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Nilesh Kumar
M.Sc. (Hort.), Department of Vegetable Science, CHRS, Saja, Bemetara, Chhattisgarh, India

Pushpanjali Pankaj
Assistant Professor, Department of Vegetable Science, CHRS, Saja, Bemetara, Chhattisgarh, India

Dr. Anita Kerketta
Assistant Professor, Department of Vegetable Science, CHRS, Sankara-Patan, Durg, Chhattisgarh, India

Manisha Kashyap
Assistant Professor (Floriculture and Landscape Architecture), CHRS, Saja, Bemetara, Chhattisgarh, India

Dr. Namita Singh
Assistant Professor (Genetics & Plant Breeding), CHRS, Arjunda, Balod, Chhattisgarh, India

Jitendra Kumar
Department of Vegetable Science, CHRS, Saja, Bemetara, Chhattisgarh, India

Khel Sai Paikra
Department of Vegetable Science, CHRS, Saja, Bemetara, Chhattisgarh, India

Corresponding Author:
Nilesh Kumar
M.Sc. (Hort.) Department of Vegetable Science, CHRS, Saja, Bemetara, Chhattisgarh, India

Effect of nano urea on growth and yield of Tomato (*Solanum lycopersicum* L.) in Bemetara district of Chhattisgarh

Nilesh Kumar, Pushpanjali Pankaj, Anita Kerketta, Manisha Kashyap, Namita Singh, Jitendra Kumar and Khel Sai Paikra

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Abstract
A field experiment entitled "Effect of nano urea on growth and yield of Tomato (*Solanum lycopersicum* L.) in Bemetara district of Chhattisgarh" was conducted at Department of Horticulture, Government Nursery, Mohgaon, Saja, Bemetara (C.G.) during *kharif* 2024-25. The trial was laid out in CRD with three replications and eight nutrient management practices: T_0 - Control, T_1 - 100% RDF (NPK), T_2 - 100% RDF (P_2O_5, K_2O) + 75% N basal + 1 foliar spray Nano N at 30 DAT, T_3 - 100% RDF (P_2O_5, K_2O) + 50% N basal + 2 sprays Nano N at 30 & 45 DAT, T_4 - 100% RDF (P_2O_5, K_2O) + 25% N basal + 3 sprays Nano N at 30, 45 & 60 DAT, T_5 - 100% RDF (P_2O_5, K_2O) + 4 sprays Nano N at 15, 30, 45 & 60 DAT, T_6 - 100% RDF (P_2O_5, K_2O) + 50% N basal + 25% N top dressing (30 DAT) + 1 spray Nano N at 45 DAT, and T_7 - 100% RDF (P_2O_5, K_2O) + 25% N basal + 25% N top dressing (30 DAT) + 2 sprays Nano N at 45 & 60 DAT. Growth parameters (plant height, branches, leaves, days to flowering) and yield attributes (flowers, fruit sets, clusters, fruits per plant, fruit diameter, weight, and yield) were recorded. Results showed that T_3 (100% RDF (P_2O_5, K_2O) + 50% N basal + 2 sprays Nano N at 30 & 45 DAT) gave maximum plant height, leaves, branches, clusters, fruit set, fruit diameter, average fruit weight, and yield, followed by T_6 (100% RDF (P_2O_5, K_2O) + 50% N basal + 25% N top dressing at 30 DAT + 1 spray Nano N at 45 DAT). Earliness and yield were significantly highest in T_3, with intermediate results in T_2 and T_1. Lower yields occurred in T_4, T_5 and T_7, while the minimum was in control (T_0).

Keywords: Tomato, nano urea, nutrient management, growth, yield

Introduction
India's diverse climate ensures the availability of all varieties of fresh fruit and vegetable. As per NHB (3rd Advance estimates) published by NHB, during 2021-22, India produce 204.84 million metric tonnes of vegetables. (Anonymous, 2022) [1]. Tomato (*Solanum lycopersicum* L.), a member of the Solanaceae family with a diploid chromosome number of 2n = 24, is an important crop cultivated worldwide under varied conditions such as open fields, greenhouses, net houses, and home gardens. Its popularity arises from versatile uses - fresh consumption in salads, as a cooked vegetable, and in processed products like soups, sauces, ketchups, pastes, and purees. Nutritionally, tomato is a rich source of vitamins, minerals, and organic acids, contributing significantly to human diet (Kumar *et al.*, 2017) [7]. India is the second-largest producer of tomatoes after China, with 848.56 thousand hectares under cultivation, producing 20.40 million metric tonnes annually and an average productivity of 24.0 t/ha (Anonymous, 2024) [2]. Major tomato-producing states are Madhya Pradesh, Andhra Pradesh, Karnataka, Odisha, and Maharashtra. In Chhattisgarh, tomato covers 24.54 thousand hectares, yielding 590.15 thousand metric tonnes with an average of 24.04 t/ha. Key producing districts include Raipur, Durg, Bilaspur, Rajnandgaon, and Bemetara. Notably, Bemetara is emerging as a leading district due to improved practices and better market access. In 2022-23, it accounted for 2,502 hectares with a production of 520,040 quintals (Anonymous, 2024) [2]. Nitrogen is essential for chlorophyll, photosynthesis, vegetative growth, and is a component of enzymes and proteins regulating plant physiology (Narayan *et al.*, 2012) [13]. Vegetable yield depends on fertilizer quality and quantity, but losses via leaching, runoff, and volatilization cause economic and environmental issues. Excessive chemical fertilizers also lead to soil pollution and heavy metal accumulation (Durlabh *et al.*, 2025) [4].

Nanotechnology, through nanoparticles (<100 nm), improves nutrient uptake and efficiency. Nano-urea enhances absorption via stomata and plasmodesmata, increasing nitrogen use efficiency (NUE), productivity (6-17%), and crop quality (Roushan *et al.,* 2023). It provides controlled nutrient release and is environmentally safer than conventional fertilizers (Panda *et al.,* 2020). In India, urea (46% N) is widely used, but losses reduce N availability and pollute soil and water (Nair *et al.,* 2010) [12]. IFFCO's nano urea reduces conventional urea use by 50%, promotes growth, photosynthesis, and yield, with 2-4 ml L^{-1} foliar application and >80% absorption efficiency (Mishra *et al.,* 2020) [10]. Foliar nano-urea improves NUE, yield, and reduces input costs, though studies on tomato are limited. Tomato productivity depends on essential nutrients, especially nitrogen (Kumar *et al.,* 2020) [8].

Methods and Materials

A field investigation was conducted at the Department of Horticulture, Government Nursery, Mohgaon, Saja, Bemetara (C.G.) during the *kharif* season of 2024-25 to study the "effect of nano urea on the growth and yield of Tomato (*Solanum lycopersicum* L.) in Bemetara district of Chhattisgarh". The materials and methods used during the study are described in this chapter. The was laid out in a Completely Randomized Design (CRD) with three replications. A total of eight treatments were tested and these were randomly allocated within each replication. Size of grow bag 12 × 12 inch Tomato cv. Kashi Aman. T_0 - Control; T_1 - 100% RDF (NPK); T_2 - 100% RDF (P_2O_5, K_2O) + 75% N basal + 1 foliar spray of Nano N at 30 DAT; T_3 - 100% RDF (P_2O_5, K_2O) + 50% N basal + 2 foliar sprays of Nano N at 30 and 45 DAT; T_4 - 100% RDF (P_2O_5, K_2O) + 25% N basal + 3 foliar sprays of Nano N at 30, 45, and 60 DAT; T_5 - 100% RDF (P_2O_5, K_2O) + 4 foliar sprays of Nano N at 15, 30, 45, and 60 DAT, T_6 - 100% RDF (P_2O_5, K_2O) + 50% N basal + 25% N top dressing at 30 DAT + 1 foliar spray of Nano N at 45 DAT; and T_7 - 100% RDF (P_2O_5, K_2O) + 25% N basal + 25% N top dressing at 30 DAT + 2 foliar sprays of Nano N at 45 and 60 DAT. RDF: N-300 kg, P-250 kg, K-250 kg), Spray of nano urea (N) at 15 DAT, 30 DAT, 45 DAT and 60 DAT.

Results and Discussion

Growth Parameters

The progression of plant height (Table 1, Fig. 1) showed maximum growth in T_3 (100% RDF P_2O_5, K_2O + 50% N basal + 2 foliar sprays of Nano N at 30 & 45 DAT), statistically at par with T_6 (100% RDF P_2O_5, K_2O + 50% N basal + 25% N top dressing at 30 DAT + 1 foliar spray at 45 DAT). Heights (cm) at 30, 60, 90 DAT and harvest were: T_3 - 28.76, 53.21, 69.02, 83.40; T_6 - 28.15, 52.08, 67.56, 81.64. Both were superior to T_2 (26.07, 46.38, 60.17, 72.70) and T_1 (25.68, 45.66, 59.23, 71.57), followed by T_7 (23.54, 39.85, 51.70, 62.47), T_4 (23.32, 39.44, 51.17, 61.83), and T_5 (22.98, 38.81, 50.35, 60.84). The lowest was in the control T_0 (20.24, 31.89, 41.38, 50.00), indicating basal N with foliar Nano N ensured prolonged nitrogen supply.

The data in (Table 2, Fig. 2) revealed that the number of branches per plant increased with crop growth stages under different nutrient management practices. At 30 DAT, the maximum number of branches (2.07) was recorded in T_3, while the control had only 1.02. At 60 DAT, T_3 again produced the highest branches (8.49) compared to 4.18 in the control. Similarly, at 90 DAT, T_3 recorded 12.42 branches per plant, followed by T_6 (11.94), whereas the control had only 6.12. At harvest, the highest number of branches (14.49) was observed in T_3, followed by T_6 (13.93) and T_2 (12.25), while the minimum (7.14) was recorded in the control. These results clearly indicate that T_3 was the most effective treatment for improving branching, closely followed by T_6 due to efficient nitrogen utilization through basal and foliar application of Nano N.

Flowering and Fruiting Parameters

The number of flower clusters per plant, fruit sets per cluster, total flower clusters, and fruits per plant were significantly influenced by nutrient management involving Nano urea (Table 3, Fig. 3). Across all parameters, T_3 (100% RDF P_2O_5, K_2O + 50% N basal + 2 foliar sprays at 30 & 45 DAT) recorded the highest values, statistically at par with T_6 (100% RDF P_2O_5, K_2O + 50% N basal + 25% N top dressing at 30 DAT + 1 foliar spray at 45 DAT). Number of flower clusters per plant: T_3 - 12.29, T_6 -12.06, intermediate in T_2 - 11.18, T_1 - 11.02, lowest in T_0 - 8.82. Number of flower clusters per plant (cluster-1): T_3 - 5.53, T_6 - 5.47, intermediate in T_2 - 5.16, T_1 - 5.11, lowest in T_0 - 4.29. Fruit sets per cluster: T_3 - 3.23, T_6 - 3.17, intermediate in T_2 - 2.94, T_1 - 2.89, lowest in T_0 - 2.24. Number of fruits per plant: T_3 - 39.85, T_6 - 38.69, intermediate in T_2 - 34.43, T_1 - 33.17, lowest in T_0 - 22.26.

Yield Parameters

The fruit quality and yield of tomato were significantly influenced by nutrient management involving Nano urea (Table 4 and Fig 4). Across all parameters, T_3 (100% RDF P_2O_5, K_2O + 50% N basal + 2 foliar sprays at 30 & 45 DAT). recorded the highest values, statistically at par with T_6 (100% RDF P_2O_5, K_2O + 50% N basal + 25% N top dressing at 30 DAT + 1 foliar spray at 45 DAT). Fruit diameter: T_3 - 5.81 cm, T_6 - 5.71 cm; intermediate in T_2 - 5.29 cm, T_1 - 5.20 cm. lowest in T_0 - 4.03 cm. Average fruit weight: T_3 - 85.35 g, T_6 - 84.12 g, intermediate in T_2 - 78.95 g, T_1 - 77.34 g; lowest in T_0 - 64.57 g. Fruit yield per plant: T_3 - 3.35 kg, T_6 - 3.20 kg; intermediate in T_2 - 2.67 kg, T_1 - 2.52 kg, lowest in T_0 - 1.39 kg.

Table 1: Effect of nano urea on plant height of Tomato (*Solanum lycopersicum* L.)

Treatment details	Plant height (cm)			
	30 DAT	60 DAT	90 DAT	At harvest
T_0 - Control	20.24	31.89	41.38	50.00
T_1 - 100% RDF (NPK)	25.68	45.66	59.23	71.57
T_2 - 100% RDF (P_2O_5, K_2O) + 75% N basal + 1 Foliar Spray of Nano N at 30 DAT	26.07	46.38	60.17	72.70
T_3 - 100% RDF (P_2O_5, K_2O) + 50% N basal + 2 Foliar Spray of Nano N at 30 and 45 DAT	28.76	53.21	69.02	83.40
T_4 - 100% RDF (P_2O_5, K_2O) + 25% N basal + 3 Foliar Spray of Nano N at 30, 45 and 60 DAT	23.32	39.44	51.17	61.83
T_5 - 100% RDF (P_2O_5, K_2O) + 4 Foliar Spray of Nano N at 15, 30, 45 and 60 DAT	22.98	38.81	50.35	60.84
T_6 - 100% RDF (P_2O_5, K_2O) + 50% N basal + 25% N top dressing at 30 DAT + 1 Foliar Spray of Nano N at 45 DAT	28.15	52.08	67.56	81.64
T_7 - 100% RDF (P_2O_5, K_2O) + 25% N basal + 25% N top dressing at 30 DAT + 2 Foliar Spray of Nano N at 45 and 60 DAT	23.54	39.85	51.70	62.47
S.Em (±)	0.67	1.87	2.43	2.94
CD (5%)	2.02	5.63	7.31	8.82
CV (5%)	4.69	7.49	7.48	7.49

Table 2: Effect of nano urea on Number of branches of Tomato (*Solanum lycopersicum* L.).

Treatment details	Number of branches (plant^{-1})			
	30 DAT	60 DAT	90 DAT	At harvest
T_0 - Control	1.02	4.18	6.12	7.14
T_1 - 100% RDF (NPK)	1.64	6.72	9.84	11.48
T_2 - 100% RDF (P_2O_5, K_2O) + 75% N basal + 1 Foliar Spray of Nano N at 30 DAT	1.75	7.18	10.50	12.25
T_3 - 100% RDF (P_2O_5, K_2O) + 50% N basal + 2 Foliar Spray of Nano N at 30 and 45 DAT	2.07	8.49	12.42	14.49
T_4 - 100% RDF (P_2O_5, K_2O) + 25% N basal + 3 Foliar Spray of Nano N at 30, 45 and 60 DAT	1.35	5.54	8.10	9.45
T_5 - 100% RDF (P_2O_5, K_2O) + 4 Foliar Spray of Nano N at 15, 30, 45 and 60 DAT	1.29	5.29	7.74	9.03
T_6 - 100% RDF (P_2O_5, K_2O) + 50% N basal + 25% N top dressing at 30 DAT + 1 Foliar Spray of Nano N at 45 DAT	1.99	8.16	11.94	13.93
T_7 - 100% RDF (P_2O_5, K_2O) + 25% N basal + 25% N top dressing at 30 DAT + 2 Foliar Spray of Nano N at 45 and 60 DAT	1.42	5.82	8.52	9.94
S.Em (±)	0.06	0.29	0.44	0.46
CD (5%)	0.18	0.88	1.32	1.38
CV (5%)	6.63	7.91	8.11	7.27

Table 3: Effect of nano urea on number of flowers, number of fruit sets, number of flower clusters and number of fruits of Tomato (*Solanum lycopersicum* L.).

Treatment details	Number of flowers cluster^{-1}	Number of fruit sets cluster^{-1}	Number of flower clusters plant^{-1}	Number of fruits plant^{-1}
T_0 - Control	4.29	2.24	8.82	22.26
T_1 - 100% RDF (NPK)	5.11	2.89	11.02	33.17
T_2 - 100% RDF (P_2O_5, K_2O) + 75% N basal + 1 Foliar Spray of Nano N at 30 DAT	5.16	2.94	11.18	34.43
T_3 - 100% RDF (P_2O_5, K_2O) + 50% N basal + 2 Foliar Spray of Nano N at 30 and 45 DAT	5.53	3.23	12.29	39.85
T_4 - 100% RDF (P_2O_5, K_2O) + 25% N basal + 3 Foliar Spray of Nano N at 30, 45 and 60 DAT	4.68	2.61	9.98	28.68
T_5 - 100% RDF (P_2O_5, K_2O) + 4 Foliar Spray of Nano N at 15, 30, 45 and 60 DAT	4.63	2.57	9.87	27.53
T_6 - 100% RDF (P_2O_5, K_2O) + 50% N basal + 25% N top dressing at 30 DAT + 1 Foliar Spray of Nano N at 45 DAT	5.47	3.17	12.06	38.69
T_7 - 100% RDF (P_2O_5, K_2O) + 25% N basal + 25% N top dressing at 30 DAT + 2 Foliar Spray of Nano N at 45 and 60 DAT	4.75	2.65	10.12	29.05
S.Em (±)	0.09	0.07	0.26	1.32
CD (5%)	0.27	0.2	0.78	3.96
CV (5%)	4.14	4.15	4.22	7.21

Table 4: Effect of nano urea on fruit diameter, average fruit weight and fruit yield of Tomato (*Solanum lycopersicum* L.).

Treatment details	Fruit diameter (cm)	Average fruit weight (gm)	Fruit yield (kg plant^{-1})
T_0 - Control	4.03	64.57	1.39
T_1 - 100% RDF (NPK)	5.20	77.34	2.52
T_2 - 100% RDF (P_2O_5, K_2O) + 75% N basal + 1 Foliar Spray of Nano N at 30 DAT	5.29	78.95	2.67
T_3 - 100% RDF (P_2O_5, K_2O) + 50% N basal + 2 Foliar Spray of Nano N at 30 and 45 DAT	5.81	85.35	3.35
T_4 - 100% RDF (P_2O_5, K_2O) + 25% N basal + 3 Foliar Spray of Nano N at 30, 45 and 60 DAT	4.70	71.53	2.00
T_5 - 100% RDF (P_2O_5, K_2O) + 4 Foliar Spray of Nano N at 15, 30, 45 and 60 DAT	4.63	70.68	1.90
T_6 - 100% RDF (P_2O_5, K_2O) + 50% N basal + 25% N top dressing at 30 DAT + 1 Foliar Spray of Nano N at 45 DAT	5.71	84.12	3.20

T_7 - 100% RDF (P_2O_5, K_2O) + 25% N basal + 25% N top dressing at 30 DAT + 2 Foliar Spray of Nano N at 45 and 60 DAT	4.77	72.02	2.04
S.Em (±)	0.12	1.68	0.13
CD (5%)	0.37	5.04	0.38
CV (5%)	4.26	4.85	9.21

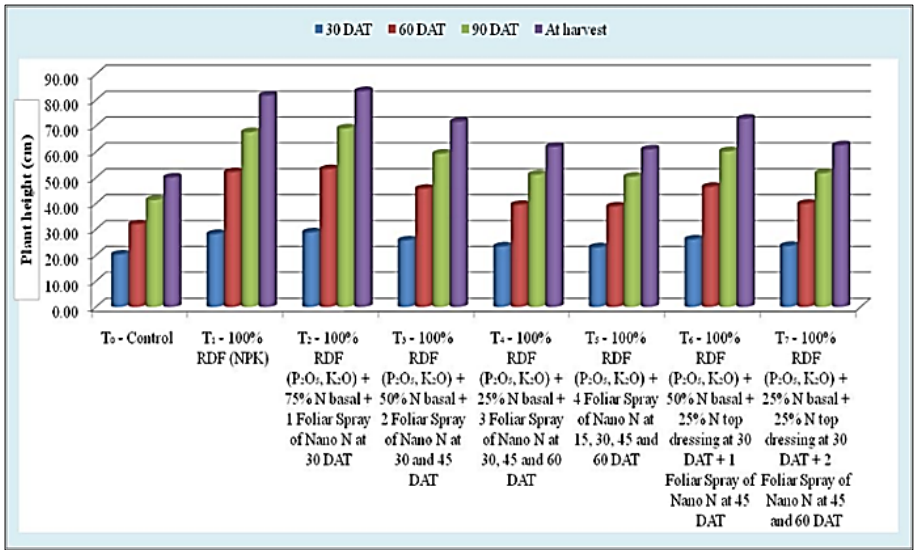

Fig 1: Effect of nano urea on plant height of Tomato (*Solanum lycopersicum* L.)

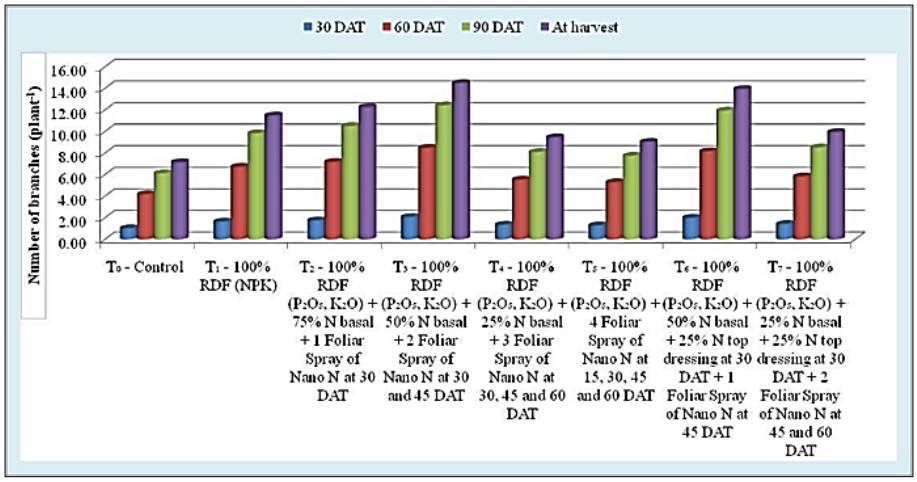

Fig 2: Effect of nano urea on number of branches of Tomato (*Solanum lycopersicum* L.)

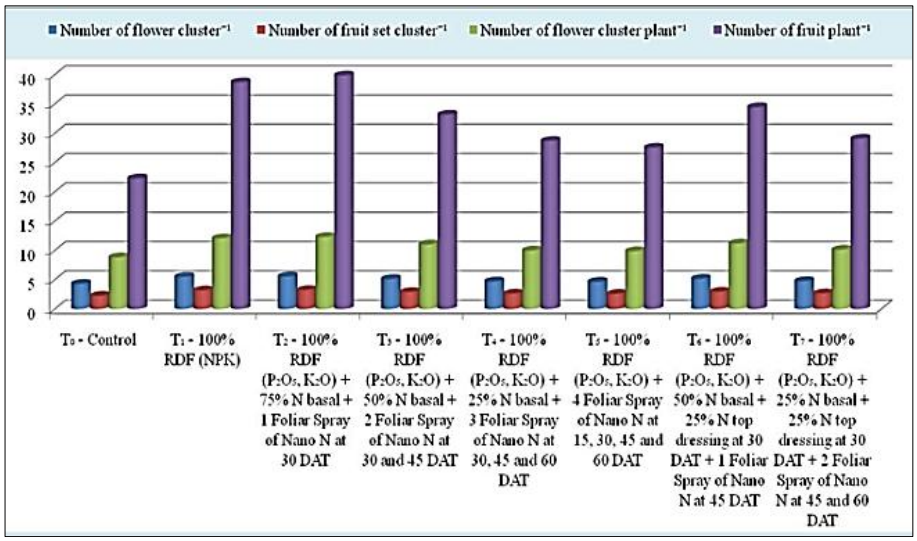

Fig 3: Effect of nano urea on number of flowers, number of fruit sets, number of flower clusters and number of fruits of Tomato (*Solanum lycopersicum* L.)

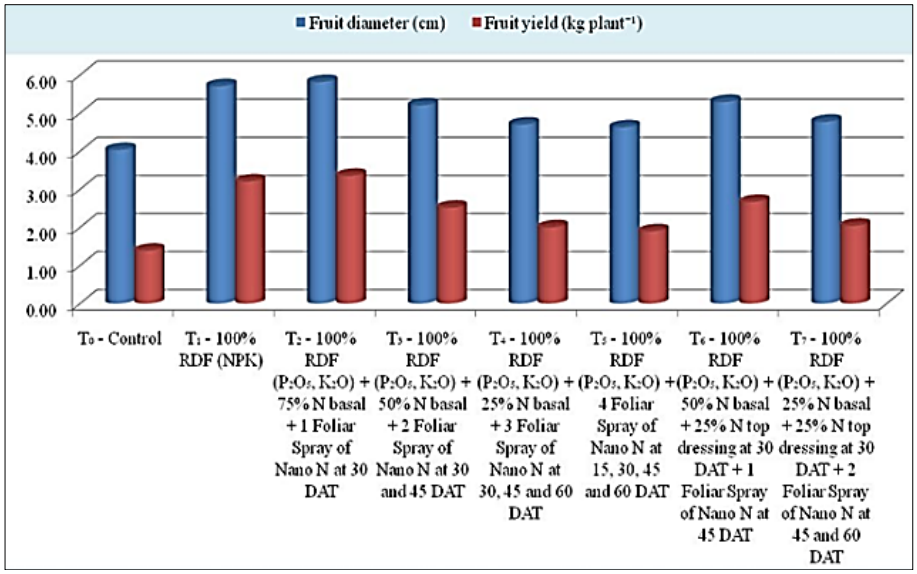

Fig 4: Effect of nano urea on fruit diameter, average fruit weight and fruit yield of Tomato (*Solanum lycopersicum* L.)

Conclusion

The results showed that growth parameters, *viz*., plant height, number of leaves, number of branches, and yield attributes, *viz*., number of flower clusters, fruit set per cluster, number of fruits per plant, fruit diameter, and average fruit weight, were found to be higher under treatment (T_3) 100% RDF (P_2O_5, K_2O) + 50% N basal + 2 foliar sprays of Nano N at 30 and 45 DAT, followed by (T_6) 100% RDF (P_2O_5, K_2O) + 50% N basal + 25% N top dressing at 30 DAT + 1 foliar spray of Nano N at 45 DAT, which produced statistically comparable results. The yield parameters like fruit yield and earliness of fruit picking recorded maximum under (T_3) 100% RDF (P_2O_5, K_2O) + 50% N basal + 2 foliar sprays of Nano N at 30 and 45 DAT, which was statistically significant over (T_6) 100% RDF (P_2O_5, K_2O) + 50% N basal + 25% N top dressing at 30 DAT + 1 foliar spray of Nano N at 45 DAT, while intermediate yields were observed in (T_2) 100% RDF (P_2O_5, K_2O) + 75% N basal + 1 Foliar Spray of Nano N at 30 DAT and (T_1) 100% RDF (NPK). Lower yields were recorded in treatments with lower basal nitrogen and multiple foliar sprays (T_4 - 100% RDF (P_2O_5, K_2O) + 25% N basal + 3 Foliar Spray of Nano N at 30, 45 and 60 DAT, T_5 - 100% RDF (P_2O_5, K_2O) + 4 Foliar Spray of Nano N at 15, 30, 45 and 60 DAT and T_7 - 100% RDF (P_2O_5, K_2O) + 25% N basal + 25% N top dressing at 30 DAT + 2 Foliar Spray of Nano N at 45 and 60 DAT), with the lowest fruit yield observed in the control (T_0).

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