) which was at par with U_2N_1 and U_2N_2. The observed increases in fruit set, number of fruits per tree and crop yield resulting from foliar nitrogen fertilization can be explained by the physiological and metabolic functions of nitrogen in the flowering and fruit set processes. Nitrogen plays a crucial role in supplying carbohydrates necessary for various stages, such as flower bud growth, flower initiation and development, ovule lifespan, effective pollination and fertility. These findings are consistent with the research conducted by Lovatt (1994) [12] in avocado, Stiles (1999) [26] in apple, and Etehadnejad and Aboutalebi (2014) [7] in apple.

Control v/s Rest

Significant differences were found in yield and yield attributing parameters (fruit set, fruit drop, yield per plant, and yield per hectare) between the control and the rest of the treatments. However, the number of fruits per plant did not show a significant difference.

The rest of the treatments showed higher fruit set (72.82%), fruit yield per plant (15.80 kg) and fruit yield per hectare (11.70 tonnes), with lower fruit drop (27.18%) compared to the control. This increase in yield can be attributed to improved nitrogen utilization. These findings align with the results reported by Rajesh *et al*. (2021) [20] in fodder oats and Velumurugan *et al.* (2021) [30] in rice.

Table 1: Effect of different doses of urea and nano urea on yield and yield attributing parameters of guava

Sr. No.	Treatments	Fruit set (%)	Fruit drop (%)	Number of Fruits/Plant	Yield (kg/plant)	Yield (t/ha)
Factor A-N Fertilizer doses						
U_1	100% RDN	73.41	26.59	93.93	16.22	12.01
U_2	80% RDN	72.24	27.76	79.30	15.37	11.39
S.Em. ±		0.483	0.397	0.944	0.248	0.184
C.D. at 5%		NS	NS	2.80	0.73	0.54
Factor B - Different nano-urea concentrations						
N_1	0.1% Nano-urea	75.33	24.67	102.58	18.64	13.81
N_2	0.2% Nano-urea	73.54	26.46	90.50	16.35	12.11
N_3	0.4% Nano-urea	72.76	27.24	89.50	16.14	11.96
N_4	0.5% Nano-urea	71.31	28.69	78.42	14.37	10.64
N_5	0.6% Nano-urea	71.17	28.83	72.08	13.48	9.98
S.Em. ±		0.764	0.627	1.492	0.392	0.291
C.D. at 5%		2.21	1.81	4.32	1.13	0.84
Interaction: U × N						
S.Em. ±		1.081	0.887	2.110	0.555	0.411
C.D. at 5%		NS	NS	6.26	1.65	1.22
Control v/s Rest						
Treatment mean		72.82	27.18	86.62	15.80	11.70
Control mean		68.99	31.01	88.00	11.11	8.23
S.Em. ±		0.156	0.116	0.282	0.121	0.104
C.D. at 5%		0.46	0.34	NS	0.36	0.31
C.V. %		4.18	5.45	7.12	6.20	6.20

Quality Parameters

Effect of urea

The data revealed that application of different treatment of urea produced significant effect on quality parameters such as TSS, total sugar, reducing sugar and non-reducing sugar. While, titratable acidity and ascorbic acid were found non-significant.

Maximum TSS (14.32 ˚Brix) was noted in 80% RDN (U_2) followed by 100% RDN (U_1). The variation might be due to the fact that nitrogen can stimulate plant growth and increase the size of the fruit, which can also increase the amount of soluble solids in the fruit. The similar reports were observed by Suriyapananont and Subhadrabandhu (1992) [27], Pereira and Mitra (1999) [17] in guava, Meera *et al.* (2021) [14] in mango; Mishra and Varu (2022) [15] in pomegranate.

Significantly maximum total sugar (5.95%) was reported in 80% RDN (U_2), which was at par with 100% RDN (U_1). This might be due the fact that increased rate of translocation of photosynthetic products from leaves bearing developing fruits, thereby increasing total sugars as mentioned earlier by Magge (1963) [13] in apple and Sharma *et al.* (2009) [24] in Guava.

The maximum reducing sugar (3.94%) was also noted in 100% RDN (U_1) followed by 80% RDN (U_2). Significantly maximum non-reducing sugar (2.17%) was noted in 80% RDN (U_2) followed by 100% RDN (U_1).

The reason behind is nitrogen fertilization increase in biomass can result in a greater accumulation of total sugars in the fruit and increase the activity of invertase, an enzyme that converts sucrose (a non-reducing sugar) into glucose and fructose (reducing sugars). This can lead to an increase in the levels of reducing sugars and decrease the non-reducing sugar levels in the fruit. Such type of variability was recorded by Fan *et al.* (2017) [8] in apricot and Sharma *et al.* (2009) [24] in Guava.

Effect of nano-urea

The variation due to different treatments was found significant in TSS, titratable acidity, total sugar, reducing sugar and non-reducing sugar and non-significant in ascorbic acid.

Significantly maximum TSS (14.58 ˚Brix) was obtained in 0.4% nano-urea (N_3) which was at par with 0.6% nano-urea (N_5) and 0.2% nano-urea (N_2). Significantly minimum titratable acidity (0.35%) was noted in 0.1% nano-urea (N_1) followed by 0.4% nano-urea (N_3). This might be because of the fact that increase in acidity with synthesis of more organic acids as a result of improved foliage due to nitrogen application. The result of the experiment is on conformity with the results opined Ahlawat and Yamdagni (1988) [2] in grape, Prasad and Mali (2000) [18] in pomegranate and Abd El-Rhman and Shadia (2012) [1] in jujube.

The maximum total sugar (6.22%) was observed in 0.2% nano-urea (N_2) which was at par with 0.4% nano-urea (N_3). Significantly maximum reducing sugar (4.05%) was observed in 0.5% nano-urea (N_4), which was at par with 0.6% nano-urea (N_5) and 0.4% N through nano-urea (N_3). Maximum non-reducing sugar (2.43%) was noted in 0.2% nano-urea (N_2) which was at par with 0.4% nano-urea (N_3). It has been reported that the effect of nitrogen fertilizers on sugar increase may help absorption of other mineral nutrients, improving fruit quality. The results are in accordance with the finding Sharma *et al.* (2014) [24] in guava.

Interaction effect of urea and nano-urea

The results pointed out that there was significant difference for interaction effect on quality parameters like TSS, total sugar, reducing sugar and non-reducing sugar. While, titratable acidity and ascorbic acid were registered non-significant.

Maximum TSS (15.43 ˚Brix) was noted in treatment combination of 80% RDN + 0.4% nano-urea (U_2N_3) which was at par with U_2N_5 and U_1N_2. This might be due to nitrogen application can be contributed to the important roles of nitrogen in chloroplast structure, CO_2 assimilation and activation of enzymes involved in photosynthesis, which lead to increases in photosynthesis and carbohydrate accumulation and also consequently increase in TSS. Earlier similar kind of results has been found by Stiles (1999) [26] in apple, Ramezanian *et al.* (2009) [21] in pomegranate, Kumar *et al.* (2014) [11] in phalsa and Garhwal *et al.* (2014) [9] in kinnow mandarin.

Table 2: Effect of different doses of urea and nano urea on quality parameters of guava

Sr. No.	Treatments	TSS (˚Brix)	Titratable acidity (%)	Ascorbic acid (mg/100 g of pulp)
Factor A-N Fertilizer doses				
U_1	100% RDN	13.51	0.45	157.87
U_2	80% RDN	14.32	0.44	160.00
S.Em.±		0.181	0.006	3.235
C.D. at 5%		0.54	NS	NS
Factor B-Different nano-urea concentrations				
N_1	0.1% Nano-urea	13.58	0.35	162.13
N_2	0.2% Nano-urea	14.00	0.47	155.73
N_3	0.4% Nano-urea	14.58	0.44	162.13
N_4	0.5% Nano-urea	13.28	0.48	154.67
N_5	0.6% Nano-urea	14.12	0.49	160.00
S.Em.±		0.287	0.010	5.114
C.D. at 5%		0.83	0.03	NS
Interaction: U × N				
S.Em.±		0.406	0.014	7.233
C.D. at 5%		1.20	NS	NS
Control v/s Rest				
Treatment mean		13.91	0.45	158.93
Control mean		14.23	0.40	151.47
S.Em.±		0.078	0.018	0.413
C.D. at 5%		NS	0.05.	NS
C.V. %		4.90	6.13	7.52

Significantly maximum total sugar (6.73%) was noted in treatment combination of 100% RDN + 0.2% nano-urea (U_1N_2) which was at par with U_1N_3 and U_2N_1. Significantly maximum reducing sugar (4.09%) was noted in treatment combination of 100% RDN + 0.2% N through nano-urea (U_1N_2) and 100% RDN + 0.5% nano-urea (U_1N_4) which was at par with U_1N_3, U_1N_5, U_2N_1, U_2N_3 and U_2N_4. The maximum non-reducing sugar (2.64%) was observed in treatment combination of 100% RDN + 0.2% nano-urea (U_1N_2) which was at par with U_2N_1 and U_2N_5. This might be due to interaction between urea and nano urea increase the quality of fruit. The results corroborate with the findings of Prasad and Mali (2000) [18] in pomegranate and total and reducing sugars Sharma *et al*. (2014) [24] in guava.

Control v/s Rest

In case of control vs rest of the treatments, maximum titratable acidity (0.45%), total sugar (5.83%) and non-reducing sugar (1.98%) were recorded in treated plants as compared to control. However, TSS, ascorbic acid and reducing sugar were noted non-significant. Increased titratable acidity with nitrogen sprays can be due to increase in synthesis and translocation of organic acids in the fruits. In conformity with the similar variations observed by Prasad and Mali, (2000) [18] in pomegranate and Abd El-Rhman and Shadia (2012) [1] in jujube and Garhwal *et al*. (2014) [9] in kinnow mandarin.

Table 3: Effect of different doses of urea and nano urea on quality parameters of guava

Sr. No.	Treatments	Total sugar (%)	Reducing sugar (%)	Non-reducing sugar (%)
Factor A-N Fertilizer doses				
U_1	100% RDN	5.72	3.94	1.79
U_2	80% RDN	5.95	3.78	2.17
S.Em.±		0.077	0.049	0.036
C.D. at 5%		0.23	0.14	0.11
Factor B-Different nano-urea concentrations				
N_1	0.1% Nano-urea	13.58	0.35	162.13
N_2	0.2% Nano-urea	14.00	0.47	155.73
N_3	0.4% Nano-urea	14.58	0.44	162.13
N_4	0.5% Nano-urea	13.28	0.48	154.67
N_5	0.6% Nano-urea	14.12	0.49	160.00
S.Em.±		0.171	0.109	0.080
C.D. at 5%		0.51	0.32	0.24
Interaction: U × N				
S.Em.±		0.171	0.109	0.080
C.D. at 5%		0.51	0.32	0.24
Control v/s Rest				
Treatment mean		5.83	3.86	1.98
Control mean		5.09	3.74	1.35
S.Em.±		0.068	0.051	0.049
C.D. at 5%		0.20	NS	0.14
C.V. %		6.24	6.03	7.02

Conclusion

From the result of field experiment, it appears reasonable to infer that there were notable differences in the outcomes of various treatments for yield and quality parameters. Most of the yield and yield attributing parameters were found maximum with application of 100% RDN through urea. While quality parameters were observed highest in 80% RDN. For nano-urea, application of 0.1% nano-urea was found highest for yield and yield attributing parameters. The interaction of 100% RDN + 0.1% nano-urea was better with yield and quality parameters. From the present investigation, it is concluded that application of 100% RDN with 0.1% nano-urea is a successful strategy for enhancing yield and quality of fruits.

References

1. Abd El-Rhman IE, Shadia AA. Effect of foliar sprays of urea and zinc on yield and physico-chemical composition on jujube (*Ziziphus mauritiana*). Middle East Journal of Agriculture Research. 2012;1:52-57.
2. Ahlawat VP, Yamdagni R. Effect of nitrogen and potassium application on berry set, berry drop and quality of grapes cultivar Perlette. Progressive Horticulture. 1988;20(1-2):53-57.
3. Anonymous. DOH Horticulture data base; c2021. Available at https://doh.gujarat.gov.in/horticulture-census,htm.
4. Anwarulhaq Z, Varu DK, Rohullah N. Recent Advances in Root Stock Management in Sub-Tropical and Temperate Fruit Crops. International Journal of Innovative Science, Engineering & Technology. 2021a;8(6):218-224.
5. Anwarulhaq Z, Varu DK, Mohammad IS, Tayebullah Z. Effect of foliar spray of multi micronutrient grade IV and different fruit covering bags on yield and different quality of pomegranate cv. Bhagwa. International Journal of Agricultural Science and Research 2021b;11(2):69-76.
6. Derosa MR, Monreal C, Schnitzer M, Walsh R, Sultan Y. Nano-technology in fertilizers. Journal of Nature Nano Technology. 2010;5:91.
7. Etehadnejad F, Aboutalebi A. Evaluating the effects of foliar application of nitrogen and zinc on yield increasing and quality improvement of apple cv. 'Golab Kohanz'. Indian Journal of Fundamental and Applied Life Science. 2014;4:125-129.
8. Fan X, Zhao H, Wang X, Cao J, Jiang W. Sugar and organic acid composition of apricot and their contribution to sensory quality and consumer satisfaction. Scientia Horticulturae. 2017;225:553-60.
9. Garhwal PC, Yadav PK, Sharma BD, Singh RS, Ramniw AS. Effect of organic manure and nitrogen on growth yield and quality of Kinnow mandarin in sandy soils of hot arid region. African Journal of Agricultural Research. 2014;9:2638-2647.
10. Hafeez A, Razzaq A, Mahmood T, Jhanzab HM. Potential of copper nanoparticles to increase growth and yield of wheat. Journal of Nanoscience with Advanced Technology. 2015;1(1):6-11.
11. Kumar M, Dwivedi R, Anand AK, Kumar A. Effect of nutrient on physicochemical characteristics of phalsa (*Grewia subinaequalis* D.C.) fruits. Global Journal of Bioscience and Biotechnology. 2014;3:320-323.
12. Lovatt CJ. Improving fruit set and yield of 'Hass' avocado with a spring application of boron and/or urea to the bloom. California Avocado Society Yearbooks. 1994;78:167-173.
13. Magge DH. The reduction in growth in apple trees brought about by fruiting. Journal of Horticultural Sciences. 1963;338:119-125.
14. Meera BS, Varu DK, Subhrajyoti M, Bhavin G, Parsana JS. Effect of Chemicals and Agro-techniques on growth and flowering of mango cv. Kesar. The Pharma Innovation Journal. 2021;10(9):1212-1217.
15. Mishra PV, Varu DK. Effect of chemicals and agro-techniques on *Hast bahar* flowering of pomegranate. The Pharma Innovation Journal. 2022;11(7):1734-1736.
16. Parsana JS, Varu DK, Parmar VM, Patel S, Kanzaria DR, Mishra S. Influence of Pruning and Integrated Nutrient Management on Custard Apple (*Annona Squamosa* L.). Agricultural Mechanoization in Asia. 2023;54(4):12865-12874.
17. Pereira LS, Mitra SK. Studies on organic along with inorganic nutrition in guava. Indian Agriculturist. 1999;43(3-4):155-160.
18. Prasad RN, Mali PC. Effect of different levels of nitrogen on quality characters of pomegranate fruit cv. Jalore Seedless. Haryana Journal of Horticultural Sciences. 2000;29(3/4):186-187.
19. Py C, Lacoeuilhe JJ, Teisson C. The Pineapple: cultivation and uses. Editions G. P. Maisonneuve, Paris; c1987. p. 568.
20. Rajesh Rakesh K, Manoj K, Ravi K, Meena Singh K, Vijendra K, Dinesh. Soil microbial and enzymatic responses as influenced by various sources through nano nitrogen in fodder oats. Frontiers in Crop Improvement. 2021;9:3668-3672.
21. Ramezanian A, Rahemi M, Vazifehshenas MR. Effect of foliar application of calcium chloride and urea on quantitative and qualitative characteristics of pomegranate fruits. Scientia Horticulturae. 2009;121:171-175.
22. Ramniwas RA, Kaushik DK, Sarolia SP, Sin V. Effect of irrigation and fertigation scheduling on growth and yield of guava (*Psidium guajava* L.) under meadow orcharding. African Journal of Agricultural Research. 2012;7(47):6350-6356.
23. Roberts TL. The role of fertilizer in growing the world's food. Better Crops Plant Food. 2009;93:12-15.
24. Sharma GO, Sharma C, Thakur BS. Systematics of fruit crops. New India Publishing Agency, New Delhi; c2009.
25. Sharma VK, Rajesh T, Preeti C. Effect of N, P and their interaction on physicochemical parameters of guava (*Psidium guajava*) cv. L-49 under Malwa plateau conditions. International Journal of Scientific Research Publication. 2014;4:1-4.
26. Stiles WC. Effects of nutritional factors on regular cropping of apple. Hort. Technology. 1999;9:328-331.
27. Suriyapananont V, Subhadrabandhu S. Fertilizer trials on mangoes (*Mangifera indica* L.) var. Nam Dok Mai in Thailand. Acta Horticulturae. 1992;321:529-534.
28. Tarafdar JC, Raliya R, Mahawar H, Rathore I. Development of zinc nano fertilizers to enhance crop production in pearl millet (*Pennisetum americanum* L). Agricultural Research. 2014;3(3):257-262.
29. Vasava HV, Tejal MC, Parasana JS, Varu DK, Patel S, Mishra S. Performance of different grafted variety and

mulching in brinjal (*Solanum melongena* L). Agricultural Mechanoization in Asia. 2023;54(4):12981-12988.
30. Velmurugan A, Subramani T, Narayanaswamy B, Ramakrishna M, Swarnam T. The effect of foliar application of nano urea (liquid) on rice (*Oryza sativa* L.). Journal of the Andaman Science Association. 2021;26(2):76-81.