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Effect of Nano Nitrogen in Conjunction with Urea on Growth and Yield of Mustard (*Brassica juncea* L.) in Northern Telangana Zone

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ABSTRACT: Recently, Indian Farmers' Fertilizer Cooperative Limited developed liquid Nano nitrogen to improve nutrient use efficiency and reduce cultivation costs and its substitute for urea to meet crop nitrogen requirements, particularly during critical growth stages. There is a lack of information on the location specific performance of nano-nitrogen fertilizer. Keeping in view of the facts a field experiment was planned and conducted at college farm, Agricultural College, Polasa, Jagtial, PJTSAU during rabi 2021-22 to evaluate the foliar application of nano nitrogen in combination with conventional urea on mustard in Northern Telangana zone conditions. The experiment was laid out with eight treatment combinations in randomized block design with three replications. Results showed that application of 100% recommended dose of nitrogen and 50 % RDN as basal +one Nano-N spray at before flowering at the rate of 1250 ml ha^{-1} recorded higher plant height, leaf area index, SPAD, dry matter accumulation and yield attributing characters of mustard.

Keywords: Mustard, foliar spray of nano nitrogen, plant height, SPAD and seed yield.

INTRODUCTION

Fertilizers play a critical role in increasing food production in developing countries, particularly after the introduction of high yielding and fertilizer responsive varieties. Despite of this, it is well known that yields of many crops have begun to decline as a result of imbalanced fertilization and a decrease in soil organic matter content. The use efficiencies of N, P, and K fertilizers have remained constant over the last few decades, at 30-35 per cent, 15-20 per cent, and 35-40 per cent, respectively, leaving a large percentage of applied fertilizer to accumulate in the soil or enter aquatic systems, causing eutrophication (NAAS, 2013).

Nitrogen plays very important role in various physiological process. Nitrogenous fertilizers, particularly urea accounts for more than 82 per cent of the nitrogenous fertilizers used for most of the crops. Every year, around 33 million tons of urea is applied to various crops. Urea imports have risen steadily throughout the years, reaching 9.12 M t in 2019-20 (FAI, 2019). To overcome this problem, fertilizer supply must be synchronized with crop demand, which has the potential to reduce nutrient losses while increasing nutrient efficiency. Nanotechnology has emerged as a viable tool to solve crop nutritional deficits by increasing nutrient bioavailability while minimizing environmental losses. Nanoscale materials can improve fertilizer use efficiency, whereas foliar application can effectively meet crop nutrient requirements.

Nano fertilizers have unique properties that improve plant performance in terms of ultra-high absorption, increased production, increased photosynthesis, and significant expansion of the leaf surface area. Furthermore, controlled nutrient release helps to prevent eutrophication and pollution of water resources. When traditional fertilizer is replaced with nano fertilizers, it releases nutrients into the soil steadily and in a controlled manner, preventing water pollution (Naderi and Danesh 2013; Moaveni and Kheiri 2011).

Nano nitrogen, developed by Indian Farmers Fertilizer Cooperative Limited (IFFCO), provides a novel alternative to easing farmers away from urea. Nano nitrogen contains nanoscale nitrogen particles (18-30 nm) which have more surface area (10,000 times over 1 mm urea prill) and number of particles (55,000 nitrogen particles over 1 mm urea prill). From experiments conducted by Yogendra Kumar *et al.* (2020), they conducted field trials on different crops reported that the foliar application of nano nitrogen at critical crop growth stages either alone or in combination with

conventional urea increased crop yields and nutrient use efficiency.

There is a lack of information on the location specific performance of nano-nitrogen fertilizer; hereby it is proposed to evaluate the foliar application of nano nitrogen in combination with conventional urea and to compare its effect with that of conventionally applied urea under Northern Telangana Zone conditions, so that farmers in this region can have a viable and economically viable option for maintaining sustainable crop production with improved nitrogen use efficiency in mustard crop.

Mustard (*Brassica juncea* L.) belongs to the family of *cruciferae.* The seed contains 40-45 % oil and 20-25 % protein. The seed and oil of mustard are used as a condiment in the preparation of pickles, flavoring curries and vegetables as well as for cooking and frying purposes. Its oil is used in many industrial products, cakes, as cattle feed, and manure while the green leaves are used as vegetable and green fodder (Anup Das *et al*., 2018).

Rapeseed and Mustard is one of the most important oil seed crops of the world with production of 68.87 million metric tons (Statista Research Department, 2020). It is the second most important edible oilseed crop after groundnut in India (Mishra *et al*., 2019). In India it is cultivated in an area of 9.38 million hectares with an average production of 9.12 million tons with productivity of 1190 kg ha^{-1}. As a *rabi* crop, mustard is grown on 2498.85 ha mostly in Northern Telangana Zone's Jagtial, Nizamabad, Nirmal, and Kamareddy districts. (Season and Crop Coverage Report Yasangi-2020-21). Keeping in view of the facts, an investigation on Effect of nano nitrogen in conjunction with urea on mustard (*Brassica juncea* L.) growth and yield In Northern Telangana Zone was undertaken during *rabi,* 2021-22.

METHODOLOGY

The present investigation was carried out at College Farm, Agricultural College, Jagtial, Professor Jayashankar Telangana State Agricultural University during *rabi* 2021-22 with an objective to evaluate the effect of nano nitrogen in conjunction with urea on mustard growth and yield under Northern Telangana Zone conditions. The experiment was laid out in randomized bock design with three replications. The experiment consisted of eight treatments *viz;* T_1: Control (No Nitrogen) T_2: 100% RDN T_3: 50% RDN as basal +1 Nano-N spray (before flowering) @1250 ml ha^{-1} T_4: 50% RDN as basal + 1 Nano-N spray(before flowering) @725 ml ha^{-1} T_5: 50% RDN as basal + 2 Nano-N sprays (branching & before flowering) @ 725 ml ha^{-1} in two equal splits, T_6: 50% RDN + 1 Urea spray (before flowering) @ 2% 500 L ha^{-1} T_7: 3 Nano-N sprays (vegetative, branching & before flowing) @ each time 725 ml ha^{-1} T_8: 3 urea sprays (vegetative, branching & before flowing) @ 2% each time 500 L ha^{-1}.

The soil of the experiment field was sandy clay loam in texture. The variety under study was NRCHB-101 at a seed rate of around 5 kg ha^{-1} with spacing of 45 × 15 cm. The recommended dose of fertilizer for the mustard *i.e.,* 60:40:40 Kg ha^{-1}, urea (46% N), SSP (16 % P_2O_5), and MOP (60% K_2O) were used as N, P & K fertilizers, respectively. Phosphorus, potassium, and half of the nitrogen dose were applied at the time of sowing of crop, with the remaining half dose applied during the flowering stage of mustard and the spray solution of nano nitrogen and urea were applied through foliar spray as per the treatment requirement and combinations. The data obtained analysed statistically by Analysis of Variance (Panse and Sukhatme 1967) utilizing Randomized Block Design. Statistical difference (CD) tested by applying F test at 0.05 level of probability.

RESULTS AND DISCUSSION

Effect of nano nitrogen and urea on crop growth parameters. The plant height, leaf area index, SPAD and dry matter of mustard at harvest as influenced by urea and nano nitrogen foliar application was presented in Table 1. The maximum plant height (168 cm) was recorded by application of 100% RDN which was statistically at par with 50% RDN as basal +1 Nano-N spray @1250 ml ha^{-1}, 50% RDN as basal + 1 Nano-N spray @ 725 ml ha^{-1}, 50% RDN as basal + 2 Nano-N sprays @ 725 ml ha^{-1}, 50% RDN + 1 Urea spray @ 2% 500 L ha^{-1} and lowest were recorded in control(136 cm). Increase in plant height with application of 50% RDN as basal + 1 Nano-N spray @1250 ml ha^{-1}may be because of large dose of nano-nitrogen fertilizer boosts the synthesis of auxins, which promotes cell division and elongation across the entire vegetative plant. This directly affects the plant's height and other growth-attributing traits. The results are in accordance with Al-Gym and Al-Asady (2020); Singh and Kumar (2017).

Leaf area index at harvest was highest in 100% RDN (1.25) which was statistically at par with 50% RDN as basal +1 Nano-N spray @1250 ml ha^{-1} (1.16). However, 50 % RDN basal + nano and urea sprays were statistically significant over control. Application of 100% RDN recorded highest SPAD values compared to other nano and urea foliar application treatments and lowest recorded in control.

The dry matter increased with crop growth stage progression, reaching a peak at harvest. Different nitrogen levels and foliar sprays had a significant impact on plant dry matter accumulation. Highest dry matter accumulation was found in 100% recommended dose of nitrogen (4060 kg/ha) and among the nano nitrogen treatments application of 50% recommended dose of nitrogen + one foliar spray before flowering at the rate of @1250 ml ha^{-1} recorded highest dry matter (3542 kg/ha) compared to other treatments. However,

significantly lowest plant height, leaf area index, SPAD value and dry matter were recorded with control.

With the advancement of crop growth, it was observed that crop growth parameters such as plant height, leaf area index, and SPAD values increased consistently; however, at 15 DAS, they were not statistically significant. Among different treatments, crop growth parameters were highest when the recommended nitrogen dose was used in full. One application of nano nitrogen @ 1250ml/ha at the pre-flowering stage of 50 percent RDN as basal and foliar sprays produced higher crop growth parameters than nano nitrogen and urea applications at the rate of 725 ml/ha and 2 percent urea applications. Crop growth parameters could not be increased by additional foliar applications of nano nitrogen and urea solution with no basal nitrogen. However, recorded crop growth parameters are higher as compared to control. The two primary physiological processes responsible for growth are cell division and cell expansion. Nitrogen is an absolute necessity for these two. Nitrogen supplementation via soil application and foliar application most likely resulted in increased crop growth characters. Similar results have been also reported by Sai Kumar *et al.* (2022) found similar results in rice and Sumanta *et al.* (2022) in rabi maize. Raghuvanshi *et al.* (2018) also recorded that application of 120 kg ha^{-1} of nitrogen as basal and topdressing in two equal splits resulted in significantly higher crop growth parameters in mustard.

Effect of nano nitrogen and urea on yield attributes and yield

Yield attributing characteristics. Data pertaining to yield attributes as influenced by nitrogen management practices were presented in Table 2. Among all the treatments highest number of siliquae $plant^{-1}$ (143), number of filled seeds $siliqua^{-1}$ (15) and test weight (5.20 g) was recorded in treatment (T_2) with 100% RDN which was found to be significantly on par with the 50% RDN as basal +1 Nano-N spray @1250 ml ha^{-1} and lowest number of siliquae $plant^{-1}$ (79.9), number of filled seeds siliqua-1 (7.30) and test weight (4.69g)was recorded with control (T_1).

Table 1: Effect of nano nitrogen in conjunction with urea on mustard growth at harvest.

Treatment	Plant height (cm)	Leaf area index	SPAD reading	Dry matter (kg/ha)
T_1- Control (No Nitrogen)	136	0.83	28.1	2359
T_2-100% RDN	168	1.25	35.6	4060
T_3-50% RDN as basal +1 Nano-N spray @1250 ml ha^{-1}	162	1.16	35.4	3542
T_4-50% RDN as basal + 1 Nano-N spray @ 725 ml ha^{-1}	156	1.04	35.4	3418
T_5-50% RDN as basal + 2 Nano-N sprays @ 725 ml ha^{-1}	161	1.06	35.5	3474
T_6- 50% RDN + 1 Urea spray @ 2% (500 L ha^{-1})	155	1.02	35.3	3388
T_7- 3 Nano-N sprays @ 725 ml ha^{-1}	148	0.98	34.2	2811
T_8- 3 urea sprays @ 2% (500 L ha^{-1})	142	0.96	32.8	2772
SE (m)	4.48	0.05	2.20	124.5
CD @5%	13.6	0.17	6.65	376.8
CV (%)	5.05	9.41	11.25	6.68

Table 2: Effect of nano nitrogen in conjunction with urea on yield attributes.

Treatment	No. of siliqua/plant	No. of seeds/siliqua	Test weight (g)
T_1- Control (No Nitrogen)	79.9	7.30	4.69
T_2-100% RDN	143	15.0	5.20
T_3-50% RDN as basal +1 Nano-N spray @1250 ml ha^{-1}	130	14.0	4.94
T_4-50% RDN as basal + 1 Nano-N spray @ 725 ml ha^{-1}	117	13.6	4.77
T_5-50% RDN as basal + 2 Nano-N sprays @ 725 ml ha^{-1}	125	14.0	4.76
T_6- 50% RDN + 1 Urea spray @ 2% (500 L ha^{-1})	113	12.4	4.74
T_7- 3 Nano-N sprays @ 725 ml ha^{-1}	106	13.0	4.98
T_8- 3 urea sprays @ 2% (500 L ha^{-1})	104	12.3	4.92
SE (m)	5.84	0.63	0.13
CD @5%	17.9	1.92	NS
CV (%)	8.82	8.55	4.48

The test weights were found to be non-significant in all the nitrogen application levels. The increase in yield attributes was owing to increased availability of nutrients and adequate nitrogen supply enabled improved crop growth and development, increased nutritional content, and resulted in a considerable improvement in yield characteristics results are in accordance with Raghuvanshi *et al.* (2018).

Yield. The seed yield (Kg ha^{-1}), stover yield (Kg ha^{-1}) and harvest index as influenced by foliar application of urea and nano urea was presented in Fig. 1. The maximum seed yield ((1260 kg ha^{-1}), stover yield (2800 Kg ha^{-1}) and harvest index (31.0) were recorded by 100 % recommended dose of nitrogen application through urea. Among nano and urea sprays significantly higher seed, stover yield and harvest index was recorded with application of 50% RDN as basal +1 Nano-N spray @1250 ml ha$^{-1.}$ Among the nano sprays highest stover yield 2452 kg ha^{-1} was observed with 50% RDN as basal +1 Nano-N spray @1250 ml ha^{-1} this increase might be due the fact that nano fertilizers due to quick absorption by the plant and translocated at a faster rate which resulted in higher rate of photosynthesis and more dry matter accumulation. These findings agreed with reports of Tarafdar *et al.* (2014); Hafeez *et al.* (2015). However, the harvest index was found to be non-significant in all the nitrogen application levels. Yield improvement was primarily associated with the contribution of yield components attributing it. The positive influence of increased nitrogen utilization on yield attributing character is most likely the reason for the increase in mustard yield. These results are in conformity with Rajesh *et al.* (2021) in fodder oats and Velumurugan *et al.* (2021) in rice.

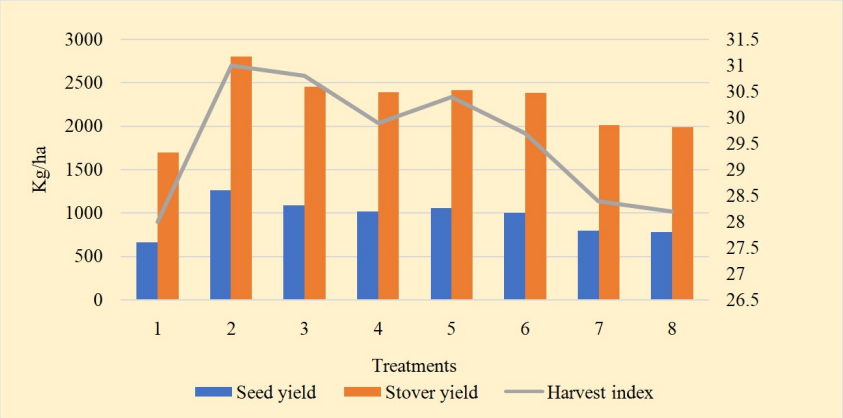

Fig. 1. Effect of nano nitrogen and urea on seed, stover yield and harvest index.

CONCLUSION

Considering the study's objectives and the results obtained after one season of experimentation, it was concluded that application of 100% recommended dose of nitrogen and 50% RDN as basal + 1 Nano-N spray at before flowering at the rate of 1250 ml ha^{-1} recorded highest crop growth parameters, yield, and yield attributing characters.

FUTURE SCOPE

There is a need to study nano nutrient delivery in plant systems, assess the impact of nano fertilizers on soil and soil beneficial microorganisms. Liquid Nano-N can improve crop yields while leaving a small environmental footprint. Extensive field trials and laboratory investigations are required to determine the efficacy, biosafety, and biotoxicity of liquid Nano nitrogen**.**

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Conflict of Interest. None.

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