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Research Article

Comparative Study of Nano Urea and Nitrogen Levels on Growth and Productivity of Indian Mustard (*Brassica juncea* L.)

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Abstract
Field experiment was conducted during Rabi, 2023-24 at Research farm, Vivekananda Global University, Jaipur to study the effect of nitrogen levels and nano urea on growth, yield and quality of mustard (*Brassica juncea* L.). The field experiment was laid out in split plot design comprising 12 treatment combinations replicated thrice. The treatments comprise of various levels where, main factor (nitrogen levels) viz., 0, 100, 75% of RDN and sub factor (nano urea) viz., 0, 10, 30 and 60 ppm @ 30 and 60 DAS. Results show that application of 75 % Recommended dose of nitrogen (RDN) along with two sprays of nano urea @ 30 ppm significantly recorded higher growth attributing characters, yield and yield attributing characters in mustard crop, nutrient content (N, P and K) in seed and straw and maximum gross returns (Rs. 124792.29 ha-1), net returns (Rs. 67149.29 ha^{-1}) and highest B: C ratio (1.16). Thus, spraying of nano urea @ 30 ppm could substitute's 25 % nitrogen need of mustard crop, which can economize the 25 % nutrient requirement without any detrimental effect on mustard production. Hence, 75 % Recommended dose of nitrogen (RDN) along with two sprays of nano urea @ 30 ppm is judicious blend to stabilized yield of mustard at maximum level without adverse effect on soil.

Keywords: Growth, Nano nitrogen, nano urea and yield

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Introduction

Indian mustard (*Brassica juncia* L.) is the most important oilseed crop of India, occupying the first rank in area and second in production next to China. In India, mustard is cultivated on an area of 8.06 million hectares with production of 11.75 million tonnes and productivity of 1458 kg/ha [1]. Rajasthan is leading state particularly Indian mustard production contributing about 45 per cent of the country it occupies 3.94 million hectares area and produces 6.26 million tonnes yield with productivity of 1587 kg/ha [2].

Over 60% of the population in developing nations depends on agriculture for their livelihood, making it the backbone of these nations [3]. In addition to creating better environments and supplying nutrients when needed, nanotechnology can deepen our knowledge of the biology of various crops, which may improve yield or nutritional content. It may also provide pathways to higher-value crops or environmental restoration. Up to 35-40% of agricultural productivity is derived from fertilizer, making it an essential component of production. Nano fertilizer may be the best option to improve nutrient use efficiency and address the enduring issues with eutrophication [4]. Fertilizer is being used to increase production by producing enough food. However, because of their poor use efficiency and lack of availability in the preferred chemical form that plants absorb, fertilizers-in particular, nitrogen (N) and phosphate (P)-are used in many times excess.

Conventional fertilizers provide nutrients in chemical forms that frequently do not allow plants full access. Furthermore, the reason for the extremely low utilization of the majority of the added micronutrients is inversion of these chemical fertilizers to sparingly soluble forms in soil. It is essential to use fertilizers frequently because of these issues. It is generally well known that an increase in soil organic matter and imbalanced fertilization have caused many crops' yields to start declining. Nano fertilizers have a special quality that improves plant performance by increasing production, increasing the surface area of the leaves, and achieving ultrahigh absorption. In addition, the deliberate release of nutrients helps keep water resources clean and free of pollution and eutrophication. It is advantageous to use nano fertilizer instead of traditional fertilizers because it releases nutrients into the soil gradually and under control upon application, preventing water pollution [5 & 6]. The use of nano fertilizers not only increases use efficiency due to ultra-high nutrient absorption and increases photosynthesis brought on by an increase in leaf surface area, but it also lessens toxicity caused by excessive fertilizer application in the soil and split fertilizer application. In order to increase nutrient use efficiency and stop nutrient ions from either fixing themselves or dispersing into the environment, it is possible to control the release of nutrients from fertilizer granules using Nano fertilizers and nano composites (Subramanian *et al*. 2008). The information on the effect of nano fertilizers on agronomic traits based on field experiments are almost lacking hence the research has been formulated to find out the effect of nano urea on mustard crop.

Materials and Methods

The experiment was carried out at Research farm, Vivekananda Global University, Jaipur, the study area is located at 74^0 89' East longitudes, at $29^0$22' North latitude and at altitude of 197 m above mean sea level. The soil was sandy loam with pH (1:2 soil water ratio)-8.11, Organic carbon-0.27 EC and dS/m-0.25. The climate of this location is semi-arid characterized by aridity of the atmosphere and extremity of temperature during both summers (40.6º C) and winters (2.7º C). The average rainfall is 557 mm per annum, which is mostly received during July to September. There are 10 treatments combinations were laid out in Randomized Block Design and Treatments details of experiment are presented (Table 1).

Table 1 Details of treatments.

Treatments		Symbols
A. Main Plot-Nitrogen level		
0 kg/ha	:	H_0
100 % of Recommended Dose of Nitrogen (RDN)	:	H_1
75 % of Recommended Dose of Nitrogen (RDN)	:	H_2
B. Sub-Plot-Nano urea		
Control	:	N_1
Nano urea- 10 ppm (Two spray at 30 and 60 DAS)	:	N_2
Nano urea- 30 ppm (Two spray at 30 and 60 DAS)	:	N_3
Nano urea- 60 ppm (Two spray at 30 and 60 DAS)		N_4

Treatments application

Half of the recommended dose of nitrogen and full dose of phosphorus i.e., 90 kg N ha^{-1} and 45 kg P_2O_5 ha^{-1} was applied at the time of sowing by placement of 2 - 3 cm below the seed according to the main plot treatment. The side dressing of remaining half dose of N i.e., 90 kg N ha^{-1} was done after one month of sowing. The N was applied in the form of urea and P_2O_5 in the form of single super phosphate. Foliar application of nano urea was done 30 days after sowing and 60 days after sowing by using battery operated sprayer.

Nano urea

Foliar application of nano urea was done 30 days after sowing and 60 days after sowing by using battery operated sprayer.

Seed and Sowing

Seeds of mustard variety "DRMRIJ-31" were sown manually at rate of 5.0 kg ha-1 maintaining row to row distance of 30 cm and plant to plant distance of 10 cm placed at depth of 3-4 cm and sowing was done at 20^{th} October 2023.

Statistical analysis

Experimental data were analyzed statistically by applying technique of analysis of variance as applicable in split plot design. The significance of the treatment difference was tested by variance ratio test (f value), critical difference (C.D) at 5 % level of probability was worked out for comparison and statistical interpretation of significance between treatments means [7].

Results and Discussion

Effect of nitrogen levels

The number of plants per net plot counted at 30 DAS and at harvest did not differ significantly due to the various nitrogen levels during the investigation period. Plant height increased with the advancement in age of the crop and significantly higher values were observed in nitrogen level H_2 (75 % of RDN) after 60 DAS till harvest. H_2 (75 %

of RDN) this treatment was found superior over rest of the nitrogen levels (Table 2). These results were corroborated with the findings of [8] also reported that levels of nitrogen significantly affect the plant height. Periodical data pertaining to the dry matter accumulation per plant of mustard revealed that, the mean dry matter accumulation (g plant^{-1}) influenced significantly from 40 DAS till the harvest. This higher dry matter accumulation in H_2 (75 % of RDN) followed by H_1 (100 % of RDN) was observed due to mainly availability of nutrients to the crop show their performance at highest level which leads to synthesis of more source which hasted more dry matter production. These results are in agreement with those of [9]. The data pertaining to the yield attributing characters of mustard viz., number of siliquae plant^{-1}, number of seed siliquae^{-1}, length of siliquae (cm) and test weight (g) (Table 3). In respect of yield attributing characters, the crop responded in accordance with the nitrogen levels tested during the experimentation, the number of siliquae plant^{-1}, number of seed siliquae^{-1}, length of siliquae (cm) and test weight (g) influenced significantly during the study period. The treatment H_2 (75 % of RDN) recorded significantly more siliquae plant^{-1}, number of seed siliquae^{-1}, length of siliquae (cm) and test weight (g) followed by H_1 (100 % of RDN). The increase in number of siliquae plant^{-1}, number of seed siliquae^{-1}, length of siliquae (cm) and test weight (g) due to more nitrogen consumption emphasizes the existence of source limitation which results in competition within plants and different parts of each plant for receiving assimilates. This competition brings forth the flower per siliquae abscission. Therefore, there was a remarkable difference between the highest and lowest level of nitrogen consumption regarding this trait. These results confirmed the findings of earlier researchers [10]. The data in respect of the mean seed yield and straw yield (kg ha^{-1}) revealed that, different levels of nitrogen significantly influenced the mean straw yield of mustard. The treatment H_2 (75 % of RDN) recorded significantly maximum seed yield (1848.87 kg ha^{-1}) and straw yield (3220.28 kg ha^{-1}) (Table 3). These results are in conformity with [11]. Application of nitrogen enhances the cell division and multiplication which enhance cell elongation that strengthen the sink capacity which favours to acquire more photosynthesis.

Effect of nano-urea

The data pertaining to various growths attributing character viz., plant height (cm), number of branches plant^{-1}, dry matter production plant-1 (g) of mustard were influenced significantly under the different nano urea levels (Table 2). The findings indicated that, the nano urea spray significantly found to be superior in respect of almost all parameters under study. The plant population at 30 DAS and at harvest of mustard crop not significantly influenced due to the nano urea spray. This indicated that the plant population was uniform throughout its life cycle under all treatments of nanu urea levels. The treatment N_3 (spraying of nano urea @ 30 ppm) recorded significantly more plant height than the remaining treatments from 60 DAS till the harvest stage. The treatment N_3 (30 ppm) also recorded significantly higher dry matter accumulation plant^{-1} than the remaining treatments at all growth followed by N_2 and N_4. Significantly higher number of branches was observed under the treatment N_3. Nano fertilizers increase availability of nutrient to the growing plant which increase chlorophyll formation, photosynthesis rate, dry matter production and result improve overall growth of the plant. These results are in collaboration with [12]. Who reported that, as compared to conventional, commercially available nano urea were better in increasing growth and yield parameters. The availability of more sources proportionately maintains ideal source-sink relationship throughout the experimentation eventually results into better yield attributing characteristics and final yield of mustard. The values of yield attributing characters of mustard in present investigation viz., number of siliquae plant^{-1}, number of seed siliquae^{-1}, length of siliquae (cm) and test weight (g) were significantly influenced by nano urea. In respect of yield attributing characters, the crop responded in accordance with the nano urea levels tested during the experimentation, the number of siliquae plant^{-1}, number of seed siliquae^{-1}, length of siliquae (cm) and test weight (g) influenced significantly during the study period (Table 3). The treatment N_3 (30 ppm) recorded significantly more siliquae plant^{-1}, number of seed siliquae^{-1}, length of siliquae (cm) and test weight (g) followed by N_2 (10 ppm). The increase in number of siliquae plant^{-1}, number of seed siliquae^{-1}, length of siliquae (cm) and test weight (g) due to to reason that two spray of nano urea of 30ppm helped to enhanced more enzymatic activities constantly with greater nutrients availability hasten the photosynthetic activities in the plant resulting in creation of more dry matter which led to more number of siliquae per plant, number of seed siliquae^{-1}, length of siliquae (cm) and test weight. Similar results were found by [13, 14 and 15]

Two spray of nano urea @ 30 ppm (N_3) produces significantly higher seed yield (1539.31 kg ha^{-1}) which was significantly higher than the other nano urea treatments. Similarly, data pertaining to the straw yield observed that, two spray of nano urea @ 30 ppm (N_3) produced significantly higher straw yield (2709.95 kg ha^{-1}) over remaining treatments (Table 4). This can be attributed to higher photosynthetic activities in the crop provided with two sprays of nano urea @ 30 ppm (N_3) than the other treatments, which stimulated growth in both roots and shoots, which consequently induced higher biomass production that finally resulted in production of significantly higher straw yield. Similar results were also observed by [16 & 17].

Conclusions

It can be concluded that, application of 75 % Recommended dose of nitrogen (RDN) along with two sprays of nano urea @ 30 ppm significantly recorded higher growth attributing characters, yield and yield attributing characters in mustard crop, as well as registered maximum gross returns (Rs. 124792.29 ha^{-1}), net returns (Rs. 67149.29 ha^{-1}) and highest B : C ratio (1.16). Thus, spraying of nano urea @ 30 ppm could substitute's 25 % nitrogen need of mustard crop, which can economized the 25 % nutrient requirement without any detrimental effect on mustard production. Hence, 75 % Recommended dose of nitrogen (RDN) along with two sprays of nano urea @ 30 ppm is judicious blend to stabilized yield of mustard at maximum level without adverse effect on soil.

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