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RESPONSE OF FOLIAR APPLICATION OF UREA AND NANO UREA ON YIELD AND NUTRIENT UPTAKE OF WHEAT (*TRITICUM AESTIVUM* L.)

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ABSTRACT

Wheat (*Triticum aestivum* L.) is a crucial cereal crop globally, serving as a staple food for a vast population. Its productivity faces various challenges such as nutrient imbalance in India. To address this issue, a study was conducted during the *rabi* season of 2023-2024 at the Instructional Farm, Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth, Rahuri, with a view to study the "Response of foliar application of urea and nano urea on yield and nutrient uptake of wheat under irrigated condition". The experiment was conducted in randomized block design and treatments were consisted of 12 levels of nutrient combination with 3 replications. Results revealed that treatment GRDF- 120:60:40 kg N: P_2O_5: K_2O ha^{-1} + 10 t ha^{-1} of FYM recorded the highest total nutrient uptake of nitrogen, phosphorus and potassium (103.7, 27.5 and 81.3 kg ha^{-1}, respectively) which was significantly superior over other treatments but was at par with treatments 75% RDN through soil + foliar spray of urea @ 6% (99.5, 26.0 and 78.2 kg ha^{-1}, respectively) as well as 75% RDN through soil + foliar spray of urea @ 4% (95.5, 24.9 and 75.8 kg ha^{-1}, respectively).

Key words : Yield, Nutrient uptake, Nitrogen, Phosphorus, Potassium, Nano urea and Urea.

Introduction

Wheat (*Triticum aestivum* L.) is an important cereal crop belongs to family "Poaceae" and genus "Triticum". It is the world's most important cereal crop, accounting for 30% of all cereal food produced globally. It occupies around 220.7 million hectares of area across the world with the annual production of 783.43 million tones with the productivity of 3.55 metric tons per hectare (USDA, 2023). It has been under cultivation in the Indian subcontinent from pre-historic times and is an integral part of country's economy and food security. Wheat accounts for almost 55% of all carbohydrates and 20% of all dietary calories consumed globally (Graur and Breiman, 1995). Wheat is grown in India on 31.23 million hectares and produces of 112.92 million ton with national average productivity of 3615 kg ha^{-1} during 2023-24 (IIWBR, Karnal, 2023-24).

Nitrogen is the universal deficient macro nutrient in Indian soil (Dey and Sekhon, 2016). Wheat is highly responsive to nitrogen fertilization and is sensitive to insufficient nitrogen. Macro nutrients like N, P and K in sufficient quantity throughout the growing season are essential for optimum plant growth (Haque *et al*., 2001). Nitrogen is fundamental part of protein and it is an essential part of chlorophyll molecule which helps in food production process called photosynthesis. Thus, nitrogen supply determines amount of protein, chlorophyll, protoplasm which ultimately determine leaf area and cell size. Growth of plants takes place with optimum rate with adequate supply of nitrogen and leaves remains dark green. However, under nitrogen deficiency light green leaves are observed and it results in reduced tillering, low protein synthesis and thus reduce the growth and yield of crop.

Materials and Methods

The field experiment entitled "Response of foliar application of urea and nano urea on growth, yield and

quality of wheat under irrigated condition" was conducted at Post Graduate Institute Farm, MPKV, Rahuri during *rabi* 2023-24. The experiment consists of 12 treatments *viz.*, T_1: Absolute control; T_2 : General recommended dose of fertilizers (120:60:40 N:P_2O_5:K_2O Kg ha^{-1} + 10 t ha^{-1} of FYM); T_3 : 75% RDN through soil + foliar spray of nano urea @ 0.2% ; T_4 : 75% RDN through soil + foliar spray of urea @ 2% ; T_5 ; 75% RDN through soil + foliar spray of nano urea @ 0.4% ; T_6 : 75% RDN through soil + foliar spray of urea @ 4% ; T_7 : 75% RDN through soil + foliar spray of nano urea @ 0.6% ; T_8 : 75% RDN through soil + foliar spray of urea @ 6% and T_9 : 50% RDN through soil + foliar spray of nano urea @ 0.4%; T_{10} : 50% RDN through soil + foliar spray of urea @ 4%; T_{11} : 50% RDN through soil + foliar spray of nano urea @ 0.6% ; T_{12} : 50% RDN through soil + foliar spray of urea @ 6%. Potassium and Phosphorus will be applied through MoP and single super phosphate; P_2O_5 and K_2O applied as per the recommended dose of fertilizer for wheat except T_1.

The experiment was laid out in randomized block design (RBD) with three replications. Line sowing of wheat seeds was done on flat beds at spacing of 20 cm between rows. The soil was clay loam in texture, low in available nitrogen (191.6 kg ha^{-1}), medium in available phosphorus (18.3 kg ha^{-1}) and high in potassium (436.6 kg ha^{-1}). The mean available nitrogen, phosphorus and potassium content in soil after harvest of wheat crop were 210.5, 45.4 and 418.2 kg ha^{-1} respectively. The soil was slightly alkaline in reaction (pH 8.16) with medium in organic carbon content (0.57 %). The pH is measured by Potentiometry and electrical conductivity measured by Conductometry method. The organic carbon estimated by Wet oxidation method Walkey and Black (Nelson and Sommer, 1982). The available Nitrogen, Phosphorus and potassium measured by Alkaline permanganate method (Subbiah and Asija, 1956), Olsen method 0.5 M $NaHCO_3$ (Watanabe and Olsen, 1965) and Flame photometry method (Jackson, 1973), respectively.

The recommended dose of fertilizer (120:60:40 N:P_2O_5:K_2O kg ha^{-1} + 10 t ha^{-1} of FYM) was applied 60:40 kg ha^{-1} P_2O_5:K_2O as a basal through SSP and MOP in treatment T_2 to T_{12}. N applied as per treatments. Thereafter, foliar application of urea and nano urea was done at 20 and 35 days after sowing, respectively.

Results and Discussion

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads

Table 1 : Effect of foliar application of urea and nano urea on grain, straw, biological yield and harvest index of wheat.

S. no.	Treatments	Yield (q ha^{-1})			Harvest index (%)
		Grain yield	Straw yield	Biological yield	
T_1	Absolute control	21.3	37.1	58.4	36.5
T_2	General recommended dose of fertilizers (120:60:40 N: P_2O_5:K_2O Kg ha^{-1} + 10 t ha^{-1} of FYM)	41.4	52.1	93.5	44.3
T_3	75% RDN through soil + foliar spray of nano urea @ 0.2%	34.8	43.1	77.9	44.7
T_4	75% RDN through soil + foliar spray of urea @ 2%	37.8	46.4	84.2	45.0
T_5	75% RDN through soil + foliar spray of nano urea @ 0.4%	35.8	44.2	80.0	44.7
T_6	75% RDN through soil + foliar spray of urea @ 4%	40.2	48.6	88.8	45.3
T_7	75% RDN through soil + foliar spray of nano urea @ 0.6%	38.9	47.7	86.5	44.9
T_8	75% RDN through soil + foliar spray of urea @ 6%	40.9	50.7	91.6	44.7
T_9	50% RDN through soil + foliar spray of nano urea @ 0.4%	27.7	40.1	67.8	40.9
T_{10}	50% RDN through soil + foliar spray of urea @ 4%	31.9	42.1	74.0	43.1
T_{11}	50% RDN through soil + foliar spray of nano urea @ 0.6%	29.3	41.7	71.1	41.3
T_{12}	50% RDN through soil + foliar spray of urea @ 6%	32.7	42.8	75.4	43.3
	S.E. m ±	0.8	1.2	2.2	-
	C.D. at 5%	2.3	3.6	6.4	-
	General mean	34.4	44.7	79.1	43.2

Table 2 : Effect of foliar application of urea and nano urea on nitrogen uptake by wheat.

Tr. no.	Treatments	Nitrogen uptake (kg ha^{-1})		
		Grain	Straw	Total
T_1	Absolute control	55.9	13.0	68.9
T_2	General recommended dose of fertilizers (120:60:40 N: P_2O_5:K_2O kg ha^{-1} + 10 t ha^{-1} of FYM)	79.9	23.9	103.7
T_3	75% RDN through soil + foliar spray of nano urea @ 0.2%	65.8	16.9	82.7
T_4	75% RDN through soil + foliar spray of urea @ 2%	70.3	19.9	90.2
T_5	75% RDN through soil + foliar spray of nano urea @ 0.4%	69.7	17.9	87.5
T_6	75% RDN through soil + foliar spray of urea @ 4%	74.1	21.8	95.5
T_7	75% RDN through soil + foliar spray of nano urea @ 0.6%	71.8	20.3	92.0
T_8	75% RDN through soil + foliar spray of urea @ 6%	76.8	22.7	99.5
T_9	50% RDN through soil + foliar spray of nano urea @ 0.4%	58.4	15.0	73.4
T_{10}	50% RDN through soil + foliar spray of urea @ 4%	60.8	15.9	76.7
T_{11}	50% RDN through soil + foliar spray of nano urea @ 0.6%	59.1	15.1	74.2
T_{12}	50% RDN through soil + foliar spray of urea @ 6%	62.0	16.5	78.5
	S.E. m ±	2.7	0.7	3.4
	C.D. at 5%	8.0	2.2	10.2
	General mean	67.0	18.2	85.2

Yield studies (q ha^{-1})

The data in respect of grain, straw and biological yield of wheat as influenced by different treatments during *rabi* season of 2023-2024 are presented in Table 1. The mean grain, straw and biological yield of wheat (34.4, 44.7 and 79.1 q ha^{-1}, respectively) were obtained during investigation.

The application of treatment general recommended dose of fertilizers (120:60:40 N: P_2O_5: K_2O kg ha^{-1} + 10 t ha^{-1} of FYM) produced significantly the highest grain, straw and biological yield (41.4, 52.1 and 93.5 q ha^{-1}, respectively) of wheat among all treatments. The significantly lowest grain, straw and biological yield in wheat (21.3, 37.1 and 58.4 q ha^{-1}, respectively) was obtained with the application of treatment absolute control.

This significant difference in grain, straw and biological yield of wheat may be due to involvement of sprayed nutrient i.e. nitrogen in chlorophyll synthesis, enzyme activity, stomata regulation, starch translocation and assimilation into grains. It may result in increasing number and weight of wheat grains as well as physiological performance of wheat. Rapid and efficient response is given by the nutrients applied through general recommended dose of fertilizers. There was cumulative effect in the more accumulation of photosynthates and its translocation from sink to reproductive part like grain of wheat. These results are similar with the results reported by Wagan *et al*. (2017), Vikas *et al*. (2019), Yadav *et al*. (2021), Dhaker *et al*. (2022), Rawate *et al*. (2022) and Ojha *et al*. (2023).

Nitrogen uptake (kg ha^{-1})

The data in respect of nitrogen uptake by wheat as influenced by different treatments during *rabi* season of 2023-2024 are presented in Table 2. The mean nitrogen uptake of wheat by grain and straw of wheat was 67.0 and 18.2 kg ha^{-1}, respectively.

Among the applied treatments, general recommended dose of fertilizer (120:60:40 N:P_2O_5:K_2O kg ha^{-1} + 10 t ha^{-1} of FYM) recorded significantly higher nitrogen uptake by grain (79.9 kg ha^{-1}), straw (23.9 kg ha^{-1}) and total (103.7 kg ha^{-1}) as compare to other treatments (Table 2). The significantly minimum nitrogen uptake by grain (55.9 kg ha^{-1}), straw (13.0 kg ha^{-1}) and total uptake (68.9 kg ha^{-1}) by wheat was observed in treatment absolute control.

The current experiment's results are consistent with those published by Surve and Bhosale (2015), Wagan *et al*. (2017), Vikas *et al*. (2019), Yadav *et al*. (2021), Rawate *et al*. (2022) and Ojha *et al*. (2023).

Phosphorous uptake (kg ha^{-1})

The data in respect of phosphorus uptake after harvest of wheat as influenced by different treatments during *rabi* season of 2023-2024 are presented in Table 3. The mean phosphorous uptake by grain 14.2 kg ha^{-1}, straw 7.5 kg ha^{-1} and total uptake 21.7 kg ha^{-1} by wheat were obtained during investigation.

Table 3 : Effect of foliar application of urea and nano urea on phosphorus uptake after harvest of wheat.

Tr. no.	Treatments	Phosphorus uptake (kg ha^{-1})		
		Grain	Straw	Total
T_1	Absolute control	10.3	4.8	15.0
T_2	General recommended dose of fertilizers (120:60:40 N: P_2O_5:K_2O kg ha^{-1} + 10 t ha^{-1} of FYM)	17.6	9.9	27.5
T_3	75% RDN through soil + foliar spray of nano urea @ 0.2%	14.0	7.3	21.2
T_4	75% RDN through soil + foliar spray of urea @ 2%	15.0	8.3	23.3
T_5	75% RDN through soil + foliar spray of nano urea @ 0.4%	15.0	7.8	22.8
T_6	75% RDN through soil + foliar spray of urea @ 4%	16.0	8.9	24.9
T_7	75% RDN through soil + foliar spray of nano urea @ 0.6%	15.8	8.4	24.2
T_8	75% RDN through soil + foliar spray of urea @ 6%	16.9	9.1	26.0
T_9	50% RDN through soil + foliar spray of nano urea @ 0.4%	11.9	6.0	17.9
T_{10}	50% RDN through soil + foliar spray of urea @ 4%	12.9	6.8	19.6
T_{11}	50% RDN through soil + foliar spray of nano urea @ 0.6%	12.2	6.2	18.3
T_{12}	50% RDN through soil + foliar spray of urea @ 6%	13.2	7.0	20.1
	S.E. m ±	0.6	0.4	0.1
	C.D.at 5%	1.7	1.1	2.9
	General mean	14.2	7.5	21.7

Table 4 : Effect of foliar application of urea and nano urea on potassium uptake after harvest of wheat.

Tr. no.	Treatments	Potassium uptake (kg ha^{-1})		
		Grain	Straw	Total
T_1	Absolute control	14.4	41.3	55.7
T_2	General recommended dose of fertilizers (120:60:40 N: P_2O_5:K_2O Kg ha^{-1} + 10 t ha^{-1} of FYM)	22.6	58.7	81.3
T_3	75% RDN through soil + foliar spray of nano urea @ 0.2%	17.9	49.1	67.0
T_4	75% RDN through soil + foliar spray of urea @ 2%	19.4	52.1	71.5
T_5	75% RDN through soil + foliar spray of nano urea @ 0.4%	18.4	51.3	69.6
T_6	75% RDN through soil + foliar spray of urea @ 4%	20.4	55.5	75.8
T_7	75% RDN through soil + foliar spray of nano urea @ 0.6%	19.6	52.4	72.0
T_8	75% RDN through soil + foliar spray of urea @ 6%	21.4	56.8	78.2
T_9	50% RDN through soil + foliar spray of nano urea @ 0.4%	16.1	43.3	59.4
T_{10}	50% RDN through soil + foliar spray of urea @ 4%	16.8	46.4	63.2
T_{11}	50% RDN through soil + foliar spray of nano urea @ 0.6%	16.4	44.5	60.9
T_{12}	50% RDN through soil + foliar spray of urea @ 6%	17.0	47.3	64.3
	S.E. m ±	0.8	2.1	2.9
	C.D. at 5%	2.4	6.2	8.6
	General mean	18.4	49.9	68.2

Among all the treatments, wheat crop applied with treatment general recommended dose of fertilizers (120:60:40 kg N: P_2O_5:K_2O ha^{-1} + 10 t ha^{-1} of FYM) was resulted in significantly the higher phosphorous uptake by grain (17.6 kg ha^{-1}), straw (9.9 kg ha^{-1}) and total uptake (27.5 kg ha^{-1}) by wheat. However, the treatment absolute control produced significantly lower phosphorous uptake by grain (10.3 kg ha^{-1}) straw (4.8 kg ha^{-1}) and total uptake

(15.0 kg ha^{-1}) of wheat.

These results are similar with the results reported by Vikas *et al*. (2019), Yadav *et al*. (2021), Surve and Bhosale (2015), Wagan *et al*. (2017), Rawate *et al*. (2022) and Ojha *et al.* (2023).

Potassium uptake (kg ha^{-1})

The data in respect of potassium uptake after harvest of wheat as influenced by different treatments during *rabi* season of 2023-2024 are presented in Table 4. The mean potassium uptake by grain, straw and total uptake of wheat were 18.4, 49.9 and 68.2 kg ha^{-1} respectively obtained during investigation.

The wheat crop applied with general recommended dose of fertilizers (120:60:40 kg N: P_2O_5:K_2O ha^{-1} + 10 t ha^{-1} of FYM) produced significantly maximum potassium uptake by grain (22.6 kg ha^{-1}), straw (58.7 kg ha^{-1}) and total uptake (81.3 kg ha^{-1}) of wheat as compared to rest of the nutrient management treatments. Whereas the minimum potassium uptake by wheat grain (14.4 kg ha^{-1}), straw (41.3 kg ha^{-1}) and total uptake (55.7 kg ha^{-1}) of wheat were recorded in the treatment absolute control, where no fertilizers were applied during the experimentation. These results are in collaboration with findings of Wagan *et al*. (2017), Vikas *et al*. (2019), Yadav *et al*. (2021), Dhaker *et al*. (2022), Rawate *et al.* (2022) and Ojha *et al.* (2023).

Conclusion

The application of general recommended dose of fertilizers (120:60:40 N: P_2O_5: K_2O kg ha^{-1} + 10 t ha^{-1} of FYM) to wheat found beneficial for increase in yield and nutrient uptake of wheat grown in medium deep soil. The total NPK uptake by the grain and straw of wheat crop was recorded significantly the highest in treatment of GRDF (120:60:40 kg N:P_2O_5:K_2O ha^{-1} + 10 t ha^{-1} of FYM) compared to all other treatments. However, the treatments of 75% RDN through soil and foliar spray of urea @ 4% and 6% at crown root initiation (CRI) and tillering stage were at par with treatment general recommended dose of fertilizers which showed saving of 25 % N to wheat crop.

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Conflict of interest

The authors declare there are no conflict of interest relevant to this article.

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