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Studies on effect of foliar application of nano N fertilizer on growth and yield of sorghum (*Sorghum bicolor* L)

PM Chavan, YM Waghmare, SD Maindale and LR Shinde

Abstract
A field experiment was conducted at Farm of Agronomy section, College of Agriculture, Latur (Maharashtra) during *kharif* season of 2021 to study the "Effect of foliar application of nano N fertilizer on growth and yield of sorghum *(Sorghum bicolor* L)". The experiment was laid out in Randomized Block Design with nine treatments and was replicated thrice *viz*., T_1 - Control, T_2 - 75% RDN with commercial urea in 2 equal splits - At sowing & 30 DAS, T_3 - Foliar spray of 75% RDN with nano urea in 2 equal splits - 20 & 40 DAS, T_4 - Foliar spray of 75% RDN with nano urea in 3 equal splits - 15, 30 & 45 DAS, T_5 - 100% RDN with commercial urea in 2 equal splits - At sowing & 30 DAS, T_6 - Foliar spray of 100% RDN with nano urea in 2 equal splits - 20 & 40 DAS, T_7 - Foliar spray of 100% RDN with nano urea in 3 equal splits - 15, 30 & 45 DAS, T_8 - Foliar spray of 125% RDN with nano urea in 2 equal splits - 20 & 40 DAS, T_9 - Foliar spray of 125% RDN with nano urea in 3 equal splits - 15, 30 & 45 DAS. The results of the study revealed that higher growth attributes, yield attributes, grain yield (2730 kg ha^{-1}) and stalk yield (6152 kg ha^{-1}) was found in the treatment of 100% RDN with commercial urea in 2 equal splits - At sowing & 30 DAS (T_5). It was followed by foliar spray of 125% RDN with nano urea in 3 equal splits - 15, 30 & 45 DAS (T_9), foliar spray of 125% RDN with nano urea in 2 equal splits - 20 & 40 DAS (T_8) and foliar spray of 100% RDN with nano urea in 3 equal splits - 15, 30 & 45 DAS (T_7) and also found significantly superior over rest of the treatments.

Keywords: Sorghum, RDF, commercial urea, nano urea, foliar application, fertilizers

Introduction
India is the second largest country in the world by population, which is increasing day by day. However, the rate of increase in food grain production is not matching to meet the requirement of food. In India, most of the available land had brought under cultivation and there is little scope to get additional land for cultivation. The present agricultural production can be increased by adopting improved agricultural practices. Grain sorghum (*Sorghum bicolor* L.) is a major dry land crop and one of the most important dietary sources of calories for the world's population and it is the fifth most important cereal grain on the basis of world production after wheat, maize, rice and barley. India is major sorghum growing country in the world. Sorghum stands third in respect of area and production among the cereals. Its importance is ever increasing as a major source of staple food for human. It serves as an important source of cattle feed, fodder and also raw material for industries. Sorghum is a genus of about 25 species of flowering plants in the grass family *Ponceau*. Some of these species are grown as cereals for human consumption and some in pastures for animals. One species, (*Sorghum bicolour* L.), was originally domesticated in Africa and has since spread throughout the globe. Seventeen of the 25 species are native to Australia, with the range of some extending to Africa, Asia, Mesoamerica and certain islands in the Indian and Pacific Oceans. One species is grown for grain, while many others are used as fodder plants, either cultivated in warm climates worldwide or naturalized in pasture lands. Sorghum is in the subfamily *Panicoideae* and the tribe *Andropogon*.
Low soil fertility, particularly N and P deficiencies are among the major biophysical constraints affecting agriculture. According to Sanchez *et al*. (1997) [10], soil fertility depletion in smallholder farmers' holdings is the fundamental biophysical root cause of declining per capita food production. Black (1957) [3] reported that plant growth is affected more due to deficiency of nitrogen than that of any other nutrient. Nitrogen (N) is commonly the most limiting nutrient factor for crop production in the majority of the world's agricultural areas and therefore adoption of good N management strategies often results in large economic benefits to

farmers. Fertilizer N has contributed more than any other fertilizer towards increasing yield of grain crops, including sorghum. Consequently, N has become the foremost input in relation to cost and energy requirement in advanced agricultural production systems (Yousf 1993) [16]. The conventional nitrogenous fertilizer industries generally produce synthetic ammonia, nitric acid, ammonium nitrate, urea and urea-ammonium nitrate (UAN). These fertilizers may also contain sulphur, chlorine, potassium, calcium, carbon besides the major nutrient 'Nitrogen'. However, the percentage of nitrogen taken up by the plants is far less than the quantity of fertilizer applied. Thereby the farmers are forced to apply more fertilizers to satisfy the plant's needs. More than 70 percent of the conventional urea applied in the soil remains unabsorbed by plant and is wasted. It makes the soil acidic, and the run-off ends up polluting water bodies. The present drawbacks forced the agricultural scientist to develop new fertilizer formulation with higher efficiency and having lesser soil, water and air pollution. Nano urea is like taking an intravenous injection rather than popping a capsule. The ultra-small particles are better absorbed directly from the leaf than through the soil. Nano fertilizers enhance growth parameters (plant height, leaf area, number of leaves per plant), dry matter production, chlorophyll production, rate of the photosynthesis which result more production and translocation of photosynthesis to different parts of the plant compare with traditional fertilizers (Ali and Al-Juthery 2017; Singh *et al.* 2017) [2, 11]. Foliar application is the technique of feeding plants by spraying liquid fertilizers or other chemical or natural product directly to the leaves of macro and micronutrients are more effective in term of getting maximum yield and reduce losses (Rahman *et al*. 2014) [9]. Keeping these facts in view the present field experiment entitled "Studies on effect of foliar application of nano N fertilizer on growth and yield of sorghum (*Sorghum bicolour* L)." was planned.

Material and Methods

A field experiment was carried out during *kharif* season of 2021 at Experimental Farm of Agronomy Section, College of Agriculture, Latur to study the effect of foliar application of nano N fertilizer on growth and yield of sorghum (*Sorghum bicolour* L). The soil of experimental plot was clayey in texture with chemical composition such as low in available nitrogen (230.00 kg ha^{-1}), very low in available phosphorous (17.50 kg ha^{-1}) and very high in available potassium (443 kg ha^{-1}). The soil was slightly alkaline in reaction having pH (7.7). A field experiment was laid out in a Randomized Block Design (RBD) with nine treatments replicated three times. The treatments were T_1 - Control, T_2 - 75% RDN with commercial urea in 2 equal splits - At sowing & 30 DAS, T_3 - Foliar spray of 75% RDN with nano urea in 2 equal splits - 20 & 40 DAS, T_4 - Foliar spray of 75% RDN with nano urea in 3 equal splits - 15, 30 & 45 DAS, T_5 - 100% RDN with commercial urea in 2 equal splits - At sowing & 30 DAS, T_6 - Foliar spray of 100% RDN with nano urea in 2 equal splits - 20 & 40 DAS, T_7 - Foliar spray of 100% RDN with nano urea in 3 equal splits - 15, 30 & 45 DAS, T_8 - Foliar spray of 125% RDN with nano urea in 2 equal splits - 20 & 40 DAS, T_9 - Foliar spray of 125% RDN with nano urea in 3 equal splits - 15, 30 & 45 DAS. The gross plot size of each experimental unit was 5.4 m x 4.5 m and net plot size was 4.5 m x 3.9 m. The recommended dose of fertilizer (RDF) was 80:40:40 NPK kg ha^{-1} given as per treatment.

Results and Discussion

Growth attributes

Growth attributing characters *viz*., plant height (cm), number of functional leaves, leaf area plant^{-1} (dm^2), dry matter plant^{-1}, number of internodes plant^{-1}, days to 50% flowering and circumference of stem were influenced significantly due to different treatments (Table 1). Soil application of 100% RDN with commercial urea in 2 equal splits - At sowing & 30 DAS (T_5) recorded significantly higher plant height, number of functional leaves, leaf area plant^{-1}, dry matter plant^{-1}, number of internodes plant^{-1} and circumference of stem at all growth stages of crop which was at par with foliar spray of 125% RDN with nano urea in 3 equal splits - 15, 30 & 45 DAS (T_9) , foliar spray of 125% RDN with nano urea in 2 equal splits - 20 & 40 DAS (T_8) and foliar spray of 100% RDN with nano urea in 3 equal splits - 15, 30 & 45 DAS (T_7) and also found significantly superior over rest of the treatments. An increase in plant height might be attributed to positive effect of RDF which supplied the required nutrients at an optimum rate at all growth stages of crop. Nitrogen is associated with protoplasm synthesis and vigorous vegetative growth. These findings are supported by Kalibhavi *et al*. (2001) [5], Miko & Manga (2008) [7], Afzal *et al*. (2012) [1], Singh & Sumeriya (2012) [14] and Singh *et al.* (2013) [13]. Increase in dry matter productions in the treatments were attributed to higher photosynthetic rate of plants, which depends upon number of functional leaves, plant height, and dry matter accumulation in plants. Similar results were also found by similar with Kalibhavi *et al*. (2001) [5], Miko & Manga (2008) [5], Singh & Sumeriya (2012) [14], Singh *et al*. (2013) [13] and Chaudhary *et al*. (2018) [4].

Yield and yield attributes

The yield attributing characters of sorghum *viz*., length of ear head (cm), breadth of ear head (cm), weight of ear head plant^{-1} (g), weight of grains plant^{-1} (g), number of grains earhead^{-1}, test weight (g), weight of stalk (kg ha^{-1}) and grain yield (kg ha^{-1}) were influenced significantly by different treatments (Table 2). Maximum length of ear head (27.10 cm), breadth of ear head (7.63 cm), weight of ear head plant^{-1} (51.73 g), weight of grains plant^{-1} (37.17 g), number of grains earhead^{-1} (1656), weight of stalk (6152 kg ha^{-1}) and grain yield (2730 kg ha^{-1}) was recorded with the soil application of 100% RDN with commercial urea in 2 equal splits - At sowing & 30 DAS (T_5) which was at par with foliar spray of 125% RDN with nano urea in 3 equal splits - 15, 30 & 45 DAS (T_9) , foliar spray of 125% RDN with nano urea in 2 equal splits - 20 & 40 DAS (T_8) and foliar spray of 100% RDN with nano urea in 3 equal splits - 15, 30 & 45 DAS (T_7) and also found significantly superior over rest of the treatments. The control treatment (T_1) observed lowest length of ear head (20.37 cm), breadth of ear head (4.83 cm), weight of ear head plant^{-1} (31.40 g), weight of grains plant^{-1} (21.13 g), number of grains earhead^{-1}(1052), weight of stalk (3756 kg ha^{-1}) and grain yield (1343 kg ha^{-1}). Increase in weight of ear head plant^{-1} (g), weight of grains plant^{-1} (g), number of grains earhead^{-1} might be due to increase in translocation of assimilates from source to sink. The similar results were also found by Singh *et al*. (2012) [12], Munagilwar *et al*. (2020) [8] and Kubsad (2018) [6].

The maximum test weight (24.17 g) was recorded due to the application of 100% RDN with commercial urea in 2 equal splits - At sowing & 30 DAS (T_5). The lowest test weight

(20.27 g) recorded with control treatment (T_1). This might be due to balanced supply of NPK nutrients which helped in increased rate of photosynthesis and also active absorption of various nutrients and translocation of photosynthates to the site of storage organ (sink). The present findings are in collaborative with Kubsad (2018) [6], Soleymani *et al*. (2011) [15] and Singh *et al*. (2012) [12].

Table 1: Effect of different treatments on growth attributing characters of sorghum.

Treatments	Plant Height (cm) at harvest	No. of functional leaves at 90 DAS	Leaf area plant^{-1} (dm^2) at 90 DAS	Dry matter plant^{-1} (g) at harvest	No. of internodes plant^{-1} at harvest	Days to 50% flowering	Circumference of stem (cm)
T_1 – Control	147.00	7.73	41.47	52.50	7.73	66.00	5.70
T_2 - 75% RDN with commercial urea in 2 equal splits - At sowing & 30 DAS.	162.40	10.67	51.27	92.80	8.87	68.67	6.60
T_3 - Foliar spray of 75% RDN with nano urea in 2 equal splits - 20 & 40 DAS.	154.37	9.00	44.40	66.27	8.27	67.33	6.00
T_4 - Foliar spray of 75% RDN with nano urea in 3 equal splits - 15, 30 & 45 DAS.	156.93	9.87	48.17	81.70	8.60	68.33	6.23
T_5 - 100% RDN with commercial urea in 2 equal splits - At sowing & 30 DAS.	191.27	13.07	62.20	142.60	10.80	71.00	8.23
T_6 - Foliar spray of 100% RDN with nano urea in 2 equal splits - 20 & 40 DAS.	167.47	11.00	54.80	100.20	9.20	69.00	7.03
T_7 - Foliar spray of 100% RDN with nano urea in 3 equal splits - 15, 30 & 45 DAS.	180.50	11.93	57.10	124.80	10.13	70.67	7.70
T_8 - Foliar spray of 125% RDN with nano urea in 2 equal splits - 20 & 40 DAS.	182.17	12.33	58.23	126.57	10.20	69.33	7.87
T_9 - Foliar spray of 125% RDN with nano urea in 3 equal splits - 15, 30 & 45 DAS.	187.00	12.60	60.77	130.03	10.53	72.33	8.00
SEm ±	7.24	0.51	2.36	5.99	0.47	3.00	0.37
CD at 5%	21.71	1.52	7.09	17.96	1.40	NS	1.12
General Mean	169.90	10.91	53.16	101.94	9.37	69.19	7.04

Table 2: Effect of different treatments on yield attributing characters and yield of sorghum

Treatments	Length of ear head (cm)	Breadth of ear head (cm)	Weight of ear head (g) plant^{-1}	Weight of grains (g) plant^{-1}	Number of grains earhead^{-1}	Test weight (g)	Grain Yield (Kg ha^{-1})	Straw Yield (Kg ha^{-1})
T_1 – Control	20.37	4.83	31.40	21.13	1052	20.27	1343	3756
T_2 - 75% RDN with commercial urea in 2 equal splits - At sowing & 30 DAS.	23.03	5.77	40.63	28.90	1363	22.40	2012	5115
T_3 - Foliar spray of 75% RDN with nano urea in 2 equal splits - 20 & 40 DAS.	21.50	5.27	36.30	25.50	1250	21.03	1854	4565
T_4 - Foliar spray of 75% RDN with nano urea in 3 equal splits - 15, 30 & 45 DAS.	22.47	5.50	38.53	27.53	1324	21.30	1937	4875
T_5 - 100% RDN with commercial urea in 2 equal splits - At sowing & 30 DAS.	27.10	7.63	51.73	37.17	1657	24.17	2730	6152
T_6 - Foliar spray of 100% RDN with nano urea in 2 equal splits - 20 & 40 DAS.	23.23	6.03	42.77	30.40	1423	22.07	2348	5413
T_7 - Foliar spray of 100% RDN with nano urea in 3 equal splits - 15, 30 & 45 DAS.	24.77	6.57	44.60	32.73	1483	23.53	2536	5649
T_8 - Foliar spray of 125% RDN with nano urea in 2 equal splits - 20 & 40 DAS.	26.03	7.07	46.87	34.77	1556	22.60	2606	5913
T_9 - Foliar spray of 125% RDN with nano urea in 3 equal splits - 15, 30 & 45 DAS.	26.47	7.40	49.53	35.63	1599	23.73	2664	6004
SEm ±	1.22	0.42	2.40	1.91	74.02	0.90	107.65	239.61
CD at 5%	3.65	1.27	7.19	5.74	221.91	NS	322.73	718.35
General Mean	23.89	6.23	42.49	30.42	1411.63	22.34	2226	5271

Conclusion

The soil application of 100% RDN with commercial urea in 2 equal splits - At sowing & 30 DAS (T_5) recorded higher growth attribute, yield attribute, stalk yield (6152 kg ha^{-1}) and grain yield (2730 kg ha^{-1}) of sorghum. It was followed by foliar spray of 125% RDN with nano urea in 3 equal splits - 15, 30 & 45 DAS (T_9), foliar spray of 125% RDN with nano urea in 2 equal splits - 20 & 40 DAS (T_8) and foliar spray of 100% RDN with nano urea in 3 equal splits - 15, 30 & 45 DAS (T_7).

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