ISSN Print: 2664-844X
ISSN Online: 2664-8458
NAAS Rating (2025): 4.97
IJAFS 2025; 7(12): 459-464
www.agriculturaljournals.com
Received: 15-09-2025
Accepted: 19-10-2025

Choundkar AS
M.Sc. Scholar, Interfaculty Department of Irrigation Water Management, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra, India

Kadam SA
Professor of Irrigation and Drainage Engineering and Head, Department of Agricultural Engineering, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra, India

Bade AS
Research Associate (Plant Protection), CoE-DTSPA, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra, India

Patil VS
Head, Interfaculty Department of Irrigation Water Management, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra, India

Bhanage GB
Research Associate (FMPE), CoE-DTSPA, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra, India

Tayade NR
Research Associate (GPB), CoE-DTSPA, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra, India

Patil MR
Head, Department of Statistics, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra, India

Corresponding Author:
Choundkar AS
M.Sc. Scholar, Interfaculty Department of Irrigation Water Management, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra, India

Impact of foliar application of nitrogen on growth and yield attributes in maize (*Zea mays*) through drone

Choundkar AS, Kadam SA, Bade AS, Patil VS, Bhanage GB, Tayade NR and Patil MR

DOI: https://www.doi.org/10.33545/2664844X.2025.v7.i12f.1077

Abstract
A field experiment was conducted at Climate Smart Research Block of Centre of Excellence on Digital Technologies for Climate Smart Agriculture (CoE-DTSPA), Mahatma Phule Krishi Vidyapeeth, Rahuri, during *Kharif*-2024 with to assess efficacy of foliar application of nitrogen on growth, yield attributes and cost economics in maize (*Zea mays*) through drone. The experiment was carried out in a Randomized Block Design with ten treatments replicated three times. A hexacopter drone with 10 L capacity was used for the foliar application of nitrogen as per the treatments. The results revealed that ttreatment T_7 with foliar application of conventional urea @ 1.0% + Micrograde II @ 0.5% at 30, 45 and 70 DAS recorded highest grain yield (69.09 q ha^{-1}). However, treatment T_9 (Foliar application of NU @ 2.5% + Micrograde II @ 0.5% at 30, 45 and 70 DAS) and treatment T_6 (Foliar application of conventional urea @ 2.5% at 30, 45 and 70 DAS) which recorded (66.67 q ha^{-1}) and (65.76 q ha^{-1}) grain yield, respectively and at par with treatment T_7. Treatment T_1 (100% GRDF) recorded highest stover yield (79.96 q ha^{-1}). However, treatment T_3 (Foliar application of conventional urea @ 1.0% at 30, 45 and 70 DAS) and treatment T_8 (Foliar application of NU @ 2.5% at 30, 45 and 70 DAS) were at par with treatment T_1 (100% GRDF) with (76.87 q ha^{-1}) and (76.71 q ha^{-1}) stover yield respectively. Treatment T_7 (Foliar application of conventional urea @ 1.0% + Micrograde II @ 0.5% at 30, 45 and 70 DAS) resulted into higher gross monetary return (₹ 171851.61 ha^{-1}), net monetary returns (₹ 77000.71 ha^{-1}), B:C ratio (1.81). However, treatment T_9 (Foliar application of NU @ 2.5% + Micrograde II @ 0.5% at 30, 45 and 70 DAS) was at par with T_7 and recorded gross monetary return (₹ 167099.63 ha^{-1}), net monetary returns (₹73415.78 ha^{-1}), B:C ratio (1.78).

Keywords: Maize, drone, foliar application, conventional urea, NU- Nano urea, Micrograde II

Introduction
Maize (*Zea mays* L.) is one of the most cultivated cereal crop globally and serves as a major source of calories and protein for more than a billion people. Taxonomically, it belongs to the family Poaceae, subfamily Panicoideae, with a chromosome number of 2n=20. Owing to its exceptional yield potential, maize is often regarded as the "queen of cereals" and a "miracle crop" (Ikramullah *et al*., 2011) [9]. Globally, maize production has reached 1220.3 million metric tonnes, cultivated over 205.4 million hectares with an average productivity of 5.95 t ha^{-1} (Anonymous, 2023) [2]. The United States (31.9%), China (23.7%), Brazil (10.8%), Argentina (3.4%), and India (3.1%) are the leading producers, placing India fifth in global maize production. In India, the maize-growing area during 2023-24 was 9.96 million hectares (Anonymous, 2024) [3], with Madhya Pradesh and Karnataka contributing the largest acreage. Karnataka ranks first in maize production (43.29 lakh tonnes), followed by Madhya Pradesh and Maharashtra. In Maharashtra, maize is cultivated over 0.92 million hectares with a production of 1.441 million tonnes and a productivity of 1.58 t ha^{-1}, which remains below the national average (Anonymous, 2024) [4]. Nitrogen is a critical nutrient that significantly influences maize growth, biomass accumulation, and grain yield. Application of nitrogen has been reported to enhance maize grain yield by 43-68% and biomass by 25-42% (Ogola *et al*., 2002) [14]. Because nitrogen plays a central role in physiological and metabolic processes, its efficient and balanced application is essential for achieving optimal crop performance (Fathi and Zeidali, 2021) [8]. Foliar application of nutrients directly to plant foliage offers improved

nutrient uptake efficiency, particularly for macro- and micronutrients, when compared to soil application (Arif *et al*., 2006; Ali *et al*., 2008) [5, 1]. Recent technological advancements have enabled the use of Unmanned Aerial Vehicles (UAVs) or drones for precise foliar application. Drone-based spraying facilitates uniform application of water-soluble fertilizers, reduces labour dependence, and overcomes the limitations of manual spraying in tall crops like maize. It also minimizes chemical usage and enhances operational efficiency and sustainability (Kanisha *et al*., 2022) [10]. Considering these advantages, the present study was undertaken to evaluate the impact of foliar application of nitrogen on growth and yield attributes in maize through drone.

Materials and Methods

Experimental Site

A field experiment was conducted at Climate Smart Research Block of Centre of Excellence on Digital Technologies for Climate Smart Agriculture (CoE-DTSPA), Mahatma Phule Krishi Vidyapeeth, Rahuri, during *Kharif*-2024 with 19.4733° N latitude and 74.6275° E longitude at an altitude of 567 m above mean sea level.

Experimental Design and Treatment Details

A field experiment was carried out in *Kharif*-2024. The experiment was laid out in Randomized Block Design (RBD) with 10 treatments and 3 replications, with gross plot size 66.00 m x 33.00 m and net plot size 10.00 m x 5.25 m. The maize variety Phule Champion developed by MPKV, Rahuri was taken as experimental material with spacing of 75 cm x 20 cm. The treatment details are as follows: T_1 - 100% GRDF, T_2 - Foliar application of conventional urea @ 0.5% at 30, 45 and 70 DAS, T_3- Foliar application of conventional urea @ 1.0% at 30, 45 and 70 DAS, T_4 - Foliar application of conventional urea @ 1.5% at 30, 45 and 70 DAS, T_5 - Foliar application of conventional urea @ 2.0% at 30, 45 and 70 DAS, T_6 - Foliar application of conventional urea @ 2.5% at 30, 45 and 70 DAS, T_7 - Foliar application of conventional urea @ 1.0% + Micrograde II @ 0.5% at 30, 45 and 70 DAS, T_8 - Foliar application of NU @ 2.5% at 30, 45 and 70 DAS, T_9 - Foliar application of NU @ 1.0% + Micrograde II @ 0.5% at 30, 45 and 70 DAS, T_{10} - Water spray at 30, 45 and 70 DAS through drone whereas 100% P_2O_5 **:** K_2O with FYM 10 t ha^{-1} were common to all treatments.

Fertilizer Details

The fertilizers *viz*., urea, contains 46% of N, SSP contains 16% P_2O_5 and MOP containing 60% K_2O, NU (20% N w/v), Micrograde II (0.5%) and FYM were applied as per treatment with 50% N, 100% P_2O_5 and K_2O and 10 tons FYM/ ha were applied as basal dose to each treatment and remaining 50% dose of nitrogen was applied only for treatment T_1 one month after sowing.

Technical parameters of spraying drone

A battery-operated hexacopter drone with a 10-litre tank capacity was used for the foliar application of nitrogen on the maize crop during the experiment. The technical parameters of the drone are given in Table 1.

Table 1: Technical parameters of the drone

Sr. No.	Classification	Parameters
1.	Dimensions (mm)	1800 X 1800 X 500
2.	Nozzle type	Flat fan
3.	Tank capacity (lit.)	10
4.	Battery capacity	16000mAh X 2 (50V)
5.	Spraying width (m)	4
6.	Flying height (m) above crop canopy	2
7.	Number of nozzles	4
8.	Drone Speed (m/s)	3.5

Result and Discussion

Growth Parameters

The growth parameters studied in the experiment, *viz.* plant height and cob placement were evaluated to assess the impact of foliar nitrogen application through drone on maize crop and are depicted in Table 2.

Plant Height

The plant height was significantly influenced by different treatments. T_1 with 100% GRDF recorded significantly highest plant height (222 cm) at harvest. Among the foliar applications, T_6 (Foliar application of conventional urea @ 2.5% at 30, 45 and 70 DAS through drone) showed notable plant height (212 cm). Treatment T_{10} (50% N + 100% P_2O_5 and K_2O as a basal dose) recorded the lowest plant height (200 cm) at harvest. Similar trend of plant height was also recorded at 60, 75 and 90 DAS of maize crop. Comparable results on plant height were observed by Veeresh *et al.* (2024) [17] in finger millet and by Devekar *et al.* (2024) [6] in maize, where application of 100% recommended dose of nitrogen (RDN) significantly increased plant height.

Height of Cob Placement

Cob placement height was measured from ground level to the point of first cob emergence using a metric scale on five randomly selected plants from each treatment. The highest cob placement height (115.80 cm) was recorded in treatment T_1 (100% GRDF) at 65 DAS followed by treatment T_5 (Foliar application of conventional urea @ 2.0% at 30, 45 and 70 DAS), treatment T_2 (Foliar application of conventional urea @ 0.5% at 30, 45 and 70 DAS), treatment T_7 (Foliar application of conventional urea @1.0% + Micrograde II @ 0.5% at 30, 45 and 70 DAS) and treatment T_6 (Foliar application of conventional urea @ 2.5% at 30, 45 and 70 DAS) and were statistically at par with treatment T_1 (100% GRDF) with 114.60 cm, 113.87 cm, 113.07 cm, 112.47 cm cob placement height respectively.

Table 2: Effect of foliar application of nitrogen through drones on height of maize crop

Tr. No.	Treatments	Plant height (cm)						
		15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	At harvest
T_1	100% General Recommended Dose of Fertilizer (GRDF)	14.53	27.20	65.73	155.93	213.00	218.00	222.00
T_2	Foliar application of conventional urea @ 0.5% at 30, 45 and 70 DAS	14.47	27.47	59.33	147.87	195.33	200.33	206.33
T_3	Foliar application of conventional urea @ 1.0% at 30, 45 and 70 DAS	15.40	28.73	59.40	142.40	198.67	203.60	209.22
T_4	Foliar application of conventional urea @ 1.5% at 30, 45 and 70 DAS	15.20	27.67	62.73	147.47	195.33	200.67	204.67
T_5	Foliar application of conventional urea @ 2.0% at 30, 45 and 70 DAS	16.27	30.00	66.40	146.00	202.00	205.67	211.00
T_6	Foliar application of conventional urea @ 2.5% at 30, 45 and 70 DAS	15.67	29.40	64.53	150.27	201.00	206.00	212.00
T_7	Foliar application of conventional urea @ 1.0% + Micrograde @ 0.5% at 30, 45 and 70 DAS	14.13	28.60	61.13	148.07	196.00	202.00	205.00
T_8	Foliar application of NU @ 2.5% at 30, 45 and 70 DAS	15.93	29.87	63.07	148.73	199.67	207.00	209.00
T_9	Foliar application of NU @ 2.5% + Micrograde II @ 0.5% at 30, 45 and 70 DAS	16.07	30.07	59.53	144.40	199.00	204.00	208.00
T_{10}	Water spray at 30, 45 and 70 DAS through drone	15.53	28.40	57.13	134.80	189.67	195.00	200.00
	S.E.(m) ±	0.83	0.823	1.15	2.47	2.34	2.78	2.67
	C.D at 5%	N.S.	N.S.	3.32	7.35	6.96	8.27	7.93
	General mean	15.32	28.74	61.90	146.59	198.97	204.00	209.13

Yield Contributing Parameters

The data on yield contributing characters like number of cobs per plant, Number of grain rows per cob, Length of cob, Girth of cob, 1000 grain weight, Total weight of cob (without husk), Grain weight per cob affected by foliar application of nitrogen through drone is presented in Table 3.

Number of Cobs per Plant

The treatment T_7 (Foliar application of conventional urea @ 1.0% + Micrograde II @ 0.5% at 30, 45 and 70 DAS) recorded highest number of cobs per plant (1.4) which was significantly superior over rest of the treatments. The lowest number of cobs per plant (1.07) were recorded in treatment T_6 (Foliar application of conventional urea @ 2.5% at 30, 45 and 70 DAS) and treatment T_8 (Foliar application of NU @ 2.5% at 30, 45 and 70 DAS), respectively.

Number of Grain Rows per Cob

The effect of different treatments on the number of grain rows per cob was statistically non-significant. Treatment T_6 with foliar application of conventional urea @ 2.5% at 30, 45 and 70 DAS recorded highest mean value for number of grain rows per cob (16.13). Conversely, the lowest number of grain rows per cob (14.80) was observed under Treatment T_{10}, which involved water spray at 30, 45, and 70 DAS along with 50% nitrogen and full basal application of phosphorus and potassium.

Length of Cob

Treatment T_7 (foliar application of conventional urea @ 1.0% + Micrograde II @ 0.5% at 30, 45, and 70 DAS) produced the maximum cob length (21.06 cm) and was significantly superior to T_1, T_2, T_3, and T_{10}. Treatments T_6, T_4, T_8, T_5, and T_9 were statistically at par with T_7, recording cob lengths ranging from 19.63 to 20.43 cm. These results corroborate the findings of Ninama *et al*. (2023) [12], who reported enhanced cob length in maize with zinc application (30 kg ha^{-1}) combined with NU (4 ml L^{-1}). The minimum cob length (16.00 cm) was observed in T_{10} (water spray at 30, 45, and 70 DAS + 50% N + full basal P and K).

Girth of Cob

Treatment T_9 (foliar application of NU @ 2.5% + Micrograde II @ 0.5% at 30, 45, and 70 DAS) recorded the maximum cob girth (16.37 cm) and was significantly superior to T_1, T_2, T_3, T_4, T_5, T_8, and T_{10}. Treatments T_7 (urea @ 1.0% + Micrograde II @ 0.5%) and T_6 (urea @ 2.5%) were statistically at par with T_9, recording cob girths of 15.85 cm and 15.49 cm, respectively. These findings align with Arya (2024), who reported that application of 50% RDN with two sprays of 0.5% NU resulted in maximum ear head girth in pearl millet. The lowest cob girth (13.07 cm) was observed in T_{10} (water spray + 50% N + full basal P and K).

1000 Grain Weight

Treatment T_7 with foliar application of conventional urea @ 1.0% + Micrograde II @ 0.5% at 30, 45 and 70 DAS recorded maximum 1000 grain weight (367.50 g) showing significant superiority over all other treatments. In contrast, the minimum 1000 grain weight (264.67 g) recorded in treatment T_{10} (water spray at 30, 45, 70 DAS + 50% N + 100% P_2O_5 and K_2O as a basal dose).

Total Weight of Cob (Without Husk)

Treatment T_7 with foliar application of conventional urea @ 1.0% + Micrograde II @ 0.5% at 30, 45 and 70 DAS recorded maximum total weight of cob (242.63 g) which was significantly superior over rest of the treatments. In contrast, the minimum total weight of cob (189.10 g) recorded in treatment T_{10} (water spray at 30, 45, 70 DAS + 50% N + 100% P_2O_5 and K_2O as a basal dose).

Grain Weight per Cob

Treatment T_7 (foliar application of conventional urea @ 1.0% + Micrograde II @ 0.5% at 30, 45, and 70 DAS) recorded the highest grain weight per cob (161.10 g), showing significant superiority over T_1, T_2, T_4, T_5, T_8, and T_{10}. Treatments T_6 (urea @ 2.5%), T_3 (urea @ 1.0%) and T_9 (NU @ 2.5% + Micrograde II @ 0.5%) were statistically at par with T_7, recording 158.73 g, 158.73 g, and 156.57 g grain weight per cob, respectively. These findings corroborate the results of Dhawne *et al*. (2023) [7], who reported maximum grain weight per panicle in rice with 50% RDN and two sprays of NU @ 3 ml. The lowest grain weight per cob (141.27 g) was observed in T_{10} (water spray + 50% N + full basal P and K).

Table 3: Effect of foliar application of nitrogen through drones on yield contributing characters of maize

Tr. No.	Treatments	No. of cobs per plant	No. of grain rows per cob	Length of cob (cm)	Girth of cob (cm)	1000 grain weight (g)	Total weigh of cob (without husk) (g)	Grain weight of cob (g)
T_1	100% General Recommended Dose of Fertilizer (GRDF)	1.24	15.07	19.06	13.36	332.50	218.87	145.93
T_2	Foliar application of conventional urea @ 0.5% at 30, 45 and 70 DAS	1.13	15.87	17.20	13.59	277.00	212.31	149.13
T_3	Foliar application of conventional urea @ 1.0% at 30, 45 and 70 DAS	1.20	15.20	17.33	14.75	314.67	230.15	158.73
T_4	Foliar application of conventional urea @ 1.5% at 30, 45 and 70 DAS	1.13	15.87	20.03	14.62	285.00	222.83	150.47
T_5	Foliar application of conventional urea @ 2.0% at 30, 45 and 70 DAS	1.13	15.47	19.83	14.09	339.83	224.93	152.87
T_6	Foliar application of conventional urea @ 2.5% at 30, 45 and 70 DAS	1.07	16.13	20.43	15.49	340.17	231.10	158.73
T_7	Foliar application of conventional urea @ 1.0% + Micrograde @ 0.5% at 30, 45 and 70 DAS	1.40	15.47	21.06	15.85	367.50	242.63	161.10
T_8	Foliar application of NU @ 2.5% at 30, 45 and 70 DAS	1.07	14.93	20.03	14.37	302.17	229.33	149.13
T_9	Foliar application of NU @ 2.5% + Micrograde II @ 0.5% at 30, 45 and 70 DAS	1.20	15.60	19.63	16.37	321.00	234.27	156.57
T_{10}	Water spray at 30, 45 and 70 DAS through drone	1.13	14.80	16.00	13.07	264.67	189.10	141.27
	S.E.(m) ±	0.05	0.56	0.62	0.54	2.97	1.81	2.74
	CD at 5%	0.15	N.S.	1.85	1.61	8.84	5.39	8.16
	General mean	1.18	15.44	19.36	14.61	314.41	223.55	152.39

Yield

The data on grain yield (q ha^{-1}), stover yield (q ha^{-1}) and the percentage increase (%) in these yield parameters as affected by the various treatments was depicted in table 4.

Grain Yield

Treatment T_7 (foliar application of conventional urea @ 1.0% + Micrograde II @ 0.5% at 30, 45 and 70 DAS) recorded the highest grain yield (69.09 q ha^{-1}) and was significantly superior over all the treatments. However, treatments T_9 (nano urea @ 2.5% + Micrograde II @ 0.5%) and T_6 (conventional urea @ 2.5%) with 66.67 q ha^{-1} and 65.76 q ha^{-1} yield, respectively were statistically found at par with T_7. The lowest grain yield (55.17 q ha^{-1}) was obtained in T_{10} (water spray + 50% N + 100% P_2O_5 and K_2O as basal). Treatment T_7 (foliar application of conventional urea @ 1.0% + Micrograde II @ 0.5% at 30, 45 and 70 DAS) recorded the highest percent increase in grain yield (25.23%) over T_{10}. The lowest percent increase (9.40%) was observed under T_2 (foliar application of conventional urea @ 0.5% at 30, 45 and 70 DAS) over T_{10}. The higher yield under T_7 may be attributed to improved nutrient absorption and utilization through drone-assisted foliar delivery, which enhances cuticular penetration, ensures targeted application, and improves nutrient-use efficiency. The additional supply of micronutrients likely further supported physiological processes contributing to yield improvement. These findings align with the observations of Nirere *et al*. (2019) [13], who reported significantly higher yield with foliar application of water-soluble fertilizers, as well as those of Samui *et al*. (2022) [16]. The results also concur with Ninama *et al*. (2023) [12], who reported yield enhancement with combined foliar application of zinc and nano urea.

Stover yield

Treatment T_1 (100% GRDF) recorded the highest stover yield (79.96 q ha^{-1}) and was significantly superior over all treatments. However, treatments T_3 (foliar application of conventional urea @ 1.0% at 30, 45 and 70 DAS) and T_8 (foliar application of NU @ 2.5% at the same intervals) recorded 76.87 q ha^{-1} and 76.71 q ha^{-1}, respectively and found statistically at par with T_1. The higher stover yield under these treatments may be attributed to greater nutrient absorption and allocation towards vegetative growth rather than reproductive development. Similar findings were reported by Kumar *et al*. (2024) [11] and Devekar *et al*. (2024) [6], who observed higher stover yield in maize with 100% RDF. The lowest stover yield (63.25 q ha^{-1}) was obtained in T_{10} (water spray + 50% N + 100% P_2O_5 and K_2O as basal), likely due to insufficient nutrient supply. In terms of percent increase in yield over T_{10}, treatment T_3 recorded the highest improvement (21.53%), followed by T_8 (21.28%) and T_9 (17.69%). The lowest percent increase in yield (6.71%) was observed under T_2 (foliar application of conventional urea @ 0.5% at 30, 45 and 70 DAS).

Table 4: Effect of foliar application of nitrogen through drone on grain yield (q ha^{-1}) and stover yield (q ha^{-1}) of maize crop

Tr. No.	Treatments	Grain yield (q ha^{-1})	Stover yield (q ha^{-1})	Increase in the grain yield (%)	Increase in the stover yield (%)
T_1	100% General Recommended Dose of Fertilizer (GRDF)	61.51	79.96	-	-
T_2	Foliar application of conventional urea @ 0.5% at 30, 45 and 70 DAS	60.37	67.50	9.4	6.71
T_3	Foliar application of conventional urea @ 1.0% at 30, 45 and 70 DAS	64.40	76.87	16.73	21.53
T_4	Foliar application of conventional urea @ 1.5% at 30, 45 and 70 DAS	64.19	70.00	16.34	10.67
T_5	Foliar application of conventional urea @ 2.0% at 30, 45 and 70 DAS	60.46	69.67	9.58	10.15
T_6	Foliar application of conventional urea @ 2.5% at 30, 45 and 70 DAS	65.76	73.00	19.19	15.41
T_7	Foliar application of conventional urea @ 1.0% + Micrograde @ 0.5% at 30, 45 and 70 DAS	69.09	72.93	25.23	15.30
T_8	Foliar application of NU @ 2.5% at 30, 45 and 70 DAS	60.04	76.71	8.82	21.28
T_9	Foliar application of NU @ 2.5% + Micrograde II @ 0.5% at 30, 45 and 70 DAS	66.67	74.44	20.84	17.69
T_{10}	Water spray at 30, 45 and 70 DAS through drone	55.17	63.25	-	-
	S.E.(m) ±	1.18	1.55	0.89	1.32
	C.D at 5%	3.51	4.66	2.65	3.97
	General mean	62.76	72.57	12.61	11.71

Cost Economics

Table 5 represents cost of Cultivation (₹ ha^{-1}), gross monetary return (₹ ha^{-1}), net monetary return (₹ ha^{-1}) and benefit-cost ratio (B: C Ratio) under different treatments. Treatment T_7 (foliar application of conventional urea @ 1.0% + Micrograde II @ 0.5% at 30, 45 and 70 DAS) incurred the highest cultivation cost (₹ 94,850.90 ha^{-1}), followed by T_8 (foliar application of NU @ 2.5% at 30, 45 and 70 DAS) with ₹ 94,824.80 ha^{-1}. The lowest cost of cultivation (₹ 87,061.09 ha^{-1}) was recorded in T_{10} where only water spray at 30, 45 and 70 DAS with only half dose of N + 100% P_2O_5 and K_2O as basal resulted in the lowest input requirement.

Gross monetary return

Treatment T_7 (foliar application of conventional urea @ 1.0% + Micrograde II @ 0.5% at 30, 45 and 70 DAS) recorded the highest gross monetary return (₹ 171,851.61 ha^{-1}) and was significantly superior among all treatments. However, T_7 was statistically at par with T_9 (foliar application of NU @ 2.5% + Micrograde II @ 0.5% at 30, 45 and 70 DAS), which recorded a gross monetary return of ₹ 167,099.63 ha^{-1}. The lowest gross monetary return (₹ 138,692.25 ha^{-1}) was obtained under T_{10} (water spray at 30, 45 and 70 DAS + 50% N + 100% P_2O_5 and K_2O as basal dose).

Net monetary return

Treatment T_7 (foliar application of conventional urea @ 1.0% + Micrograde II @ 0.5% at 30, 45 and 70 DAS) recorded the highest net monetary return (₹ 77,000.71 ha^{-1}) and was significantly superior among all treatments. Treatment T_9 (foliar application of NU @ 2.5% + Micrograde II @ 0.5% at the same intervals) was statistically at par with T_7, registering a net monetary return of ₹ 73,415.78 ha^{-1}. The lowest net monetary return (₹ 51,664.49 ha^{-1}) was obtained under T_{10} (water spray at 30, 45 and 60 DAS + 50% N + 100% P_2O_5 and K_2O as basal).

Table 5: Effect of foliar application of nitrogen through drone on economic of maize

Tr. No.	Treatments	Cost of Cultivation (₹ ha^{-1})	Gross Monetary Returns (₹ ha^{-1})	Net Monetary Returns (₹ ha^{-1})	B:C ratio
T_1	100% General Recommended Dose of Fertilizer (GRDF)	92764.62	157009.67	64245.05	1.69
T_2	Foliar application of conventional urea @ 0.5% at 30, 45 and 70 DAS	91540.86	153601.25	62060.39	1.67
T_3	Foliar application of conventional urea @ 1.0% at 30, 45 and 70 DAS	93029.49	162277.91	69631.75	1.74
T_4	Foliar application of conventional urea @ 1.5% at 30, 45 and 70 DAS	93030.45	160462.75	67465.63	1.72
T_5	Foliar application of conventional urea @ 2.0% at 30, 45 and 70 DAS	91551.90	151828.34	60276.44	1.65
T_6	Foliar application of conventional urea @ 2.5% at 30, 45 and 70 DAS	93541.39	164708.00	71166.61	1.76
T_7	Foliar application of conventional urea @ 1.0% + Micrograde @ 0.5% at 30, 45 and 70 DAS	94850.90	171851.61	77000.71	1.81
T_8	Foliar application of NU @ 2.5% at 30, 45 and 70 DAS	94824.80	152919.00	58094.20	1.61
T_9	Foliar application of NU @ 2.5% + Micrograde II @ 0.5% at 30, 45 and 70 DAS	93683.85	167099.63	73415.78	1.78
T_{10}	Water spray at 30, 45 and 70 DAS through drone	87061.09	138692.25	51664.49	1.59
	S.E.(m) ±	-	2299.42	1251.25	-
	C.D at 5%	-	6831.94	3717.65	-
	General mean	-	1581053	655623	-

B: C Ratio

A benefit-cost (B:C) ratio greater than 1 indicates economic profitability, while a value below 1 denotes economic loss; a ratio of exactly 1 implies no profit or loss. The B:C ratio of maize was influenced significantly by foliar application of nitrogen through drone at variable rates. Treatment T_7 (foliar application of conventional urea @ 1.0% + Micrograde II @ 0.5% at 30, 45 and 70 DAS) recorded the highest B:C ratio (1.81), followed by T_9 (NU @ 2.5% + Micrograde II @ 0.5%) with a ratio of 1.78. The lowest B:C ratio (1.59) was observed under T_{10} (water spray at 30, 45 and 70 DAS + 50% N + 100% P_2O_5 and K_2O as basal). These findings are in close agreement with Rajesh *et al*. (2021), who reported higher net monetary returns and B:C ratio with 75% RDN + 100% P_2O_5 and K_2O along with foliar spray of nano urea @ 4 mL L^{-1} and zinc @ 2 mL L^{-1}.

Conclusion

The study clearly demonstrates that foliar application of nitrogen through drone has a positive influence on growth and productivity of maize. Growth parameters, particularly plant height and cob placement, were significantly superior under T_1 (100% GRDF), indicating the effectiveness of adequate soil-applied nutrients in supporting vegetative development. Foliar nutrient application through drone showed pronounced effects on yield attributes and grain yield. Treatment T_7 (conventional urea @ 1.0% + Micrograde II @ 0.5% at 30, 45 and 70 DAS) produced the highest grain yield (69.09 q ha^{-1}), while treatments T_9 and T_6 recorded statistically comparable yields (66.67 q ha^{-1} and 65.76 q ha^{-1}, respectively). Stover yield was highest under T_1 (79.96 q ha^{-1}), with treatments T_3 and T_8 performing at par. Economic analysis further highlighted the superiority of drone-assisted foliar nutrition. Treatment T_7 resulted in the maximum gross monetary return (₹ 171,851.61 ha^{-1}), net monetary return (₹ 77,000.71 ha^{-1}), and B:C ratio (1.81). Treatment T_9 remained statistically comparable, reinforcing the effectiveness of drone-based foliar application of nitrogen and micronutrients. Overall, the findings suggest that foliar application of conventional urea @ 1.0% + Micrograde II @ 0.5% at 30, 45 and 70 DAS through drone, along with a basal dose of 50% N (60 kg ha^{-1}) and 100% P_2O_5 (60 kg ha^{-1}) and K_2O (40 kg ha^{-1}), is a highly effective strategy for improving growth, yield, and economic returns in maize. The study underscores the potential of drone-assisted nutrient delivery as an efficient, precise, and sustainable alternative to traditional fertilization methods in modern maize cultivation**.**

References

1. Ali S, Khan AR, Mairaj G, Arif M, Fida M, Bibi S. Assessment of different crop nutrients management practices for improvement of crop yield. Australian Journal of Crop Science. 2008;2(3):150-157.
2. Anonymous. Food and Agriculture Organization of the United Nations [Internet]. 2023 [cited year not specified]. Available from: http://www.fao.org
3. Anonymous. Agricultural and Processed Food Products Export Development Authority [Internet]. 2024 [cited year not specified]. Available from: http://www.apeda.gov.in
4. Anonymous. Department of Agriculture, Government of Maharashtra [Internet]. 2024 [cited year not specified]. Available from: http://www.krishi.maharashtra.gov.in
5. Arif M, Chohan MA, Ali S, Gul R, Khan S. Response of wheat to foliar application of nutrients. International Journal of Agriculture and Biology. 2006;1(4):30-34.
6. Devekar MM, Kale KD, Mane MS, Khedkar DD. Effect of foliar spray of super nano urea on growth and economics of hybrid maize in inceptisols. International Journal of Research Publication and Reviews. 2024;5(12):4937-4944.
7. Dhawne MN, Shamkuwar GR, Shamkuwar SG, Landge NH, Sable AD, Tinpayle AD. Influence of foliar applications of nano urea on morpho-physiological and yield parameters in rice (*Oryza sativa* L.). Biological Forum - An International Journal. 2023;15(11):548-553.
8. Fathi A, Zeidali E. Conservation tillage and nitrogen fertilizer: a review of corn growth and yield and weed management. Central Asian Journal of Plant Science Innovation. 2021;1(3):121-142.
9. Ikramullah, Hussain I, Noor M, Kausar M, Shah N, Khalil H, *et al*. Heterotic effects for yield and protein content in white quality protein maize. Sarhad Journal of Agriculture. 2011;27(3):403-409.
10. Kanisha K, Jagadeeswaran R, Kumaraperumal R, Ragunath K, Balaji K, Muthumanickam D, Pazhanivelan S. Impact of drone spraying of nutrients on growth and yield of maize crop. International Journal of Environment and Climate Change. 2022;12(11):274-282.
11. Kumar AMR, Fathima PS, Yogananda SB, Sowmyalatha BS. Comparative evaluation of nano urea and urea foliar sprays on nutrient uptake and soil fertility in fodder maize (*Zea mays* L.) production. Journal of Scientific Research and Reports. 2024;30(5):939-946.
12. Ninama J, Debbarma V, Bhakher R, Meena RK. Response of zinc and nano urea on growth and yield of maize (*Zea mays* L.). International Journal of Environment and Climate Change. 2023;13(9):1046-1052.
13. Nirere D, Murthy K, Lalitha KN, Murukannappa BS, Murorunkwere F. Effect of foliar application of water soluble fertilizers on growth and yield of maize. Rwanda Journal of Agricultural Sciences. 2019;1(1):44-51.
14. Ogola JBO, Wheeler TR, Harris PM. Effects of nitrogen and irrigation on water use of maize crops. Field Crops Research. 2002;78(2-3):105-117.
15. Rajesh H, Yadahalli GH, Chittapur BM, Halepyati AS, Hiregoudar S. Growth, yield and economics of sweet corn (*Zea mays* L. saccarata) as influenced by foliar sprays of nano fertilisers. Journal of Farm Sciences. 2021;4:381-385.
16. Samui S, Sagar L, Sankar T, Manohar A, Adhikary R, Maitra S, Praharaj S. Growth and productivity of rabi maize as influenced by foliar application of urea and nano-urea. Crop Research. 2022;57(3):136-140.
17. Veeresh H, Ravi S, Srinivasa DK, Kumar A. Effect of nano urea on growth, yield and nutrient uptake of finger millet (*Eleusine coracana* L.). International Journal of Plant and Soil Science. 2024;36(9):660-667.