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Effect of foliar spray of nano fertilizer on yield and yield attributing traits of Rabi maize (*Zea mays* L.) in Malwa region (MP), India

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ABSTRACT

An experiment was conducted to estimate the effect of foliar spray of nano fertilizer on yield and yield attributing traits of maize during the *Rabi* season 2022-23 at the Crop Research Cafeteria of Mandsaur University, Mandsaur. This experiment was set in Randomized Block Design (RBD) with three replication involving eight treatments and seven yield and yield attributing traits of maize. The analysis of variance (ANNOVA) revealed the presence of a significant amount of variability among all the eight treatments and all the seven yield traits studied. This study has indicated that the application of 100% NPK + 2 spray of nano fertilizer is more beneficial in terms of yield and suitability over rest of the treatments which confirmed that 100% NPK + 2 spray of nano fertilizer is a better scientific nutrient management technique for the sandy loam soil of Malwa region (Madhya Pradesh). This study resulted as additional dose of nano fertilizer along with chemical fertilizer can improve the production and productivity of maize crop at the Malwa region of Madhya Pradesh.

Keywords: *Maize, Nano fertilizer, Treatment, Foliar spray, Nutrient, Yield*

Introduction

Maize (*Zea mays* L.) is one of the main adaptable crops having wider adaptableness under diverse agro-climatic conditions. Globally, maize is recognized as queen of cereals as it has the maximum genetic yield potential in compare of other cereal crops. Maize is a multi-purpose crop used as a food tool for human beings and feed and fodder for animals and also an outstanding source of bio fuel in present context also remained in the past (Kaul *et al*., 2019). In India, maize is grown in 10.04 million hectares area with production and productivity of 33.62 million tonnes and 3348 kg/ha, respectively (Anonymous, 2022). The major maize growing states of India are Madhya Pradesh, Bihar, Tamil Nadu, Maharashtra, Gujarat, Telangana and West Bengal. Moreover in India, Tamilnadu is the first and Madhya Pradesh is the second biggest producer of maize (23.10 MT) with an area of 3.98 lakh/ha in 2021. The maize is stated as an exhaustive crop, since it requires nutrients more. The organic nutrient management plays a vital role in increased productivity of maize. A sustainable yield levels might be attained by applying suitable combination of chemical fertilizers and organic manures. The modern farming is mostly dependent upon fertilizers which are an unavoidable threat to Agriculture. However,

([1 & 2]Assistant Professor, [3]Associate Professor, [4]M.Sc. Scholar) they persist to be essential tools for worldwide food security. When sustainable Agriculture is the universal target, the bothersome effects of chemical fertilizers cannot be overlooked. Chemical fertilizer plays an indispensable role in enhancing crop yield and soil fertility. Chemical fertilizers are of different types. They can be in the form of nitrogenous, phosphate, potassium fertilizers. The application of fertilizers not only increase crop yield, but also changes the soil physicochemical and biological property. Imbalanced use of chemical fertilizers can alter soil pH, and increase pests attack, acidification, and soil crust, which results in a decrease in soil organic carbon and useful organisms, stunting plant growth and yield, and even leading to the emission of greenhouse gases (Pahalvi and Rashid *et al.*, 2021).A latest approach and technology is needed in order to achieve the worldwide demand which is sustainable both in terms of economics and environment. Generally the material which are of up to 100 nm particle size in at least one dimension are categorized as nonmaterial (Kim, *et al.*, 2018 and Kah, 2015)which is the base of nanotechnology (Monreal, *et al.*, 2016).With the distinctive property of nano materials such as, controlled-release kinetics to targeted sites, sorption capacity and high surface-to-volume ratio, the following nanotechnology has a prominent significance as a use of novel fertilizers (Feregrino-Perez, *et al.,* 2018).

Basically the nano fertilizers are nutrients encapsulated/layered with nano material targeted to organized and unhurried delivery of one or more nutrients for assuring the crucial nutrient supplies of plants (Zuverza-Mena, *et al.*, 2017).A high concentration of nano fertilizer, which amplifies auxin synthesis, is accountable for the increased growth. Across all rising plant sections, auxin can stimulate cell division and elongation. Further, this rise may be associated to the fact that nano fertilizers, which are rapidly absorbed by plants, may lead to improved rates of photosynthesis and an increase of dry matter (Navya *et al*., 2022). Nano particles which are less than 5 nm, in the leaves cuticles can penetrate through stomotal pores and travel through vascular systems, affecting the efficacy of nano particles by interfering the chemical composition and shape, which can lead to biological yield (Reddy *et al*., 2022). Keeping these points in view the current study was carried out to know the effect of foliar spray of nano fertilizer on yield of *Rabi* maize (*Zea Mays* L.) in the Malwa region of Madhya Pradesh.

Materials and Methods

A field experiment was carried out during year 2022-23 at the Agriculture field of Agriculture sciences Mandsaur University, Mandsaur in *Rabi* crop season in order to study the effect of foliar spray of nano fertilizer on seven yield and yield attributing traits of Rabi maize (*Zea mays* L.) in the Malwa region (MP). The total number of plots was 24 with a gross plot size of 6.0 x 4.0 m^2 net plot size of 5.4 x 4.0 m^2. The Gross plot area was hence 576 m^2. The variety of maize take for the study was "Pioneer". The seed rate and spacing (Row x Plant) was 25 kg/ha and 60 x 25 cm respectively. In this study, a dose of 135 kg/ha nitrogen in the form of urea was applied in 2 splits *i.e.* half at the time of sowing and half at knee high stage. A common dose of 62.5 kg P_2O_5 and 50 kg K_2O per hectare was applied as basal dose in the form of single super phosphate and muriate of potash, respectively, at the time of sowing. The field was prepared by ploughing with cultivator and cross ploughing by disc harrow. Planking was done after each ploughing for well leveling and to make soil friable to insure proper germination. The pre-treated seed of maize (Pioneer) was sown at a depth of 4-5 cm so as to have a plant population of 66,666 plant per ha. Irrespective of the treatments, gap filling was done manually at 10 days after sowing DAS to maintain optimum plant population and recommended intra-row spacing of 25 cm. A total of five irrigations were given to critical stages of crop preventing drought condition. However, a shallow one come up irrigation was given immediately after sowing to the maize crop in all the plots just to facilitate proper germination of maize seeds. In order to control the weeds, the herbicide atrazine @ 500 g/ha was applied one day after sowing as pre-emergence spray. The manually harvested cobs from each net plot area was kept separately and weighed. Total plants were harvested as stover by cutting close to the ground with the help of sickles.

This experiment was laid out in Randomized Block Design (RBD) with three replications involving 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 N2 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_2 nano fertilizers). The data on Cobs/ plant, Cob length (cm), Seeds/cob, Seed yield (kg/ha), Stover yield (kg/ha), Harvest Index (%) and Seed index (g) were obtained and later subjected to statistical analysis using the techniques of Analysis of Variance (ANOVA) as suggested by Cochran and Cox (1967). Thereafter the standard error of mean (S.Em±) for each observation and critical difference (CD) for significant difference was calculated.

Results and Discussion

The data on the yield attributing character such as number of cobs per plant, cob length (cm) and number of seeds per cob as influenced by different integrated nutrient treatments are presented in Table 1. It is clear from the Table 1 that the number of cobs per plant varied significantly due to different nutrient treatments. Among all the treatments, the minimum number of cobs per plant (1.07) was recorded under T1. The treatment T5 registered higher number of cobs per plant (1.55) followed by T3, T2, T7 and T8 and being at par with T6 and T4.

Data pertaining to cob length of maize as influenced due to different treatments shows that among all the treatments, T5 have remarkably lengthy cobs (18.8 cm) followed by T2, T7 and T8 and at par with T6, T4 and T3. The length of cobs was comparatively shorter (12.1 cm) under T1. From the data pertaining to seeds per cob-as influenced due to different integrated nutrient treatments it is obvious that the number of seeds per cob differed significantly under different treatments. Among all the treatments, the minimum number of seeds per cob (415) was recorded under control (T1). The application of different nutrient treatments increased the seeds per cob significantly and was maximum (568) due to T5 where 100% NPK + 2 spray of 2 ml./lit. N2 nano fertilizers and followed by other treatments except T6 and T5.

Hence it is clear from the data that the yield attributing character varied significantly due to different integrated nutrient treatments. Among all the treatments, the minimum yield attributing character were recorded under control (T1) and the treatment T5 registered more yield attributing character. Among all treatment, T5 where 100% NPK + 2 spray of 2 ml./lit. N2 nano fertilizers registered maximum number of cobs/plant, number of grains/cob and cob length whereas the minimum was recorded under control T1. The above findings showed similar result with Mustfa *et al.* (2019), Dhariya *et al.* (2018) and Khan *et al.* (2018).

Data on the yield character such as seed yield (kg/ha), stover yield (kg/ha) and harvest index (%) and seed index as influenced by different integrated nutrient treatments are also presented in Table 1. Among all the treatments, the maximum seed yield (7483 kg/ha) in T5 where 100% NPK + 2 spray of 2 ml/l N2 nano fertilizers and which were at par with by T6, T4 and T3 and minimum seed yield (2382 kg/ha) was recorded under T1.It is evident from the data that the different treatments caused significantly variation on stover yield of maize. The stover yield was maximum (12773 kg/ha) found under application of treatment T5 and it was at par with other treatments except T7, T8 and T2 whereas the lowest stover yield (7175 kg/ha) was recorded in T1.

Hence the treatments caused significant variation in yield of maize. The minimum seed and stover

Table 1. Effect of integrated nutrient management on number of cobs per plant, Cob length (cm), Seeds per cob, Seed yield (kg/ha), Stover yield (kg/ha), Seed index (g) and Harvest index (%) of maize (*Zea mays* L.)

T. No.	Treatments	Cobs/ plant	Cob length (cm)	Seeds/ cob	Seed yield (kg/ha)	Stover yield (kg/ha)	HI (%)	Seed index (g)
T_1	Control (No nitrogen with 100% P&K)	1.07	12.1	415	2382	7175	24.92	19.69
T_2	T_1+2 spray with 6 ml/l N_2 nano fertilizer	1.37	16.4	460	4375	8278	34.58	20.68
T_3	T1+3 spray with 8 ml/l N_2 nano fertilizer	1.38	16.9	490	5891	10882	35.12	20.74
T_4	100% RDF (chemical fertilizers)	1.48	17.2	531	6149	10191	37.63	20.96
T_5	100% NPK+2 spray of 2 ml/l N_2 nano fertilizers	1.55	18.8	568	7483	12773	36.94	21.13
T_6	75% NPK+2 spray of 3 ml/l N_2 nano fertilizers	1.53	18.4	548	6788	10754	38.70	21.04
T_7	50%NPK+2 spray of 4 ml/l N_2 nano fertilizers	1.33	15.3	447	4272	8982	32.23	20.37
T_8	25% NPK+2 spray of 5 ml/l N_2 nano fertilizers	1.27	13.8	430	3283	8467	27.94	20.11
	SEm±	0.031	0.69	15.1	562	703	0.62	0.49
	CD(P=0.05)	0.088	2.03	45.3	1691	2114	1.86	NS

yield was obtained under control (T1), while it was increased when nutrients were applied in different treatments. The application of 100% NPK + 2 spray of 2 ml./lit. N2 nano fertilizers (T5) resulted in significantly maximum seed and stover yield over rest of other treatments. These result was similar with Kaur *et al.*(2019), Mustafa *et al.* (2019), Raman *et al.* (2018), Panchal *et al.* (2018) and Paikra *et al.* (2018).

Among all the treatments, the minimum harvest index (24.92%) was recorded in T1 (control). The application of different nutrient treatments increase in the grain nitrogen uptake was noted and registered significantly maximum harvest index (38.70%) in T6 where 75% NPK + 2 spray of 3 ml/l N2 nano fertilizers and it was followed by other treatments except T5 and T4. It is obvious from data that seed index was not differed significantly and found statistically non-significant among all the treatments including control plots where no nitrogen fertilizer was applied. Among all the treatments, the maximum seed index (21.13 g) in T5 where 100% NPK + 2 spray of 2 ml/l N2 nano fertilizers. N2 nano fertilizer and minimum seed index (19.69 g) was recorded under T1.

Conclusion

In this study we observed that the application of 100% NPK + 2 spray of 2 ml/l N_2 nano fertilizers is more beneficial in terms of productivity over rest of the treatments, which suggests that the 100% NPK + 2 spray of 2 ml/l N_2 nano fertilizers application is a scientific nutrient management in the sandy loam soil for maize in the area of Malwa (MP). This study recommends the application of additional dose of nano fertilizer in addition of chemical fertilizers in Malwa and it's nearby region.

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Conflict of interest

All authors declare that they have no conflicts of interest.

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