Review Article

Effect of Foliar application of Nano Urea on Growth and Yield of Maize (*Zea mays* L.) - A Review

Abstract

maize requires large amounts of nutrients for appropriate growth, production, and yield, it is regarded as a crop that is nutrient-exhaustive. The nutrient requirements of the maize crop can be maintained with the use of effective nutrient management techniques. Nanotechnology is gradually making its way from the experimental to the useful realms, like the development ofslow-releasefertilizers, conditional release of pesticides and herbicides, on the basis of nanotechnology has become critically important for promoting the development of environment friendly and sustainable agriculture. Traditional fertilisation techniques may undergo a revolution thanks to the inherent features of nanoparticles, which enable improved nutrient absorption, precision distribution and greater bioavailability. The results, as evidenced by multiple studies, indicate significant improvements in growth parameters, seed production, and overall plant health.

Key words: *Nano urea, Sustainable Agriculture, Environment, Maize*

Introduction

Comment [MF1]: Paraphrasing and arranging

Maize is the third most essential cereal crop after rice and wheat, respectively. It serves as a staple food crop to people residing in rainfed areas (Samui *et al*., 2022). Maize is also known as "Queen of Cereals". Among the cereals, maize is the only cereal having the ability to attain highest yield potential (Siatwiinda*et al*., 2021). The nutritional valueof maize is high as it contains 72% starch, 10% protein, 8.5% fiber, 4.8% oil, 3.0% sugarand 1.7% ash.

Nano Urea (Liquid) includes nanoscale nitrogen particles with 10,000 times the surface area and number of particles of 1 mm Urea prills (55,000 nitrogen particles over 1 mm Urea prill). When compared to urea, nano urea has an uptake efficiency of more than 80%.Stead of dumping granular urea into the soil, nano urea in liquid form can be sprayed directly on the leaves during two important growth stages of a crop. A 45kg bag of urea can be replaced with a 500ml vial of nano urea (Naveen *et al*., 2021). Nanotechnology comes into play and nano fertilizers can go a long way in ensuring sustainable soil health and crop production (Lal,

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2008). In recent years, researchers have tended to study several modern techniques in the agricultural field, particularly the possibility of using nanotechnology to improve fertilizer use efficiency towards the design and development of so-called nano fertilizers (NF) (Rastogi*et al*. 2017). Nano fertilizers are important in modern agriculture having appropriate formulations and delivery mechanisms to ensure optimal uptake in plants (Adisa*et al*. 2019).

Plant Height

The highest plant height recorded in 100% RDN + FSNU @ 4 ml/l at knee height and tasseling (234.1 cm) (Samui *et al*., 2022). This result similar finding to Movahhedi (2015) and Mohapatro*et al*. (2021). Application of nano urea (2-4 ml of Nano urea (4 % N) in one litre of water and sprayed on crop leaves at its active growth stages) increase plant height (42 cm) in blackgram as compare to control (Islam *et al.* 2022). The maximum plant height (178.46 cm) recorded application of Nitrogen 100 kg/ha with the application of Zinc 30 kg/ha (Tharaka *et al.* 2021). the experiment on *kharif* during maize. The treatmentcombination of Nano urea (50 %) along with urea (50%) recorded significantly higherplant height (195.80 cm) this experiment was conduct on *kharif* maize (Reddy *et al*., 2022). The experiment conduct on *kharif* maize the treatment combination of zinc (15 kg/ha) along with the application of nitrogen (200 kg/ha) recorded significantly higher plant height (232.6 cm) (Iqbal *et al*. 2016). The experiment was done on *kharif* maize the treatment combination of Zinc (15 kg/ha) along with nitrogen (150 kg/ha) recordedsignificantly higher plant height (148.23 cm) (Marngar and Dawson, 2017). The higher plant height (82.23 cm) was recorded with the application of Nitrogen (Nano urea) @ 3000 ppm and Boron @ 0.3 kg//ha (Sudhir *et al*. 2023). Foliar spray of Nano Urea at knee stage and tasselling stage could be an ideal technological alternative to achieve sustainability in irrigated maize (Samui *et al*.,2021) and significantly increased the plant height. Foliar nitrogen application through Nano-N resulted in notably greater plant heights in Oats (Rajesh *et al*., 2021).

Plant dry weight

The maximum Plant Dry weight was recorded (105.58 g) under Nitrogen 100 kg/ha with the application of Zinc 30 kg/ha (Tharaka *et al*. 2021). Nitrogen increase more protein synthesis at higher nitrogen rate induced vegetative growth which resulted in increase photosynthesis surface that stimulated more leaf blade size (Jeet *et al*.2012). The maximum plant dry weight (22.41 g) was recorded with the application of Nitrogen (Nano urea) @ 3000 ppm and Boron @ 0.3 kg//ha (Sudhir *et al*. 2023).

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Yield Attributes

Numberofcob/plants

The experiment conduct during *kharif* maize recorded highest number of cobs/plant (4.19) application of Zinc 30 kg/ha along with nitrogen 120 kg/ha (Tharaka *et al.* 2021). The data recorded highest number of cobs/plant (2.47/plant) $ZnSO_4$ 30 kg/ha with the foliar application of Nano urea 3 ml/l (Aher and Umesha, 2015).

Yield

The results indicated that application of 100% RDN+FSNU @ 4 ml/L at knee height and tasselling was significantly (6.84 t/ha) this result similarly finding were observed by Rathnayaka *et al*. (2018), Alimohammadi*et al*. (2020), Bhuiya *et al*. (2020) and Mohanta *et al*. (2021). Significantly higher grain yield (8926 kg/ha) recorded in treatment Nano urea (50%) along with urea (50%) during *kharif* maize (Reddy *et al*. 2022). The experiment conduct on *kharif* maize the treatment combination of zinc (15 kg/ha) along with the application of nitrogen (200 kg/ha) recorded significantly higher grain yield (4564 kg/ha) (Iqbal *et al*. 2016). The highest seed yield per plant (14.34 g) recorded with foliar application of nitrogen (Nano urea) @ 300 ppm (Sudhir *et al.* 2023). Nano urea applied at tillering and pre-flowering stage was found superior in terms of growth, yield parameters and yield of finger millet (Samanta *et al.*,2022)

Stoveryield

The experiment was done on *kharif* maize the treatment combination of Zinc (15 kg/ha) along with nitrogen (150 kg/ha) recordedsignificantly higher stover yield (11.20 t/ha) (Marngar and Dawson, 2017). The experiment conduct during *kharif* maize recorded highest stover yield (54.8 q/ha) application of Zinc 30 kg/ha along with nitrogen 120 kg/ha (Tharaka *et al.* 2021).

Conclusion

It may be concluded that foliar application of Nano urea on Maize brought changes in growth, yield and yield attributes in vegetative and reproductive growth for higher production.

References

Comment [MF2]: Arrange sources according to the journal system
Rewrite the sources well please

Adisa, I. O., Pullagurala, V. L. R., Peralta-Videa, J. R., Dimkpa, C. O., Elmer, W. H., Gardea-Torresdey, J. L. and White, J. C. (2019). Recent advances in nano-enabled fertilizers

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and pesticides: A critical review of mechanisms of action. *Environmental Science*: Nano **6**(7):2002–2030.

Aher, A. and Umesha, C. (2015). Effect of Nano Urea and Zinc on Growth and Yield of Baby Corn (*Zea mays* L.) under Prayagraj Condition. *International Journal of Environment and Climate Change*, **13**(6): 285-291.

Alimohammadi, M., Panahpour, E. and Naseri, A. (2020). Assessing the effects of urea and nano-nitrogen chelate fertilizers on sugarcane yield and dynamic of nitrate in soil. *Soil Sci. Plant Nutr.* 66: 352-59.

Bhuiya, G. S., Shankar, T., Banerjee, M. and Malik, G. C. (2020). Growth, productivity, nutrient uptake and economics of hybrid maize (*Zea mays* L.) as influenced by precision nutrient management. *Int. J. Agric. Environ. Biotechnol*. 13: 213-18.

Iqbal, J., Khan, R., Wahid, A., Sardar, K., Khan, N., Ali, M. and Ahmad, R. (2016). Effect of nitrogen and zinc on maize (*Zea mays* L.) yield components and plant concentration. *Advances in Environmental Biology*, **10**(10): 203-209.

Islam, M. Z. A., Alim, S. M. A., Hoque, M. M., Islam, M. M. and Adhikary, S. (2022). Effect of Nano Urea Foliar Spray on Yield and Yield Attributes of Black Gram (*Vigna mungo* L.) *Journal of Agroforestry and Environment*, **16**(1):64-66.

Jeet, S., Singh, J. P. and Kumar, R. (2012). Effect of nitrogen and sulphur levels on yield, economic and quality of QPM hybrid under dryland condition of Eastern Uttar Pradesh. *Indian Journal Agriculture Science*. 4:31-38.

Lal, R. (2008). Promise and limitations of soils to minimize climate change. *Journal of Soil Water Conservation***63**(4): 113-118.

Marngar, E. and Dawson, J. (2017). Effect of biofertilizers, levels of nitrogen and zinc on growth and yield of hybrid maize (*Zea mays* L.). *International Journal of Current Microbiology and Applied Sciences*, **6**(9): 3614-3622.

Mohanta, S., Banerjee, M., Malik, G. C., Shankar, T., Maitra, S., Ismail, I. A., Dessoky, E. S., Attia, A. O. and Hossain, A. (2021). Productivity and profitability of *kharif* rice are influenced by crop establishment methods and nitrogen management in the lateritic belt of the subtropical region. Agronomy. 11: doi.org/10.3390/agronomy 11071280.

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Mohapatro, S., Shankar, T., Swami, G. V. N. S. and Sahu, S. (2020). A review on precision nutrient management in maize. *Agric. Econ*. 7: 77-82.

Movahhedi, M. (2015). Effect of different levels of nitrogen, bio-fertilizers and nano-nitrogen on some qualitative and quantitative traits in soybean (*Glycine max* L.) in Darab (Fars) region. *J. Plant Prod. Sci*. 22: 203-22.

Naveen, Suman, S., Aaxena, S. and Yadav, N. (2021). Nano urea: environment friendly and better substitute for urea, *Just Agriculture*, 35-37.

Rajesh, H., Yadahalli, G., Chittapur, B. M., Halepyati, A. S. and Hiregoudar, S. (2021). Growth, yield and economics of sweet corn (*Zea mays* L. Saccarata) as influenced by foliar sprays of nano fertilisers. *Journal of Farm Sciences*, 4:381-385.

Rastogi, A., M. Zivcak, O. Sytar, H. M., Kalaji, X. He, S. Mbarki and M. Brestic. (2017). "Impact of Metal and Metal Oxide Nanoparticles on Plant: A Critical Review". Frontiers in Chemistry 5, 78 DOI:10.3389/ fchem. 2017.00078.

Rathnayaka, R. M., Iqbal, Y. B. and Rifnas, L. M. (2018). Influence of urea and nanonitrogen fertilizers on the growth and yield of rice (*Oryza sativa* L.) cultivar 'Bg 250'. *Int. J. Res*. 5: 7-7

Reddy, B. M., Elankavi, S., Kumar, M. S., Sai, M. V. and Vani, B. D. (2022). Effects of conventional and nano fertilizers on growth and yield of maize (*Zea mays* L.). *BhartiyaKrishiAnusandhanPatrika*, 500, 1-4.

Samanta, S., Maitra, S., Shankar, T., Gaikwad, D., Sagar, L., Panda, M., Samui, S. (2022). Comparative performance of foliar application of urea and nano urea on finger millet (*Eleusine coracana* L. Gaertn). *Crop Research*, **57**(3):166-170.

Samui, S., Sagar, L., Sankar, T., Manohar, A., Adhikary, R., Maitra, S. and Praharaj, S. (2022). Growth and productivity of *rabi* maize as influenced by foliar application of urea and nano-urea. *Crop Research*, **57**(3):136-140.

Samui, S., Sagar, L., Sankar, T., Manohar, A., Adhikary, R., Maitra, S. and Praharaj, S. (2022). Growth and productivity of *rabi* maize as influenced by foliar application of urea and nano-urea. *Crop Res*. **57**(3): 136-140.

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Siatwiinda, S. M., Supit, I., van Hove, B., Yerokun, O., Ros, G. H. and de Vries, W. (2021). Climate change impacts on rainfed maize yields in Zambia under conventional and optimized crop management. *Clim. Change*. 167: 1-23.

Tharaka, M., Ravi, C. K. and Singh, V. (2021). Influence of Nitrogen and Zinc on Growth and Yield of Baby Corn (*Zea mays* L.) *International Journal of Plant & Soil Science***33**(23): 64-70.

Yadav, S. K., Khan, M. A., Prajapati, S. K., Kumar, P., Verma, S., Patel, K. and Verma, S. (2023). Foliar Application of Nano Urea and Boron on Growth, Yield Attributes and Yield in Wheat (*Triticumaestivum* L.) *Environment and Ecology***41**(2): 883—890.

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