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Effect of Foliar Application of Nano Urea on Productivity and Profitability of Fine Rice under Irrigated Subtropics of Jammu Region

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Abstract: An experiment was conducted to assess the effect of foliar application of nano urea on productivity and profitability of fine rice under irrigated subtropics of Jammu region. The experimental results revealed that 100% recommended NPKZn +2 foliar sprays of nano urea each @ 2ml/liter of water recorded significantly higher effective tillers m^{-2},number of grains $panicle^{-1}$, 1000-grain weight, grain yield and straw yield and remained statistically at par with treatment 75% recommended N+ recommended PK Zn + 2 foliar sprays of nano urea each @ 2ml/liter of water, 50% recommended N+ recommended PKZn (25:25:15 kg ha^{-1}) + 2 foliar sprays of nano urea each @2ml/liter of water), 50% recommended N+ recommended PKZn (25:25:15 kg ha^{-1}) + foliar sprays of nano urea @4 ml/liter of water) and 100% recommended NPKZn. However with regard to net returns and B: C ratio, 75% recommended N+ recommended PKZn + 2 Foliar Sprays of nano urea each @ 2ml/liter of water recorded highest net returns and B:C ratio to the tune of ₹ 79305 ha^{-1} and 1.70 respectively which was closely followed by 50% recommended N+ recommended PKZn (25:25:15 kg ha^{-1}) + 2 foliar sprays of nano urea each @ 2ml/liter of water with net returns and B:C ratio to the tune of ₹ 78,724 ha^{-1} and 1.69 respectively.

Keywords: Rice, Foliar application, Nano urea, Grain yield, Straw yield

Rice (*Oryza sativa* L.) is one of the most important cereal crops of India as well as world, grown on wide range of agro-climatic zones. It is a staple food for more than the half of the global population and its demand is expected to increase as population increases (Carriger and Vallee 2007). Globally rice is grown on an area of about 162.06 million hectares with a production of about 700 million tonnes. In India, rice crop is cultivated on an area of about 43.79 million hectares with a production of 116.42 million tonnes (Anonymous 2019a). In Union Territory of Jammu and Kashmir, rice is grown on an area of about 283.4 thousand hectares with a production of 572.5 thousand tonnes and a productivity of 2020 kg ha^{-1}. Out of 283.4 thousand hectares, rice is cultivated over an area of about 116 thousand hectares in Jammu region with production of about 168.5 thousand tonnes (Anonymous 2019b).

Rice plants require a lot of mineral nutrients, especially nitrogen, to grow, develop, and produce grains. Nitrogen is one of the important elements in plant owing to its major part in chlorophyll production, which is essential for the photosynthesis process. Nitrogen is part of different enzymatic proteins that catalyze and regulate plant development processes Sinfield et al (2010). Nano urea is liquid formulations manufactured by Nano Biotechnology Research Center in association with Indian Farmers Fertilizers Cooperative Limited. The 500 ml of nano urea is equivalent to a 45 kg urea fertilizer. It contains nano scale nitrogen particles (55,000 nano particles) with high surface area (10,000 times over 1mm Urea prilled. On foliar application, these small particles are delivered directly to the plant cell, thereby releasing nitrogen inside the cells as per the requirement in a phased manner which ensure low and target efficient release for providing the nutrients to the crop and thus increase nutrient use efficiency. Nano urea when sprayed on crop leaves triggers pathway for uptake and assimilation of nitrogen inside the plants. Thus foliar application of nano urea enhances availability of nitrogen through stomata of leaves via gaseous uptake and may activate many enzymes involved in biochemical pathways for maintenance of biological membranes. Therefore, the present study is being undertaken in view of the importance of rice crop in the region as well as need for eco-friendly foliar Nano-Urea under Jammu conditions as economically viable fertilizer-input options.

MATERIAL AND METHODS

Field experiment was conducted during *Kharif,* 2021 at Research Farm, Sher-e-Kashmir University of Agricultural Sciences Technology of Jammu, Chatha located at latitude of 32°40', longitude of 74°58' and at an altitude of 332 meters above mean sea-level in the Shiwalik foothills of North-Western Himalayas. The soil of the experimental site was

sandy clay loam in texture and slightly alkaline in reaction and low in organic carbon and available N; but medium in available P and available K. The DTPA extractable zinc was found below critical level. The experiment was laid out in Randomized block design with three replication and ten treatments (Table 1).

Agronomic practices: Seedlings of *Pusa Basmati*-1121 were transplanted at a spacing of 20 cm x 10 cm during second fortnight of July. The application of fertilizers was done in accordance with the requirement of the treatments as per technical programme of the experiment, besides 17.18 $kgha^{-1}$sulphur(S) which was applied to the treatmentsT_1, $T_5$and T_9 in addition to have uniformity in the nutrients applied to the crop. The need of application of sulphur was also aroused due to use of single super phosphate to supplement phosphorus in all the other treatments except for treatments T_1, T_5 and T_9 where diammoniumphosphate was used as a source of phosphorus which also supplies nitrogen. Therefore, in order to have uniformity of nutrients in all the treatments gypsum was applied @ $90kgha^{-1}$ to all the treatments where diammonium phosphate was used as a source of phosphorus. Foliar application of Nano urea was done as per technical programme of the experiment. First foliar spray of Nano urea was done at 30 DAT and second spray of nano urea was done at 75 DAT (one week before flowering) in case of two foliar sprays whereas single foliar spray was applied at 30 DAT only. Weed control was done by applying Butachlor @1.5 kg ha^{-1}, two days after sowing. Intercultural operations and plant protection measures were adopted as per the recommended package of practices, whenever required from sowing up to the crop harvest. The crop was irrigated as and when necessary to maintain the optimum moisture condition of the field.

Grain yield and straw yield: The rice crop harvested from the net plot area of each treatment was sundried, threshed, cleaned and grain yield was recorded at a moisture level of 12 per cent. The straw yield was worked out by subtracting the grain yield from the biological yield. The experimental results were analyzed statistically using SPSS software.

RESULTS AND DISCUSSION

Yield attributes*:* Yield attributing characters of rice were significantly influenced with the foliar application of Nano urea. The significantly higher effective tillers per metre square, number of grains per panicle, 1000-Grain weight (g) were observed with application of 100% recommended N + recommended PKZn +2 fs nano urea each @ 2 ml/litre of water which was at par with 75% recommended N + recommended PKZn +2 FS Nano urea each @ 2 ml/litre of water, 50% recommended N+ recommended PKZn +2FS nanourea each @ 2ml/liter of water, 50% recommended N+recommended PKZn +FS-Foliar spray nanourea @ 4ml/liter of water and 100 over the other treatments in comparison 100% recommended N+recommended PKZn. The highest number of panicles m^{-2} might be due to sufficient amount of nitrogen through nano urea at critical stage which would have maintained continuous supply of nitrogen, led to the meristematic activity and stimulation of cell elongation in plants which resulted in higher number of panicles m^{-2}. These were in close agreement with Jassim et al (2019). The total

Table 1. Effect of nano urea on yield attributes and yield of fine rice (Pusa Basmati-1121)

Treatments	Effective tillers/m^2	Number of grains/ panicle	1000-grain weight (g)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})
Recommended PKZN (0:25:15:20 kg/ha)	225.49	57.63	23.32	2673.62	3697.76
50% recommended N +recommended PKZn (25:25:15:20 kg/ha)	245.27	67.07	23.98	3568.01	4322.98
75% recommended N+ recommended PKZn (37.5:25:15:20 kg/ha)	255.92	67.87	24.21	3797.69	4712.40
100%r recommended NPKZn (50:25:15:20kg/ha)	256.97	69.42	24.36	4006.65	5100.12
Recommended PKZN(25:15:20kg/ha) +2FS nanourea each @ 2ml/liter of water	242.29	62.34	23.43	3567.99	4320.65
50% recommended N+ recommended PKZn (25:25:15:20 kg/ha) +2FS Nanourea each @ 2ml/liter of water	258.25	69.82	24.95	4182.12	5163.86
75%recommended N+ recommended PKZn (37.5:25:15:20 kg/ha)+2FS nano urea each @ 2ml/liter of water	258.65	69.89	24.98	4207.34	5185.66
100% recommended NPK Zn(50:25:15:20 kg/ha) +2FS nano urea each @ 2ml/liter of water	260.35	70.47	25.02	4215.09	5200.02
Recommended PKZN(25:15:20 kg/ha) +FS nanourea @ 4ml/liter of water	242.66	65.98	23.49	3588.98	4324.65
50%recommended N+ recommended PKZn (25:25:15:20 kg/ha) + FS nanourea @ 4ml/liter of water	257.73	67.98	24.57	4110.21	5151.63
CD (p=0.05)	14.07	2.50	1.02	208.44	387.00

number of grains panicle^{-1} might be due to the foliar spray of nano urea leading to more photosynthate assimilation and translocation of photosynthates from the source to the sink in addition timely supply of nitrogen stimulates the initiation of grain formation which helped to increase the number of grains panicle^{-1}. Nearly similar results were observed by Algym et al (2020). The number of filled grains panicle^{-1} be increased with the foliar application of nano urea fertilizer which might be due to the higher translocation of starch both from the active site of leaves and also straw to grain (sink) and also higher nitrogen supplied by nano urea throughout the growth stages. The increased amount of interception of photosynthetically active radiations and greater photosynthesis. Similar results were found by Gewaily et al (2019).

Grain and straw yield: The use of nano urea has a considerable impact on grain and straw yields (kg ha^{-1}) of rice (Table 2). Application of 100% recommended N + recommended PKZn+2 FS Nano Urea each @ 2 ml/litre of water (T_8) recorded significantly higher grain and straw yield which was at par with the application of 75% recommended N + recommended PKZn+2 FS nano urea each @ 2 ml/litre of water, 50% recommended N+ recommended PKZn +2FS nano urea each @ 2ml/liter of water, 50%recommended N+ recommended PKZn+FS nanourea @ 4ml/liter of water and 100%r recommended NPKZn, over the other treatments. Nano fertilizers increase rice grain yield it is mainly because of increasing growth of plant parts and metabolic process such as photosynthesis leads to higher photosynthates accumulation and translocation to the economic parts of the plant. It may be due to combined application of conventional fertilizer as basal dose and split dosage application of nano urea has been sprayed on plant surface leads to storage of remaining nitrogen in plant cells that may release slowly that can prevent the plant biotic and abiotic stress produces the high grain yield. These results were in close agreement with the findings of Kumar et al (2020). Increased straw yield with foliar spray of nano urea fertilizer might be due to nano fertilizer' quick absorption by the plant and easiness of translocation, which aided in better rates of photosynthesis and more dry matter accumulation, resulting in higher straw yield. Similar trend was observed by Khalil et al(2019).The primary reason for better performance of rice receiving two nano spray was due to nanopores and stomatal openings in plant leaves which facilitated nano material uptake and their penetration deep inside leaves leading to higher nutrient use

Table 2. Effect of Nano urea on economics of fine rice (Pusa Basmati-1121)

Cost of cultivation (Rs)	Gross returns (Rs)	Net returns (Rs)	B:C ratio
43,061	80675	37,614	0.87
44,665	106745	62,080	1.39
44,865	113783	68,918	1.54
45,065	120237	75,171	1.67
44,935	106741	61,806	1.38
46,539	125263	78,724	1.69
46,739	126004	79305	1.70
46,939	126244	79,265	1.69
44,298	107337	63,039	1.42
45,902	123224	77,322	1.68

See table 1 for details

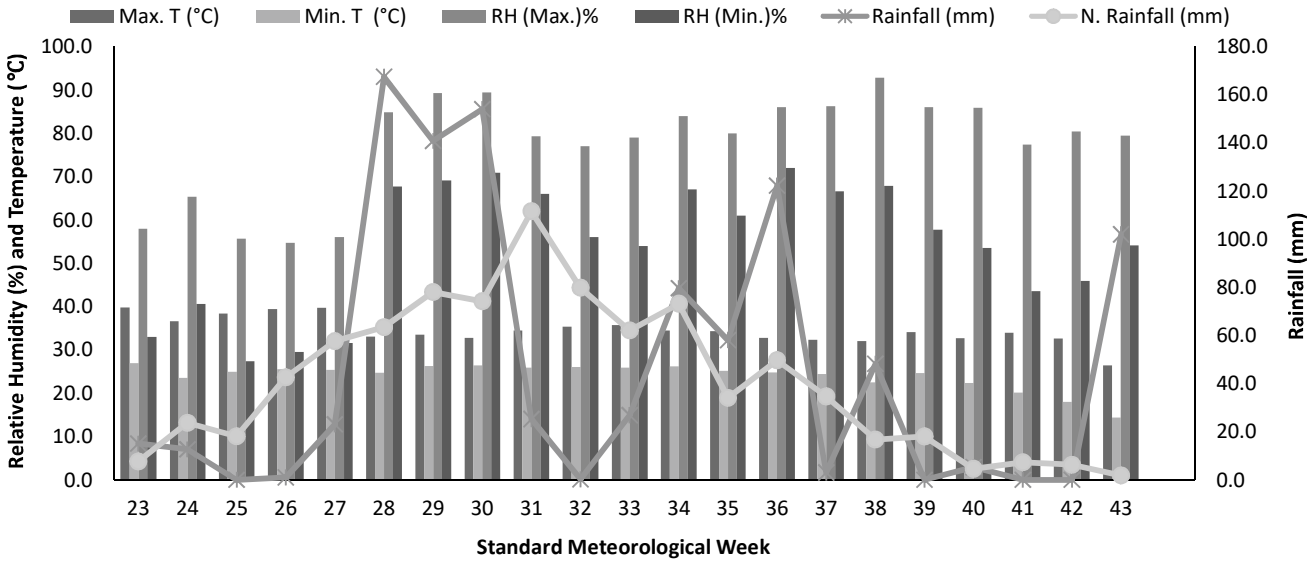

Fig. 1. Weather parameters recorded during crop growing season (*kharif* 2021)

efficiency(NUE).Precisely nano fertilizers have higher transport and delivery of nutrients through plasmodesmata, which are nano sized (50-60nm) channels between cells (Mahanta et al 2019).

Economics: The variations in economics of rice further led to marked variations in its relative economics (Table 2). The economic feasibility and usefulness of a treatment can be effectively adjusted in terms of B: C ratio and net returns. The treatment 75% recommended N+ recommended PKZn + 2 Foliar Sprays of Nano urea each @ 2ml/liter of water recorded numerically higher value for net returns to the tune of ₹ 79305 ha^{-1} followed by treatment 50% recommended N+ recommended PKZn + 2 foliar sprays of nano urea each @ 2ml/liter of water, 100% recommended NPKZn +2 urea each @ 2ml/liter of water and 100% recommended N:P:K:Zn (50:25:15:20 foliar sprays of nano $kgha^{-1}$) whereas the lowest net returns was observed in treatment (control) recommended PKZN(0:25:15:20 kg ha^{-1}) to the (₹37,614.15 ha^{-1})which was ultimately due to the significant difference in grain and straw yield of rice crop and cost of fertilizers incurred at different treatments. However, highest B:C ratio was in treatment 75% recommended N+ recommended PKZn + 2 foliar sprays of nano urea each @ 2ml/litre of water (1.70) which was closely followed by 50% recommended N+ recommended PKZn (25:25:15 kg ha^{-1}) + 2Foliar sprays of nano urea each @ 2ml/liter of water , 100% recommended NPKZn +2 foliar sprays of nano urea each @2ml/liter of water whereas the lowest B:C ratio was observed in treatment (control) Recommended PKZN(0:25:15:20 kg ha^{-1}) as 0.87 which might be due to variation in cost of cultivation and net returns. Similar trend was also observed by Kumar et al (2014).

CONCLUSIONS

Application of 100% recommended N + recommended PKZn +2 FS Nano Urea each @ 2 ml/litre of water recorded significantly higher grain and straw yield irrespective of B:C ratio. However with regard to net returns and B: C ratio, 75% recommended N+ recommended PKZn + 2Foliar Sprays of Nano urea each @ 2ml/liter of water recorded highest net returns and B:C ratio.

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