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Response of Maize under Foliar Application of Zinc Based Nano fertilizer and Varying Fertility Levels on Quality, Yield, and Economics

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ABSTRACT

The present study was carried out during two consecutive *Kharif,* seasons of 2020 & 2021 at Instructional Farm, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture & Technology, Udaipur, Rajasthan to assess the response of maize crop under foliar application of zinc based nanofertilizer and varying fertility levels on quality, yield and economics in Southern Rajasthan. The experiment was laid out in a factorial randomized design with three replications comprising four foliar application of nanofertilizer (Control, at knee high stage, at 50% tasseling stage and both at knee high stage and at 50% tasseling stage) and four fertility levels (100% RDF, 90% RDF, 80% RDF and control). Significantly highest protein content of maize (11.13 % and 10.97 %) was found in with dual foliar application of nanofertilizer and 90 per cent RDF, respectively. The significantly highest net return and B:C ratio were found under dual foliar application of nanofertilizer 82956 and 3.04) and soil application of 90 per cent RDF (Rs. 86112 and 3.15) in tested maize crop.

Key words : *Nanofertilizer, Foliar zinc, Quality, Economics, Maize*

Introduction

Maize (*Zea mays* L.) is one of the most versatile crops. It can be grown over diverse environmental conditions and diversified uses in human food, animal feed, and raw materials for many industrial products. It is a versatile crop that fits well in the existing cropping systems. In India, it is an important crop not only in terms of acreage but also in context to their versatility for adoption under wide range of agro-climatic conditions. Currently, maize is cultivated over 9.72 m ha area with 28.64 m t production and an average yield of 29.45 q ha^{-1} (GOI, 2021). In Rajasthan, the crop occupies 0.97 m ha area with an annual production of 2.70 m t and average yield of 27.69 q ha^{-1} (GOR, 2021). Maize grain has elevated nutritive value as it contains about 72% starch, 10% protein, 4.8% oil, 5.8% fiber and 3.0%

sugar (Rafiq *et al*., 2010). Among micronutrients, zinc is most important micronutrient for crop as per it's imperative role in plant's enzymes system as co-factor. Presently deficiency of zinc has become so widespread that it ranks next to N and P in Rajasthan as well as many other states under intensive cropping systems. Thus higher yield of single cross maize hybrid can be obtained through the judicious use of nitrogen, phosphorus and zinc. Nanotechnology can plays an important role in modern agriculture to address plant diseases and the limited availability of important plant nutrients. A variety of nanomaterials, mostly metal and carbon based nanomaterials has been studied in maize and wheat for plant growth. It has been proved that various nanomaterials used in various crops can be exploited as nanonutrients. It is wise to evaluate the potential of nanomaterials for their ability to fulfil the need of nutrients for plants in much efficient manner as compared to traditional fertilizers (Raliya *et al*., 2018). Chitosan based nanomaterials like Cu, Zn and salicylic acid (SA) has great potential to be use in crop plants as fertilizers.

Materials and Methods

The Study Area

The present study was conducted during both the years at the Instructional Farm, Rajasthan College of Agriculture, MPUAT, Udaipur, which is situated at 24° 35' N latitude, 72° 42' E longitude and an altitude of 579.5 m above mean sea level. It falls under agro-climatic zone IVa (Sub-Humid Southern Plain and Aravalli Hills) of Rajasthan, India. The experimental soil was clay loam in texture, having alkaline reaction (7.6), medium in available nitrogen (292.0 kg ha^{-1}) and available phosphorus (21.8 kg ha^{-1}) but high in available potassium (303.1 kg ha^{-1}) and medium in available zinc (1.89 ppm).

Study method: In order to achieve the objectives a field experiment was conducted during kharif 2020 and kharif 2021. The experiment consisted of sixteen treatment combinations comprising of two factors *viz*. 4 level of foliar application of nanofertilizer includes control (Water Spray), at knee high stage (0.1%), at 50 per cent tasseling stage (0.1 %) and at knee high stage and 50 per cent tasseling stage (0.1%) and fertility levels includes control, 100 Per cent RDF, 90 Per cent RDF and 80 Per cent RDF. The recommended dose of fertilizer was 120 kg N, 60 kg P_2O_5 and 25 kg Zn ha^{-1}. As per treatment entire quantity of phosphorus was applied at the time of sowing where as nitrogen was applied in three split application *viz.*, 1/3rd at sowing, 1/3rd at knee-high stage and remaining 1/3rd at 50 per cent tasseling stage. As per treatments Zn-chitosan NPs were prepared in Department of MBBT, Rajasthan College of Agriculture, Udaipur based on ionic gelation between chitosan and sodium tripolyphosphate. The Zn-chitosan NPs 0.1 per cent solution was sprayed at knee high stage and at 50 per cent tasseling stage as per treatments. The maize crop variety Pratap Hybrid Maize-3 was sown using 20 kg seed ha^{-1} with onset of rain on 4th July, during 2020 and 5th July 2021 in both year with a spacing of 60 × 25 cm.

Results and Discussion

Protein content: The maximum protein content (11.13 and 10.97 per cent) was observed with the foliar application of 0.1% zinc based nanofertilizer at knee high stage & 50 per cent tasseling stage and 90 per cent RDF over rest of treatments, respectively (Table 1). The significant enhancement in protein content in the seed of the maize crop may be ascribed to zinc taking part in nitrate conversion to ammonia in plants (Boorboori *et al*., 2012), zinc leads to activation, and indole acetic acid and this acid makes amino acids to protein (Moussavi and Kiani, 2012). The enhancement in protein content may also result from increased photosynthetic rates and chlorophyll content in leaves of the maize palnts and ultimately increase in growth and development of the maize crop (Shahrokhi *et al*., 2012).

Yield: The grain, stover and biological yield (51.90, 82.32 and 134.21 kg ha^{-1}) of maize significantly increased to the tune of 15.09, 19.65 and 17.84 per cent with the foliar application of 0.1% zinc based nanofertilizer at knee high stage and 50 per cent tasseling stage over control, respectively (Table 1). Application of 90 percent RDF had significant influenced on grain, stover and biological yield of maize over 80 percent RDF and control, although highest yield was recorded with 100 per cent RDF. The grain yield depends on the synthesis and accumulation of photosynthates and their distribution among various plant parts. The synthesis, assembly, and translocation of photosynthates depend upon the efficient photosynthetic structure and the extent of translocation into the sink (grains) and plant growth and development during the early crop growth

Table 1. Response of maize crop under foliar application of zinc based nanofertilizer and varying fertility levels on quality, yield and economics of maize.

Treatment	Net Return (Rs/ha^{-1})	B C ratio	Protein content (%)	Yields (q ha^{-1})		
				Grain	Stover	Biological
Foliar application						
Control	69373	2.71	09.27	45.09	68.80	113.89
At knee high stage	75064	2.86	10.92	47.79	75.43	123.21
At 50 per cent tasseling stage	72196	2.75	10.90	46.62	71.95	118.57
Both stages	82956	3.04	11.13	51.90	82.32	134.21
SEm±	1051	0.04	0.03	0.62	0.93	1.04
C.D. (P = 0.05%)	2974	0.11	0.08	1.74	2.63	2.94
Fertility levels (N, P and Zn kg ha^{-1})						
Control	49525	2.21	9.44	34.07	53.25	87.33
80 per cent RDF	76231	2.85	10.80	48.82	75.95	124.77
90 per cent RDF	86112	3.15	10.97	53.70	84.11	137.82
100 per cent RDF	87722	3.15	11.00	54.80	85.17	139.97
SEm±	1051	0.04	0.03	0.62	0.93	1.04
CD (P = 0.05%)	2974	0.11	0.08	1.74	2.63	2.94

stages. Zn, among micronutrients, is indispensable for plants as it acts as a structural, catalytic and co-catalytic component in many enzymes (Singh *et al*., 2015). Overall, it is assume that application of Zn based chitosan nanofertilizer enhanced cellular homeostasis and positively contribute source-activity and contributes to sink-strength *viz.,* yield attributes and yield (Lemoine *et al*., 2013). The study thus affirms that application of nanofertilizer both at knee high stage followed by 50 per cent tasseling stage significantly increases the activity of major enzymes of starch biosynthetic pathways and is accountable for higher starch accumulation in grains.

Net return and B: C ratio: Highest net return (Rs. 82956) and BC ratio (3.04) were recorded with foliar application of 0.1% zinc based nanofertilizer at knee high stage and 50 per cent tasseling stage over control treatments, respectively (Table 1) Similarly, application of 90 per cent RDF had significant effect on net return and BC ratio of tested maize as compared to rest of the treatments. This response might be due to a significant increase in yield with the higher supply of zinc application, Nitrogen and Phosphorous in plants and correction in hidden deficiency of zinc in maize plants or better nutrition of the maize crop (Ramanjineyulu *et al*., 2018; Kumar *et al*., 2018).

Conclusion

The present study's finding indicates that foliar application of 0.1% zinc based nanofertilizer at knee high stage and 50 per cent tasseling stage significantly increased the protein content of maize. Further, it is inferred that application of 90 per cent recommended dose of fertilizer produced statistically at net return and B C ratio and also proved economically remunerative compared to 100 per recommended dose of fertilizer.

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