



To Study the Effect of Foliar Spray of Nano Fertilizer on Growth Characters of Rabi Maize (*Zea mays* L.) in Mandsaur Region (MP), India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A study was conducted to evaluate the effect of foliar spray of nano fertilizer on growth characters of maize involving hybrid variety (pioneer) during *Rabi* season 2022-23 at Crop Research Cafeteria at Mandsaur University Mandsaur. This experiment was laid out in Randomized Block Design (RBD) with three replication involving eight treatments and five growth characters of maize. The analysis of variance (ANNOVA) has indicated significant amount of variability present among all eight treatments and all five quantitative character studies. The obtained results revealed that the application of 100% NPK + 2 spray of nano N-fertilizer is more beneficial in terms of growth, productivity, maximum gross return, net return, beneficial cost ratio and sustainability over rest of

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treatments which lead us to recommend the treatment of 100% NPK + 2 spray of nano N-fertilizer as a most proper nutrients management practice to be applied in sandy loam soil at under Mandsaur region conditions.

Keywords: Foliar spray; fertilizers; growth; nano fertilizer; maize productivity; crop; productivity; cereal crops; sustainable yield.

1. INTRODUCTION

Maize (*Zea mays* L.) is one of the important cereal crops belonging to the Poaceae family, which ranked third after wheat and rice crops in terms of productivity, production and cultivated area in the world [1]. It is a short duration, quick growing and widely grown crop with high potential, there are no cereal crops with such an immense potentiality, so it is called as “queen of cereals” [2]. Major maize growing states are Bihar, Maharashtra, Tamil Nadu Gujarat, West Bengal and Telangana. These states are major contributor of maize production. Moreover, in India, Tamilnadu have the 1st position and Madhya Pradesh came to the next as largest producer of maize (23.10 MT) and area is (3.98 lakh/ha) in 2021. As the maize is considered an exhaustive crop, it requires more nutrient, organic nutrient management practices play an important role in sustaining productivity of maize. Sustainable yield levels could be achieved by applying appropriate combination of organic manures and chemical fertilizers. Further, balanced nutrition of NPK is an essential component of nutrient management and improving quality. Modern Agriculture is largely dependent upon fertilizers. These are an unavoidable threat to Agriculture. Nevertheless, they continue to be vital tools for worldwide food safety. When sustainable agriculture is the global target, the troublesome effects of chemical fertilizers cannot be ignored. Chemical fertilizer plays an essential role in enhancing crop productivity and soil fertility. Chemical fertilizers are of various types in the form of nitrogenous, phosphate, potassium fertilizers. The application of fertilizers not only increases crop productivity, but also alters soil physicochemical and biological properties. The overuse of chemical fertilizers hardens the soil, reduces soil fertility, pollutes air, water, soil, and reduces important nutrients of soil and minerals, thereby bringing hazards to environment [3]. Nano-fertilizers have a higher surface and reactive area because of the extremely small or lowest particle size, which provides more sites to promote different metabolic processes in the plant system, resulting in more photosynthesis and eventually more growth and yield [4]. There are lots of

advantages of nano fertilizers, like they increase three times in nutrient use efficiency, 55- 60 times less requirement to chemical fertilizer, 10- 12 times more stress tolerant by the crops, complete bio-source so eco-friendly, 30-35% more nutrient mobilization by the plants, 18- 54% improvement in the crop yield [5] is Keeping these facts into consideration, the present study aimed at evaluating the effect of foliar spray of nitrogen nano-fertilizer on growth of *Rabi* maize (*Zea Mays* L.) in Mandsaur region (Madhya Pradesh).

2. MATERIALS AND METHODS

A field experiment was carried out during year 2022-23 at the department of Agriculture sciences Mandsaur University, Mandsaur in *Rabi* crop season. The soil of experimental site was sandy clay loam and very deep well drained. In this study, a dose of 135 kg/ha nitrogen in urea form was applied in 2 splits i.e. half at of sowing and half at knee high stage. A recommended doses of 62.5 kg P₂O₅ and 50 kg K₂O per hectare were applied at sowing in the form of single super phosphate and muriate of potash, respectively. Pre-treated seeds of maize were sown at a depth of 4-5 cm with spacing 60 cm x 25 cm so as to have a plant population of 66,666 plant per ha. The experiment was laid out in randomized block design with including eight treatments namely T₁ - Control (No nitrogen with 100% P & K), T₂- (T₁+2 spray with 6 ml/L nano N₂ -fertilizer), T₃ (T₁+3 spray with 8 ml/L nano N - fertilizer), T₄ (100 % RDF (chemical fertilizers), T₅ (100% NPK + 2 spray of 2 ml/L N₂ nano fertilizers), T₆ (75% NPK + 2 spray of 3 ml/L N₂ nano fertilizers), T₇ (50% NPK + 2 spray of 4 ml/L N₂ nano fertilizers), and T₈ (25% NPK + 2 spray of 5 ml/L N₂ nano fertilizers), and all of them were replicated three times.

3. RESULTS AND DISCUSSION

3.1 Plant Height

The data pertaining to the effect of different fertilization treatments on plant height (cm) recorded at 45, 60, 90 DAS and at harvest stages are presented in Table 1. At 45 DAS, the plant height was significantly varied according to different fertilization treatments.

Table 1. Effect of integrated nutrient management on plant height of maize

Treatments	Treatments Delete this column	Plant height (cm)			
		45 DAS	60 DAS	90 DAS	At harvest
T ₁	Control (No nitrogen with 100% P & K)	48.2	146.1	154.5	158.8
T ₂	T ₁ +2 spray with 6ml./lit. nano N ₂ fertilizer	64.3	167.5	175.9	179.7
T ₃	T ₁ +3 spray with 8ml./lit. nano N ₂ fertilizer	64.8	172.6	181.0	186.0
T ₄	100 % RDF (chemical fertilizers)	66.7	173.2	181.6	187.8
T ₅	100% NPK + 2 spray of 2ml./lit. N ₂ nano fertilizers	70.1	179.5	187.9	194.8
T ₆	75% NPK + 2 spray of 3ml./lit. N ₂ nano fertilizers	67.2	174.9	183.3	193.9
T ₇	50% NPK + 2 spray of 4ml./lit. N ₂ nano fertilizers	61.6	162.9	171.3	175.4
T ₈	25% NPK + 2 spray of 5ml./lit. N ₂ nano fertilizers	55.5	154.1	162.5	167.8
SEm±		1.56	3.38	3.48	3.56
CD (P=0.05)		4.68	10.14	10.44	10.68

The maximum plant height (70.1 cm) was recorded under T₅ where 100% NPK + 2 spray of 2 ml/l N₂ nano fertilizers were applied and it was nearly closed to T₄₅ and T₆. The lowest plant height (48.2 cm) was recorded in control plot (T₁). At 60 DAS, the maximum plant height (179.5 cm) was also recorded under T₅ which is significantly higher over T₂, T₇ and T₈ but statistically at par with T₆, T₄ and T₃ treatments whereas, minimum plant height (146.1 cm) was found under T₁. The different nutrient treatments exhibited almost the similar trend in plant height at 90 DAS and at harvest as noticed at 60 DAS. Similar findings were reported by several other researchers [6-9].

3.2 Dry Matter Accumulation (DMA)

The dry matter accumulation (g plant⁻¹) by crop is an important index indicating the photosynthetic efficiency of the crop which ultimately influences the crop growth and yield. Data on DMA (g plant⁻¹) of maize is affected by various treatments at different time interval and harvest. At 45 DAS, the dry matter accumulation was affected significantly due to different treatments. The maximum dry matter accumulation (21.7g) was recorded under T₅ where 100% NPK + 2 spray of 2ml./lit. N₂ nano fertilizers was applied and it was at par with T₅ and T₆. The lowest dry matter accumulation (16.5g) was recorded in control plot (T₁). At 60 DAS, the maximum dry matter accumulation (142.2g) was also recorded under T₅ which is significantly higher over T₂, T₇ and T₈ but statistically at par with T₆, T₄ and T₃ treatments whereas, minimum dry matter accumulation (105.5g) was found under T₁. The different nutrient treatments exhibited almost the similar trend in dry matter accumulation at 90 DAS and at harvest as noticed at 60 DAS. This

similar finding was reported by Raman et al. [10], Shakunthala et al. (2017), and Tomar et al. [11].

3.2.1 Days to 50% tasseling and 50% silking

Data on days to 50% silking and 50% maturity recorded under all treatments. It is Obvious from the data that day to 50% silking and 50% maturity was not differed significantly due to various treatments and it was practically similar in all the treatments including T₁ where no nitrogen fertilizer was applied. This result was recommended previously by Lahay et al. [6], Jinjala et al. [12] and Barde et al. [9].

3.3 Crop Growth Rate (CGR)

Data on crop growth rate (g/cm²/day) has been recorded at different time interval (0-45, 45-60 and 60-90 DAS) involving different treatments. At (0-45 DAS), the treatment T₅ where 100% NPK + 2 spray of 2ml./lit. N₂ nano fertilizers had found significantly higher CGR (3.21) and it was at par with T₆ and T₄, while minimum value (2.45) of CGR was recorded under Control (T₁). At (45-60 DAS), The treatment T₅ had significantly higher CGR (51.49) and it was at par with T₆, T₄ and T₃, while minimum value (39.52) of CGR was recorded under T₁. The different nutrient treatments exhibited almost the similar trend in CGR at 60-90 DAS as noticed at 45-60 DAS. This similar finding was reported by Dharaiya et al. [13] and Paikra et al. [8].

3.4 Relative Growth Rate (RGR)

Data on relative growth rate (g/g/day) has been recorded at different time interval (0-30, 30-60 DAS and 60 DAS - harvest) under different treatments. At (0-45 DAS), the treatment T₅

Table 2. Effect of integrated nutrient management on dry matter accumulation (DMA) of maize

T. No.	Treatments	Dry matter accumulation (g/plant)			
		45 DAS	60 DAS	90 DAS	At harvest
T ₁	Control (No nitrogen with 100% P & K)	16.5	105.5	123.8	142.2
T ₂	T ₁ +2 spray with 6ml./lit. nano N ₂ fertilizer	19.7	130.4	153.5	176.5
T ₃	T ₁ +3 spray with 8ml./lit. nano N ₂ fertilizer	20.2	135.8	159.4	182.3
T ₄	100 % RDF (chemical fertilizers)	20.8	136.7	161.5	185.4
T ₅	100% NPK + 2 spray of 2ml./lit. N ₂ nano fertilizers	21.7	142.2	166.6	191.1
T ₆	75% NPK + 2 spray of 3ml./lit. N ₂ nanofertilizers	21.1	138.5	163.5	188.5
T ₇	50% NPK + 2 spray of 4ml./lit. N ₂ nanofertilizers	18.9	126.5	149.2	171.8
T ₈	25% NPK + 2 spray of 5ml./lit. N ₂ nano fertilizers	17.8	118.2	139.4	160.5
SEm±		0.36	2.32	3.41	3.52
CD (P=0.05)		1.15	6.77	10.22	10.54

Table 3. Effect of integrated nutrient management on 50% silking and 50% maturity of maize

T. No.	Treatments	Days to 50 % silking	Days to 50% maturity
T ₁	Control (No nitrogen with 100% P & K)	79.2	107.2
T ₂	T ₁ +2 spray with 6ml./lit. nano N ₂ fertilizer	77.0	105.0
T ₃	T ₁ +3 spray with 8ml./lit. nano N ₂ fertilizer	77.3	105.3
T ₄	100 % RDF (chemical fertilizers)	77.1	105.1
T ₅	100% NPK + 2 spray of 2ml./lit. N ₂ nano fertilizers	76.7	104.7
T ₆	75% NPK + 2 spray of 3ml./lit. N ₂ nano fertilizers	76.9	104.9
T ₇	50% NPK + 2 spray of 4ml./lit. N ₂ nano fertilizers	77.9	105.9
T ₈	25% NPK + 2 spray of 5ml./lit. N ₂ nano fertilizers	77.8	105.8
SEm±		0.85	1.18
CD (P=0.05)		NS	NS

Table 4. Effect of integrated nutrient management on crop growth rate of maize

T. No.	Treatments	CGR (g/cm ² /day)		
		0-45	45-60	60-90
T ₁	Control (No nitrogen with 100% P & K)	2.45	39.52	4.08
T ₂	T ₁ +2 spray with 6ml./lit. nano N ₂ fertilizer	2.92	49.20	5.12
T ₃	T ₁ +3 spray with 8ml./lit. nano N ₂ fertilizer	3.00	51.36	5.23
T ₄	100 % RDF (chemical fertilizers)	3.08	51.49	5.52
T ₅	100% NPK + 2 spray of 2ml./lit. N ₂ nano fertilizers	3.21	53.54	5.44
T ₆	75% NPK + 2 spray of 3ml./lit. N ₂ nano fertilizers	3.12	52.21	5.55
T ₇	50% NPK + 2 spray of 4ml./lit. N ₂ nano fertilizers	2.80	47.82	5.03
T ₈	25% NPK + 2 spray of 5ml./lit. N ₂ nano fertilizers	2.64	44.61	4.70
SEm±		0.06	0.76	0.08
CD (P=0.05)		0.18	2.29	0.23

Table 5. Effect of integrated nutrient management on relative growth rate of maize

T. No.	Treatments	RGR (g/g/day)		
		0-45	45-60	60-90
T ₁	Control (No nitrogen with 100% P & K)	0.062	2.50	4.50
T ₂	T ₁ +2 spray with 6ml./lit. nano N ₂ fertilizer	0.066	2.66	4.70
T ₃	T ₁ +3 spray with 8ml./lit. nano N ₂ fertilizer	0.067	2.68	4.74
T ₄	100 % RDF (chemical fertilizers)	0.067	2.71	4.75
T ₅	100% NPK + 2 spray of 2ml./lit. N ₂ nano fertilizers	0.068	2.75	4.79
T ₆	75% NPK + 2 spray of 3ml./lit. N ₂ nano fertilizers	0.068	2.72	4.76
T ₇	50% NPK + 2 spray of 4ml./lit. N ₂ nano fertilizers	0.065	2.62	4.67
T ₈	25% NPK + 2 spray of 5ml./lit. N ₂ nano fertilizers	0.064	2.56	4.61
SEm±		0.0005	0.022	0.015
CD (P=0.05)		0.0015	0.067	0.046

where 100% NPK + 2 spray of 2ml./lit. N₂ nano fertilizers had significantly higher RGR (0.068) and it was at par with T₆, T₄ and T₃, while

minimum value (0.062) of RGR was recorded under control (T₁). The different nutrient treatments exhibited almost the similar trend in

RGR at 60-90 DAS as noticed at 45-60 DAS. This similar finding was reported by Dharaiya et al [13] and Paikra et al [8,14-16].

4. CONCLUSION

In this study we observed that the application of 100% NPK + 2 spray of 2 ml./lit. N₂ nano fertilizers may be more beneficial in terms of growth, productivity, profitability and sustainability over rest of the treatments, which suggests that the 100% NPK + 2 spray of 2 ml./lit. N₂ nano fertilizers application is more scientific management of nutrients in sandy loam soil for maize in Mandsaur region of Madhya Pradesh. This study recommends applying additional dose of nano fertilizer in along with chemical fertilizers at Mandsaur and nearby region.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Mishra P, Tiwari US, Pandey HP, Pathak RK, Sachan AK. Impact of INM on Growth and Yield of Maize (*Zea mays L.*) Crop in Central Plain Zone of Uttar Pradesh, India. International Journal of Current Microbiology and Applied Sciences. 2019;8(4):2319-2326.
2. Begam A, Ray M, Roy D C and Sujit A. Performance of hybrid maize (*Zea mays L.*) in different levels and time of nitrogen application in Indo-Gangetic plains of eastern India. Journal of Experimental Biology and Agricultural Sciences. 2018; 6(6):929-935.
3. Pahalvi HN, Rafiya I, Rashid S, Kamili AN. Chemical fertilizer and soil health. In: G. H. Dar et al. (eds.), Microbiota and Biofertilizers. 2021;2:1-20.
4. Qureshi A, Singh DK, Dwivedi S. Nano fertilizers: A novel way for enhancing nutrient use efficiency and crop productivity. Int. J. Cur. Microbial. App. Sci. 2018;7(2):3325-3335.
5. Do you mean, Rohit Rathore, Amreen Hasan, Arun Alfred David, Tarence Thomas and I Srinath Reddy. Effect of different levels of nano urea and conventional fertilizer on soil health of maize (*Zea mays L.*) Var, P3544 in an Inceptisols of Prayagraj, (U.P) India. The Pharma Innovation Journal. 2022;11(8): 560-563.
6. Lahay RR, Sipayung R and Sabrina T. The growth and yield of maize (*Zea mays saccharata* Sturt.) with an organic and organo-bio fertilizer. Conf. Ser.: Earth and Environmental Science. 2019;260 012156.
7. Mustafa K, Fattah, Suat S, Othman A. The Effects of Plant Density and Organic Fertilizer on Growth and Yield of Maize (*Zea mays L. var. saccharata* Sturt). Yuzuncu Yil University Journal of Science Institute. 2019;24(1):43-55.
8. Paikra JK, Dwivedi SK, Harishankar. Effect of Integrated Nutrient Management on Productivity and Profitability of Maize (*Zea mays L. saccharata*). Int. J. Curr. Microbiol. App. Sci. 2018;6:2762-2769.
9. Barde B Sasode DS, Joshi E, Singh V, Patel R. Effect of integrated nutrient management on growth, yield attributes and yield of sweet corn under northern tract condition of Madhya Pradesh. Prog. Agric. 2021;21(2):196-200.
10. Raman Rand Suganya K. Effect of Integrated Nutrient Management on the Growth and Yield of Hybrid Maize. Open Access Journal of Agricultural Research ISSN: 2474-8846. 2018;3(2)
11. Tomar SS, Singh A, Dwivedi A, Sharma R, Naresh K, Tyagi S, Yadav AS, Siddhart NR, Singh BP. Effect of integrated nutrient management for sustainable production system of maize (*Zea mays L.*) in indo-gangetic plain zone of India. International Journal of Chemical Studies. 2017;5(2): 310-316.
12. Jinjala VR, Virdia HM, Saravaiya NN, Raj AD. Effect of integrated nutrient management on baby corn (*Zea mays L.*). Agric. Sci. Digest. 2016;36(4):291-294.
13. Dharaiya BK, Asodariya KB, Vaghela TD. Effect of Nutrient Management on Growth Parameters, Yield Attributes and Yield of Rabi maize (*Zea mays L. var. saccharata sturt*). Trends Biosciences. 2018;11(24): 3293-3296.
14. Reddy BA, Elankavi S, Kumar MS. 2022. effect of conventional and nano fertilizer on

- growth and yield of maize (*Zea mays L.*)
Bhartiya Krishi Anusandhan Patrika
DOI: 10.18805/BKAP500.
15. Rathod M, Bavalgave VG, Tandel B, Gudadhe NN. Effect of spacing and INM practices on growth, yield and economics of Rabi maize (*Zea mays L. saccharata*) under south Gujarat condition. International Journal of Chemical Studies. 2018;6(5):247-250.
16. Shakunthala L, Madhavi LA, Ramulu C, Saritha JD. Influence of Integrated Nutrient Management Practices on Growth and Yield Parameters of Maize, Int. J. Pure App. Biosci. 2018; 6(4):36-41.

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