Effect of Nano Urea on Increasing Nitrogen use Efficiency and Productivity of Wheat under Restricted Irrigation Condition

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Abstract— *Nanotechnology has made a real revolution in the agriculture. The use of nano fertilizers has led to the increased productivity, reduced production costs in the last decade and also led to the increased production stability due to reduction of biotic and abiotic stresses. Nano fertilizer, the most important field of agriculture has drawn the attention of the soil scientists as well as the environmentalists due to its capability to increase yield, improve soil fertility, induce drought tolerance, reduce pollution and make a favourable environment for microorganisms. So considering these aspects a field experiment was conducted during rabi, 2021-22 to evaluate the "Effect of nano urea on increasing nitrogen use efficiency and productivity of wheat under restricted irrigation condition". The trial comprised of different nine treatments with three replications in Randomized Block Design. The result revealed that effect of different nano urea treatment affected significantly on yield and yield attributes of wheat. Significantly higher grain yield (44.40 q/ha), biomass yield (107.29 q/ha) effective tillers per metre square (387) and grains per spike (38) were recorded by application of Recommended N + two spray of nano urea at tillering (40-45 DAS) and jointing (60-65 DAS) (T_3), however other yield attributing characters like plant height (78.80 cm) and length of spike (7.25 cm) were recorded significantly by application of Rec. N + one spray of urea (5%) + nano urea at tillering (40-45 DAS) (T_8) while, there was no significant effect of any treatments on 1000 grain weight.*

Keywords— Wheat, Nano urea, 1000 grain weight, tillers, nitrogen use efficiency, food security.

I. INTRODUCTION

Wheat (*Triticum* spp.) belongs to poaceae family and is the second important food grain crop of India being next to rice. Among the different wheat species, common bread wheat [*Triticum aestivum* L. emend Fiori and Paol. (6n=42)], occupying more than 85 per cent of the total area under wheat cultivation. Wheat has its own outstanding importance as a human food, rich in carbohydrates and protein. About 35 per cent of the World's population directly or indirectly depends upon wheat for food and providing 20 per cent of human dietary and energy supply and serving as the main source of protein in developing nations (Braun *et al.*, 2010). In the world, wheat is grown in China, India, Thailand, Indonesia and U.S.A. with an area of 221.17 million hectares and produced 774.66 million tonnes with an average productivity of 3.5 tonnes per hectare (WAP, 2022). In India wheat is an important cereal crop covering an area of 30.46 million hectares and produced annually 10.77 million tonnes with the productivity of 3537 kg/ha during 2021-22 (WAP, 2022). Wheat is cultivated almost in all the states of India but extensive cultivation is confined to Uttar Pradesh, Punjab, Haryana, Madhya Pradesh, Rajasthan and Gujarat.

In Gujarat, wheat is an important *rabi* crop and is grown in Ahmedabad, Junagadh, Sabarkantha, Rajkot, Banaskantha, Kheda and Mehsana districts of the state and produced 4.01 million tonnes from 12.53 lakh hectares area with productivity of 3205 kg/ha (DOA, 2021-22). But actual yield potential of wheat in Gujarat is 6617 kg/ha. As compared to 2012- 13, the area,

production and productivity of wheat in Gujarat increased to the tune of 2.22, 7.12 and 4.64 per cent, respectively. Major constraints of lower productivity of wheat are the deteriorating effect of unjudicious use of fertilizer on soil health poor quality and facilities of irrigation, lack of adoption of agronomic techniques and light textured soil etc. Nanotechnology has made a real revolution in the agriculture. The use of nano-fertilizers has led to the increased productivity, reduced production costs in the last decade and also led to the increased production stability due to reduction of biotic and abiotic stresses. More solubility than the other similar non-nano-fertilizers is the important property of these fertilizers. Numerous reports have suggested that the application of nano particles increases the plant resistance against the drought stress by activating the antioxidant enzymes, facilitating the uptake process in the plants and enhancing their growth. (Ahmadian *et al.*, 2021).

Nano fertilizer, the most important field of agriculture has drawn the attention of the soil scientists as well as the environmentalists due to its capability to increase yield, improve soil fertility, reduce pollution and make a favourable environment for microorganisms. Nano fertilizers play role in boosting nutrients uptake and nutrients use efficiency, reducing losses through leaching and gaseous emissions along with reducing the risk of nutrient toxicity for ensuring food security achieved through higher productivity and economic turn outs by practicing the sustainable farming practices (Ahmadian *et al.*, 2021). Nano Urea (Liquid) is a source of nitrogen. It emerged as a novel fertilizer for targeted and precise application of nitrogen. It can easily transported. It is environment friendly and its production also doesn't pollute or harm environment in any way.

Hence, keeping the above facts in view, a field investigation entitled, Effect of nano urea on increasing nitrogen use efficiency and productivity of wheat under restricted irrigation condition

II. MATERIALS AND METHODS

A field experiment was conducted during the *Rabi,* 2021-22. The experimental soil was sandy loam with pH-7.47, electrical conductivity (EC) 0.19 ds/m, organic carbon 0.23 % with available N (192.85 kg/ha), P_2O_5 (78.68 Kg/ha) and K_2O (316.22 kg/ha). The experiment was laid out in Randomized Block Design with 9 treatments in 3 replications. The treatment consists different levels of urea and nano urea, *i.e.* T_1: One spray nano urea at tillering (40-45 DAS) T_2: Two spray nano urea at tillering (40-45) and jointing (60-65 DAS) T_3: Recommended N (1/3rd basal, 2/3rd CRI - Rec. N) T_4: Rec. N + one spray of nano urea at tillering T_5: Rec. N + two spray of nano urea at tillering and jointing T_6: Rec. N + one spray of urea (5%) at tillering T_7: Rec. N + two spray of urea (5%) at tillering and jointing T_8: Rec. N +one spray of urea (5%) + nano urea at tillering T_9: Absolute control (No nitrogen). Quantity of nano urea will be 4 ml/litre of water. Quantity of spray solution will be 400 litre of water/ha and urea spray according to treatment and percentage of spray. All other cultivation practices were adopted as per recommendations. There was no rainfall during the crop season. Wheat variety GW 451 sown at 20.0 cm spacing between two row @ 100 kg/ha seed rate and crop fertilized according to treatment, however recommended dose of fertilizer is 90-60-40 kg/ha N-P_2O_5-K_2O, respectively. Sowing was done on 18th November, 2021 and crop harvested on 16th March, 2022. Only three irrigation applied at CRI, Tillering and flowering stage under restricted irrigation condition. The values off "F" was worked out and compared with the values of table F at 5 per cent level of significance. The value of S.Em.±, C.D. and C.V. per cent were also calculated (Cochran and cox, 1967).

III. RESULTS AND DISCUSSION

3.1 Initial plant stand/m^2:

Initial pant stand per metre square was not affected significantly by different nano urea treatments (Table 1).

TABLE 1
EFFECT OF DIFFERENT TREATMENTS ON GROWTH AND YIELD ATTRIBUTES OF WHEAT UNDER RESTRICTED IRRIGATION CONDITION

Treatments	Initial plant stand/m^2	Plant height at harvest (cm)	Effective tillers / m^2	Length of spike (cm)	No. grains / spike	1000 grain wt. (gm)
T_1: One spray nano urea at tillering (40-45 DAS)	285	65.33	313	6.20	34	47.37
T_2: Two spray nano urea at tillering (40-45) and jointing (60-65 DAS)	258	66.07	294	6.75	30	48.91
T_3: Recommended Nitrogen (1/3rd basal, 2/3rd CRI - Rec. N) (90 kg/ha)	274	77.00	353	6.63	36	48.26
T_4: Rec. N + one spray of nano urea at tillering (40-45 DAS)	256	74.67	341	7.19	33	49.46
T_5: Rec. N + two spray of nano urea at tillering(40-45 DAS) and jointing (60-65 DAS)	288	76.53	387	6.81	38	51.24
T_6: Rec. N + one spray of urea (5%) at tillering(40-45 DAS)	285	78.40	379	7.05	35	50.02
T_7: Rec. N + two spray of urea (5%) at tillering(40-45 DAS) and jointing (60-65 DAS)	320	76.13	381	7.03	35	48.16
T_8: Rec. N +one spray of urea (5%) + nano urea at tillering (40-45 DAS)	261	78.80	366	7.25	36	51.92
T_9: Absolute control (No nitrogen)	271	66.33	308	4.73	29	45.54
S.Em+	**20.27**	**1.60**	**20.33**	**0.29**	**1.40**	**1.84**
CD @ 5%	**NS**	**4.80**	**60.90**	**0.90**	**4.20**	**NS**
CV%	**12.65**	**3.79**	**10.15**	**7.63**	**7.14**	**6.50**

RDF: 90:60:40 N P_2O_5 K_2O kg/ha (under restricted irrigation condition)

3.2 Plant height (cm) at harvest:

Plant height at harvest affected significantly by different treatment. Among the treatments, Rec. N + one spray of 5% urea + nano urea at tillering (T_8) observed significantly higher plant height at harvest (78.80 cm) as compare to other treatments (Table 1). However, it was statistically at par with treatment T_3, T_4, T_5, T_6, and T_7. The lowest plant height (65.33 cm) was observed in treatment T_1 (one spray of nano urea).

3.3 Number of effective tillers per metre square (No.):

The number of effective tillers per metre square affected significantly by different nano urea treatments. Significantly higher number of effective tillers per metre square was recorded at harvest (387) in treatment T_5 (Rec. N + two spray of nano urea at tillering and jointing) as compare to other treatments (Table 1). and it was at par with treatment T_3, T_4, T_6, T_7, and T_8. The lowest number of effective tillers per metre square (294) was noted in treatment T_2 (Two spray of nano urea at tillering and jointing).

3.4 Length of spike (cm):

Different treatment has affected significantly on length of spike at harvest. Application of Rec. N +one spray of urea (5%) + nano urea at tillering (T_8) had maximum spike length (7.25 cm) which was at par with T_2 , T_3, T_4, T_5, T_6 and T_7 and lowest spike length (4.73 cm) was recorded under Absolute control T_9 (Table 1). Due to the spray of nano urea and 5% chemical urea, the plant received more nutrition for development and growth, resulting in healthier spike length growth as compared to absolute control (Table 1).

3.5 Grain per spike (No.):

At harvest, different treatment has affected significantly on grains per spike, among the different treatment application of Rec. N+ two spray of urea (5%) at tillering and jointing (T_5) had maximum number of grains per spike (38), and the lowest number of grains was recorded under the treatment control T_9 (29) (Table 1).

3.6 1000 grain weight (g):

Effect of different treatments does not exerted any significant effect on 1000 grain weight of wheat, however numerically higher value of 1000 grain weight (51.92 g) was observed in treatment T_8 (Rec. N +one spray of urea (5%) + nano urea at tillering (40-45 DAS). The lowest 1000 grain weight (45.54 g) was recorded under treatment T_9 (Table 1).

3.7 Grain yield (q ha^{-1}):

The result revealed that effect of different treatments was significantly affected on grain yield of wheat. Application of Rec. N + two spray of nano urea at tillering (40-45 DAS) and jointing (60-65 DAS) (T_5) produced significantly higher grain yield (44.40 q ha^{-1}) however it was at par with T_3, T_4, T_6, T_7 and T_8 further the lowest grain yield was recorded (14.56 q ha^{-1}) under treatment T_9 (Absolute control) (Table 2). This may be due to the provision of N through nano urea spray at later growth stages which might have enhanced accumulation of assimilates in the grains and thus resulting in heavier grains of wheat. Such type of result were also found by Ojha *et al.* (2023), Patidar *et al.* (2022), Rawate *et al.* (2022), Khaled *et al.* (2021) and Baloch *et al*. (2019) Rahman *et al.* (2014).

TABLE 2

EFFECT OF DIFFERENT TREATMENTS ON YIELD OF WHEAT UNDER RESTRICTED IRRIGATION CONDITION

Treatments	Grain yield (q/ha)	Straw Yield (q/ha)	Biomass yield (q/ha)
T_1: One spray nano urea at tillering (40-45 DAS)	15.92	30.67	46.58
T_2: Two spray nano urea at tillering (40-45) and jointing (60-65 DAS)	14.6	30.31	47.71
T_3: Recommended Nitrogen (1/3rd basal, 2/3rd CRI - Rec. N) (90 kg/ha)	39.52	56.48	96
T_4: Rec. N + one spray of nano urea at tillering (40-45 DAS)	38.59	53.5	92.08
T_5: Rec. N + two spray of nano urea at tillering (40-45 DAS) and jointing (60-65 DAS)	44.4	62.9	107.29
T_6: Rec. N + one spray of urea (5%) at tillering (40-45 DAS)	42.46	63.13	105.58
T_7: Rec. N + two spray of urea (5%) at tillering (40-45 DAS) and jointing (60-65 DAS)	43.13	63.21	106.34
T_8: Rec. N +one spray of urea (5%) + nano urea at tillering (40-45 DAS)	42.04	63.04	105.08
T_9: Absolute control (No nitrogen)	14.56	33.15	44.92
S.Em+	**2.15**	**3.61**	**5.19**
CD @ 5%	**6.5**	**10.8**	**15.6**
CV%	**11.37**	**12.32**	**10.77**

RDF: 90:60:40 N P_2O_5 K_2O kg/ha (under restricted irrigation condition)

3.8 Straw yield (q ha^{-1}):

Effect of different treatment affected significantly on straw yield of wheat. Application of 100% RDN with two spray of nano urea (T_7) produced significantly higher straw yield (63.21 q ha^{-1}) and it was at par with T_3, T_4, T_5, T_6 and T_8 further the lowest straw yield was recorded (30.31 q ha^{-1}) under absolute control T_9 (Table 2). This may be due to the provision of N through nano urea spray at later growth stages which might have enhanced accumulation of assimilates in the grains and thus resulting in heavier grains of wheat. Such type of result were also found by Ojha *et al.* (2023), Patidar *et al.* (2022), Rawate *et al.* (2022), Khaled *et al.* (2021) and Baloch *et al.* (2019) Rahman *et al.* (2014) .

3.9 Biomass yield (q ha^{-1}):

Effect of different treatment was found significant on biomass yield of wheat. Treatment T_5 {Rec. N + two spray of nano urea at tillering (40-45 DAS) and jointing (60-65 DAS) recorded significantly higher biomass yield (107.29 q ha^{-1}) and it was at par

with treatment T_3, T_4, T_6, T_7 and T_8 further the lowest biomass yield was recorded (44.92 q ha^{-1}) under treatment of absolute control (T_9) (Table 2). Its might be due to by increasing nitrogen level with foliar application of nano urea and urea on wheat crop increased photosynthetic rate and higher leaf area that increased total biomass production. The finding of Ojha *et al.* (2023), Patidar *et al.* (2022), Rawate *et al.* (2022), Khaled *et al.* (2021) and Baloch *et al*. (2019) Rahman *et al.* (2014) is in similar pattern of the present study.

IV. CONCLUSION

Based on the above findings it is concluded that the application of Recommended dose of Nitrogen (90 kg/ha) along with two spray of nano urea at tillering (40-45 DAS) and jointing (60-65 DAS) with common application of phosphorous (60 kg/ha) and potash (30 kg/ha) performs positively and improves the growth parameters yield and yield attributes of Wheat. Since the results are based on a single season, further trails could be needed for additional confirmation.

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