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

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 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 resultsrevealed 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 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 regionconditions

Keywords:Foliar spray, Fertilizers, Growth, Nanofertilizer, Maize productivity

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, 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 ~~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 et al. 2021). 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& Reddy, 2022) 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).

MATERIALS AND METHODS

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 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 P_2O_5 and 50 kg K_2O per hectare were applied at sowingin 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. ~~An~~The experiment was laid out in randomized block design with including eight treatments namely T_1- Control (No nitrogen with 100% P & K), T_2- (T_1+2 spray with 6 ml/L nano N_2-fertilizer), T_3 (T1+3 spray with 8 ml/L nano N - fertilizer), T_4 (100 % RDF (chemical fertilizers), T_5 (100% NPK + 2 spray of 2 ml/L N_2 nano fertilizers), T_6 (75% NPK + 2 spray of 3 ml/L N_2 nano fertilizers), T_7 (50% NPK + 2 spray of 4 ml/L N_2 nano fertilizers), and T_8 (25% NPK + 2 spray of 5 ml/L N_2nano fertilizers), and all of them were replicated three times.

RESULTS AND DISCUSSION

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	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_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 T_5 where100% NPK + 2 spray of 2 ml/l N_2 nano fertilizers were applied and it was nearly closed to 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.Similar findings were reported by several other researchers (Lahay *et al*. 2019, Mustfa*et al.* 2019,Paikra*et al.* 2018 and Barde *et 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_2 nano 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 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**

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_2 nano 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 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_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**

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_2 nano 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_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**

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_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**

where100% NPK + 2 spray of 2ml./lit. N_2 nano 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_2 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. N_2 nano 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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