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Leaf Colour Chart (LCC) based nano urea fertilization in Maize (*Zea mays* L.)

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ABSTRACT: A field experiment was conducted during Kharif season 2021 on sandy loam soil at the experimental farm of the school of Lovely professional university, Phagwara, Punjab to find out the suitable dose of nano urea for Kharif maize. Treatment consists of twelve treatments. The soil was a sandy clay loam with a pH of 8.19, which indicates a perhaps alkaline response. It had low levels of readily accessible potassium and nitrogen and medium phosphate levels.

The experiment was conducted in RBD (Randomized block design) with twelve treatments and three replications *viz*., T_1: Absolute control, T_2: 2% urea spray, T_3: 100% RDF (125: 60: 30 kg N: P_2O_5: K_2O), T_4: Leaf colour chart threshold 3 with nano urea spray @ 2 ml/l, T_5: Leaf colour chart threshold 3 with nano urea spray @ 4 ml/l, T_6: Leaf colour chart threshold 3 with nano urea spray @ 6 ml/l, T_7: Leaf colour chart threshold 4 with nano urea spray @ 2 ml/l, T_8: Leaf colour chart threshold 4 with nano urea spray @ 4 ml/l, T_9: Leaf colour chart threshold 4 with nano urea spray @ 6 ml/l, T_{10}: Leaf colour chart threshold 5 with nano urea spray @ 2 ml/l, T_{11}: Leaf colour chart threshold 5 with nano urea spray @ 4 ml/l, T_{12}- Leaf colour chart threshold 5 with nano urea spray @ 6 ml/l.

The study's results indicated that application of T_{12}: Leaf colour chart threshold 5 with nano urea spray @ 6 ml/l recorded higher growth, yield attributing characters, quality, gross monetary, net monetary return and B: C ratio respectively.

Excessive use of conventional urea to grow food damages the environment. The damage is in the form of degraded soil quality that adversely impacts on the climate and contributes to global warming. IFFCO has developed a nanotechnology-based Nano Urea (liquid) fertilizer that offers solutions to most of the problems with conventional urea. Foliar application of Nano Urea (liquid) at critical crop growth stages of a plant effectively fulfils its nitrogen requirement and leads to higher crop productivity in comparison to conventional urea.

Keywords: *Solanum melongena* Linnaeus, *Leucinodes orbonalis* Guenee, newer insecticides, shoot damage, fruit damage, fruit yield, economics.

INTRODUCTION

Due to expanding demand in the livestock and poultry industries, a growing non-vegetarian population, and altered eating habits, maize consumption in India is predicted to increase further. It will be challenging to increase maize output in India's growing areas in the coming years in the face of rising demand in the era of climate change. This difficulty could only be met by science-based technological interventions, such as single cross hybrid technology and the use of innovative molecular tools and techniques in maize development. In Kharif 2021-22, maize production was 21.24 million tonnes in an area of 8.15 million hectares (www.angaru.ac.in). Kaviani *et al*. (2016) experimented on the effect of different concentrations of nitrogen nano fertilizers on improving the quality of ornamental plants box trees (Buxus Hyrcania Pojark.) in Iran. The treatments were 0.00, 0.60, 1.20, 1.80, 2.40, and 3.00 g pot^{-1} drench and 0.00, 1.00, 2.00, 3.00, 4.00, and 5.00 g leaf spray of biologic nitrogen nano fertilisers. Plants fed with a 3.00 g pot one drench +2.00 g spray of nano fertilizer specialized for ornamental plants had the highest node number (19.33), root length (6.83 cm), leaf number (133.30), and proliferation rate (133.53). When compared to the many others, the highest shoot number (8.63), root number (7.63), and root volume (163.00 ml).

The leaf colour chart (LCC) is an innovative and economical method for crop-need-based N management in rice, maize, and wheat. Compared to a chlorophyll metre or a SPAD metre, the LCC is a less costly, simpler to use, and more accurate visual and subjective

assessment of plant nitrogen shortage (soil plant analysis development).It controls the intensity of the leaf's colour, which is related to the leaf's nitrogen content (Rostami *et al*., 2017). LCC is a valuable method to improve N usage in rice, maize, and wheat at high yield levels, regardless of the type of N given, such as organic manure, biologically fixed N, or chemical fertilisers. Farmers may use it as an eco-friendly tool (Mahil and kumar 2019). Elanchezhian *et al.* (1997) conducted by them to know the physiological and biochemical responses of maize plants fertilized with nano-iron micronutrient. Plants fertilized with the optimal recommended dose of Fe in the nano-form registered as enhancement in morphological features, plant biomass such as root and shoot and diminution in antioxidant enzyme activities than the plants fertilized with the sub-optimal dose of Fe in the macro form. Half of the recommended dosage of Fe in the nano-form positively influenced leaf area and proline content of plants too. This indicated that there is a possibility of reducing the dose of Fe supplement for plants in the nano-form to increase the nutrient use efficiency in a significant cereal crop like Maize.

MATERIAL AND METHODS

A field trial was conducted at the school of Agriculture, Lovely Professional University, Phagwara during 2020-21 seasons. The site of the experiment was sandy clay loam with slightly alkaline Ph of 8.19. The available nitrogen was in the range of medium (314.66 kg ha^{-1}), P_2O_5 was medium (13.14 kg ha^{-1}) and K_2O was medium (163.77 kg ha^{-1}).

The experiment was laid out in a randomized block design consisting twelve treatments foliar application of nano urea *viz.*,T_1: Absolute control, T_2: 2% urea spray, T_3: 100% RDF (125: 60: 30 kg N: P_2O_5: K_2O), T_4: Leaf colour chart threshold 3 with nano urea spray @ 2 ml/l,T_5: Leaf colour chart threshold 3 with nano urea spray @ 4 ml/l, T_6: Leaf colour chart threshold 3 with nano urea spray @ 6 ml/l,T_7: Leaf colour chart threshold 4 with nano urea spray @ 2 ml/l,T_8: Leaf colour chart threshold 4 with nano urea spray @ 4 ml/l, T_9: Leaf colour chart threshold 4 with nano urea spray @ 6 ml/l, T_{10}: Leaf colour chart threshold 5 with nano urea spray @ 2 ml/l,T_{11}: Leaf colour chart threshold 5 with nano urea spray @ 4 ml/l, T_{12}: Leaf colour chart threshold 5 with nano urea spray @ 6 ml/l.

The crop variety DKC 9164 was used with a spacing of 60 cm x 20 cm. gross plot size was 5m × 4 m. Full dose of Phosphorus and potassium applied at the time of sowing as basal dose and N was applied through nano urea spray at 25 DAS. In order to represent the plot, five plants of maize from each net plot were selected randomly *viz.*,

Plant height, number of leaves $plant^{-1}$, leaf area $plant^{-1}$, leaf area index, leaf length, leaf width recorded at 30, 60, 90 DAS and at harvest and yield contributing characters *viz.*, No. of cobs $plant^{-1}$, number of grains cob^{-1}, no. of rows cob^{-1}, weight of 100 seeds (g), grain yield (kg ha^{-1}), straw yield (kg ha^{-1}) were also observed at harvest. The gross, net monetary returns and B: C ratios were calculated. The data were analysed as per the method suggested by Panase and Sukhatme (1971).

RESULTS AND DISCUSSION

A. Effect on growth attributes

The data about various crop growth attributes studied *viz.*, plant height, number of leaves $plant^{-1}$, leaf area $plant^{-1}$, leaf area index, leaf length, leaf width at harvest were recorded as influenced by various treatments are presented in Table 1.

Plant height (cm), number of leaves $plant^{-1}$, leaf area $plant^{-1}$, leaf length, leaf width were significantly increased due to foliar spray of leaf colour chart threshold 5 with nano urea spray @ 6 ml/l at statistically at par with LCC threshold 4 with nano urea spray @ 6 ml/l and at 30, 60, 90 DAS and harvest leaf colour chart threshold 3 with nano urea spray @ 6 ml/l. The influence of nitrogen on the metabolism of developing plants may explain the increase in plant height (cm), number of leaves per plant-1, leaf length, and leaf breadth seen in maize following application of nano urea. It is closely associated with cell division, growth, and elongation, as well as rapid root development and chlorophyll creation, which increases photosynthesis. Similar result was observed by Kaviani *et al.* (2016). According to Manikandan and Subramanian (2016), nano urea with zeolite fusing increased plant height significantly, especially during the crop's active development stage (60 & 90 DAS). The plant's height was used to gauge growth and fluctuated based on the type of fertiliser employed. The root length of plants fertilised with nano-urea was 9.1% greater than the root length of control plants, and nano-urea fertilisation increased root length by 23.8% more than plants fertilised with urea. According to Singh et al. (2019), nanourea 6ml/l foliar spray improved maize plant height (cm) and leaf output. This might be due to increasing dose of nano urea increase cell division, cell metabolism and growth of cells.

B. Effect on yield attributes and yield

Table 1 contains information about the number of cobs $plant^{-1}$, the number of grains cob^{-1}, the number of rows cob-1, the test weight (g), the seed yield (kg ha^{-1}), and the straw yield (kg ha^{-1}) as impacted by various treatments.

The number of cobs $plant^{-1}$, the number of grains cob^{-1}, the number of rows cob^{-1}, the test weight (g), the seed yield (kg ha^{-1}), and the straw yield (kg ha^{-1}) were all affected by the various treatments at harvest. Significantly increased levels of leaf colour chart threshold 5 with nano urea spray @ 6 ml/l (T_{12}) Number of cobs $plant^{-1}$, number of grains cob^{-1}, test weight (g), seed yield (kg ha^{-1}), and straw yield (kg ha^{-}

^{1}) were shown to be statistically equivalent to leaf colour chart thresholds 4 and 3 with nano urea spray at 6 ml/l (T9) and other treatments (T6).This might be due to higher production of photosynthates because of more number of leaves and leaf area (dm^2) $plant^{-1}$ of maize and adequate availability of moisture and nutrients throughout the growing season may be the reason behind this. Nano Urea (liquid) is a source of nitrogen which is an essential nutrient required for proper growth and development of a plant. Nitrogen is a crucial constituent of amino acids, enzymes, genetic materials (DNA-RNA), photosynthetic pigments (chlorophyll)and energy transfer compounds (ATP-ADP) in a plant. A similar result recorded by Rajonee (2016) indicated that, reported that number of cobs $plant^{-1}$, number of grains cob^{-1} and 100 seed weight were more in nano urea than commercial urea. Higher grain yield might be due to greater availability of nutrients and plant metabolism which in turn produced higher seed yield.

Table 1: Mean plant height, Number of functional leaves $plant^{-1}$, leaf length and width (cm), number of cobs $plant^{-1}$, grains $plant^{-1}$, seed and straw yield (kg ha^{-1}) GMR, NMR and B: C ratio influenced by various treatments.

Treatments	Plant height (cm)	No. of leaves $plant^{-1}$	Leaf length (cm)	Leaf width (cm)	cob weight (g)	No. of grains $plant^{-1}$	Seed yield (kg ha^{-1})	Straw yield (kg ha^{-1})	GMT	NMR	B: C ratio
T_1: Absolute control	119.07	9.48	52.37	5.95	90.47	328.33	21.72	34.26	40725	17965	1.79
T_2: 2% urea	122.87	9.61	54.60	6.24	96.93	333.00	24.70	34.70	46312	23492	2.03
T_3: 100% RDF (125: 60: 30 kg N: P_2O_5: K_2O)	148.24	10.20	60.40	6.64	102.56	376.67	25.93	38.55	48618	20790	1.75
T_4: Leaf colour chart threshold 3 with nano urea spray @ 2 ml/l	144.16	9.61	57.00	6.58	99.47	346.67	25.16	35.89	47175	20335	1.76
T_5: Leaf colour chart threshold 3 with nano urea spray @ 4 ml/l	152.23	10.48	60.74	6.71	103.47	380.67	26.22	38.80	49162	21922	1.80
T_6: Leaf colour chart threshold 3 with nano urea spray @ 6 ml/l	180.30	10.74	77.28	7.84	117.40	422.33	29.82	40.39	55912	28112	2.01
T_7: Leaf colour chart threshold 4 with nano urea spray @ 2 ml/l	146.61	9.88	59.64	6.61	100.00	353.00	25.23	35.98	47306	20466	1.76
T_8: Leaf colour chart threshold 4 with nano urea spray @ 4 ml/l	158.49	10.61	61.34	6.81	105.01	402.33	27.16	39.55	50925	23685	1.87
T_9: Leaf colour chart threshold 4 with nano urea spray @ 6 ml/l	181.59	11.48	78.00	8.04	117.77	442.00	31.77	40.50	59568	31768	2.14
T_{10}: Leaf colour chart threshold 5 with nano urea spray @ 2 ml/l	147.57	10.21	60.30	6.64	101.63	361.67	25.48	37.00	47775	20935	1.78
T_{11}: Leaf colour chart threshold 5 with nano urea spray @ 4 ml/l	170.41	10.74	70.97	7.04	109.13	408.00	28.11	39.91	52706	25466	1.93
T_{12}: Leaf colour chart threshold 5 with nano urea spray @ 6 ml/l	186.99	11.61	78.87	8.05	119.87	443.00	32.04	42.92	60075	32275	2.16
S.E. $\pm$	2.29	0.25	0.84	0.38	2.71	20.49	0.25	0.63	125.10	155.78	0.01
C.D. (0.05)	6.73	0.76	2.46	1.12	7.95	60.11	0.73	1.86	366.95	456.93	0.05
GM	154.75	10.39	64.27	6.93	105.30	383.13	26.94	38.20	51153	23934	1.90

C. Economic studies

Table 1 indicated data on GMR, NMR, and B:C ratio influenced by different nano urea treatments.

Application of LCC threshold 5 with nano urea spray @ 6 ml/l (T_{12}) recorded significantly higher value of GMR (Rs. 60075 ha^{-1}), NMR (Rs. 32275 ha^{-1}) and B: C ratio (2.16) compared to all other treatments. Higher gross, net monetary returns and B: C ratio with higher concentration of nano urea may be due to the increased total grain and straw yield. Similar findings were also reported by Mathukia (2014).

CONCLUSION

According to a year's worth of research, the following conclusions are made:

For enhancing maize development, yield qualities, and yield, foliar application of leaf colour chart threshold 5 with nano urea spray @ 6 ml/l was shown to be advantageous and productive. In order to increase yield qualities such as grain yield, gross monetary, net monetary returns, and B: C ratio of maize, foliar application of leaf colour chart threshold 5 with nano urea spray @ 6 ml/l was shown to be successful.

Compared to other foliar applications of nano urea, the foliar treatment of leaf colour chart threshold 5 with nano urea spray @ 6 ml/l was extremely productive, economical, and rewarding.

FUTURE SCOPE

Prills /granular urea are not only costly for the producer but may be harmful to humans and the environment. Furthermore, nano Urea may also be used for enhancing abiotic stress tolerance. Nano-Urea prevents environmental pollution and improves physiological traits of wheat grown under drought stress conditions. The nano urea consist of higher surface area because lesser in size of the nanoparticle and have high reactivity, solubility in water. Nano Urea are the important tools in agriculture to improve crop efficiency, yield and quality parameters with increase nutrient use efficiency, reduce wastage of fertilizers and cost of cultivation. Nano-urea is very effective for precise nutrient management in precision agriculture with matching the crop growth stage for nutrient and may provide nutrients throughout the crop growth period. Nano-Urea increase crop growth up to optimum concentrations further increase in concentration may inhibit the crop growth due to the toxicity of nutrient.

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Conflict of interest. Nil

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