Effect of foliar spray of nano fertilizer on growth characters of Rabi maize (*Zea mays* L.) in Mandsaur region (MP)

Is this work a part of previous published article by Rohit Rathore et al., 2022 ?

ABSTRACT

A study was conducted to ~~estimate~~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 Cafeteriaat 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~~~~present study~~revealed that the application of 100% NPK + 2 spray of nanoN-fertilizer is more beneficial in terms of growth, productivity, maximum gross return, net return, beneficial cost ratio and sustainability over rest of treatments which lead us to recommend the treatment of ~~suggested that~~ 100% NPK + 2 spray of nanoN-fertilizer as a most proper ~~is more scientific~~nutrients management practice ~~of nutrient~~to be applied in sandy loam soil ~~at~~under Mandsaur region~~conditions of Madhya Pradesh~~. ~~This study is recommended for additional dose of nano fertilizer with chemical fertilizer for enhancing the production and productivity of maize crop at Mandsaur and their nearby region.~~

Keywords:Foliar spray, Fertilizers, Growth, Nanofertilizer, Maizeproductivity

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 (Mishra *et al.*,2019). 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" (Begam*et al.*, 2018). 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, Tamilnaduhave the 1st position and Madhya Pradesh came to the next ~~is the second~~as largest producer of maize (23.10 MT) ~~production~~ and area is (3.98 lakh/ha)!!? in 2021. As the maize is considered ~~as~~ 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 (~~Pahalvi and Rashid *et al.*, 2021~~Pahalvi et al. 2021**see Ref List**). 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 (Qureshi *et al.*, 2018). 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 (Rathore R.,& Reddy I.S,. 2022is not found in Ref List !!!). Keeping these facts into consideration,~~view~~ the present study ~~was carried out to estimate~~aimed at evaluatingthe effect of foliar spray of nitrogennano-fertilizer on growth of *Rabi* maize (*Zea Mays L.*) in Mandsaur region (Madhya Pradesh).

MATERIALS AND METHODS

This section is very concise, many of details about agricultural management practices, methods of analysis, experimental layout, experimental soil analysis before sowing … etc.

A field experiment was carried out during year 2022-23 at the department of Agriculture sciences MandsaurUniversity,Mandsaurin*Rabi* crop season. The soil of experimental site was sandy clay loam and very deep well drained.In this study, a dose of135 kg/ha nitrogen in ~~the~~urea form ~~of urea~~ was applied in 2 splits i.e.half at ~~the time~~ of sowing and half at knee high stage. Arecommended ~~common~~ doses of 62.5 kg P_2O_5 and 50 kg K_2Oper hectare were appliedat sowing~~as basal dose~~ in the form of single super phosphate and muriate of potash, respectively.~~at the time of sowing~~. 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. ~~An~~The experiment was laid out in randomized block design with ~~three replicates and~~including eight treatments namely T_1- Control (No nitrogen with 100% P & K), T_2- (T_1+2 spray with 6 ml/LnanoN_2-fertilizer), T_3 (T1+3 spray with 8 ml/Lnano N~~2~~ - fertilizer), T_4 (100 % RDF (chemical fertilizers), T_5 (100% NPK + 2 spray of 2 ml/LN_2nano fertilizers), T_6 (75% NPK + 2 spray of 3ml/L N_2nano fertilizers), T_7 (50% NPK + 2 spray of 4ml/L N_2nano fertilizers), and T_8 (25% NPK + 2 spray of 5ml/L N_2nano fertilizers), and all of them were replicated three times.

Comment [A1]: Physicochemical properties of soil is needed here with special emphasis on nutrients content in origin!!!

Comment [A2]: Recently, these elements are applied as P, K and N there are no need for oxidized form anymore!

Comment [A3]: What is the seed treatment?

Comment [A4]: Since all experimental plots were treated with basal recommended doses of P and K, there are no needs to include T1 term in other treatments whereas those only dealt with application of nitrogen either conventional or nano forms 1?

Comment [A5]: N2 is a gaseous molecule not appropriate here Only use N-fertilizer

Comment [A6]: Experimental layout including the area of treated plots should be mentioned
If there are mathematical estimation of some parameters, used equations should be described in M&M section

RESULTS AND DISCUSSION

Plant height

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

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	T1+3 spray with 8ml./lit. nano N2 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_2nano fertilizers	70.1	179.5	187.9	194.8
T_6	75% NPK + 2 spray of 3ml./lit. N_2nano fertilizers	67.2	174.9	183.3	193.9
T_7	50% NPK + 2 spray of 4ml./lit. N_2nano 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**

You have replaced the full details about treatments as footnote under the first Table only and exclude it from all Tables.

~~Significantly due to different treatments.~~ The maximum plant height (70.1 cm) was recorded under T_5 where100% NPK + 2 spray of 2 ml/l N_2nano fertilizers were applied and it was nearly closed to ~~at par with~~ T_{45} and T_6. The lowest plant height (48.2 cm) was recorded in control plot (T_1). At 60 DAS, the maximum plant height (179.5 cm) was also recorded under T_5 which is significantly higher over T_2, T_7 and T_8 but statistically at par with T_6, T_4 and T_3 treatments whereas, minimum plant height (146.1 cm) was found under T_1.The different nutrient treatments exhibited almost the similar trend in plant height at 90 DAS and at harvest as noticed at 60 DAS.~~This~~Similar findings ~~was~~were reported by several other researchers (Lahay*et al*. 2019, Mustfa*et al.* 2019,Paikra*et al.* 2018 and Bardee*t al.*2021).

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

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	T1+3 spray with 8ml./lit. nano N2 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_2nano fertilizers	21.7	142.2	166.6	191.1
T_6	75% NPK + 2 spray of 3ml./lit. N_2nanofertilizers	21.1	138.5	163.5	188.5
T_7	50% NPK + 2 spray of 4ml./lit. N_2nanofertilizers	18.9	126.5	149.2	171.8
T_8	25% NPK + 2 spray of 5ml./lit. N_2 nanofertilizers	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**

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 T_5 where100% NPK + 2 spray of 2ml./lit. N_2nano fertilizers was applied and it was at par with T_5 and T_6. The lowest dry matter accumulation (16.5g) was recorded in control plot (T_1). At 60 DAS, the maximum dry matter accumulation (142.2g) was also recorded under T_5 which is significantly higher over T_2, T_7 and T_8 but statistically at par with T_6, T_4 and T_3 treatments whereas, minimum

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Comment [A8]: Similarity with others is not enough you must explain what happened and diagnose the responsible mechanisms especially when comparing between conventional and nono-fertilizers form. More and deepest discussion in this era is urgently needed

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dry matter accumulation (105.5g) was found under T_1. 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*. (2018), Shakunthala*et al.* (2017), and Tomar*et al*. (2017).

Days to 50% Tasseling and 50% Silking

Data on days to 50% silking and 50% maturity recorded under all treatments. It is

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	T1+3 spray with 8ml./lit. nano N2 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_2nano fertilizers	76.7	104.7
T_6	75% NPK + 2 spray of 3ml./lit. N_2nano fertilizers	76.9	104.9
T_7	50% NPK + 2 spray of 4ml./lit. N_2nano fertilizers	77.9	105.9
T_8	25% NPK + 2 spray of 5ml./lit. N_2 nanofertilizers	77.8	105.8
SEm±		**0.85**	**1.18**
CD (P=0.05)		**NS**	**NS**

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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 T_1 where no nitrogen fertilizer was applied. This result was recommended previously byLahay*et al.* (2019), Jinjala*et al.* (2016) and Barde*et al.* (2021)

Crop growth rate (CGR)

Data on crop growth rate (g/cm^2/day) has been recorded at different time interval (0-45, 45-60 and 60-90 DAS) involving different treatments. At (0-45 DAS), the treatmentT_5 where100% NPK + 2 spray of 2ml./lit. N_2nano fertilizers had found significantly higher CGR (3.21) and it was at par with T_6 and T_4,while minimum value (2.45) of CGR was recorded under

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	T1+3 spray with 8ml./lit. nano N2 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_2nano fertilizers	3.21	53.54	5.44
T_6	75% NPK + 2 spray of 3ml./lit. N_2nano fertilizers	3.12	52.21	5.55
T_7	50% NPK + 2 spray of 4ml./lit. N_2nano fertilizers	2.80	47.82	5.03
T_8	25% NPK + 2 spray of 5ml./lit. N_2 nanofertilizers	2.64	44.61	4.70
SEm±		**0.06**	**0.76**	**0.08**
CD (P=0.05)		**0.18**	**2.29**	**0.23**

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Control (T_1).At (45-60 DAS), The treatment T_5had significantly higher CGR (51.49) and it was at par with T_6, T_4 and T_3, while minimum value(39.52) of CGR was recorded under T_1.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.* (2018) and Paikra*et al.* (2018).

Relative growth rate (RGR)

Data on relative growth rate (g/g/day)has beenrecorded at different time interval (0-30, 30-60 DAS and 60 DAS - harvest) under different treatments. At (0-45 DAS), the treatment T_5

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	T1+3 spray with 8ml./lit. nano N2 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_2nano fertilizers	0.068	2.75	4.79
T_6	75% NPK + 2 spray of 3ml./lit. N_2nano fertilizers	0.068	2.72	4.76
T_7	50% NPK + 2 spray of 4ml./lit. N_2nano fertilizers	0.065	2.62	4.67
T_8	25% NPK + 2 spray of 5ml./lit. N_2 nanofertilizers	0.064	2.56	4.61
SEm±		**0.0005**	**0.022**	**0.015**
CD (P=0.05)		**0.0015**	**0.067**	**0.046**

where100% NPK + 2 spray of 2ml./lit. N_2nano fertilizers had significantly higher RGR (0.068) and it was at par with T_6, T4and T_3, while minimum value (0.062) of RGR was recorded under control (T_1).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.* (2018) and Paikra*et al.* (2018).

CONCLUSION

In this study we observed that the application of 100% NPK + 2 spray of 2 ml./lit. N_2nano 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. N_2nano fertilizers application is more scientific management of nutrients in sandy loam soil for maize in Mandsaur region of Madhya Pradesh. This study recommends applyingadditional dose of nano fertilizer in along with chemical fertilizers at Mandsaur and nearby region.

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Comment [A14]: Poor language, construction and it should be rewritten taking into consideration the suitability of such recommended practice for the defined area or region and compare with common practices made by farmers in the region

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Do you mean, Rohit Rathore, Amreen Hasan, Arun Alfred David, Tarence Thomas and I Srinath Reddy 2022. 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; 11(8): 560-563.**Please, chick out carefully**

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