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Research Article

Effect of urea foliar application at tillering and booting stages on yield of wheat (*Triticum aestivum* L.) under Agro climatic condition of Tandojam

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Abstract

The experiment was conducted at the Students' Farm of Sindh Agriculture University, Tandojam, during the year 2022-23, to determine the effect of urea foliar application at the tillering and booting stages on wheat yield. Drought and water stress are common problems in Pakistan's agriculture, and these problems mainly hamper the wheat crop. Foliar application of urea is more effective and efficient than broadcasting for wheat crops, especially regarding rapid nitrogen delivery, reduced environmental losses, and improved yield and grain quality. It is particularly beneficial in regions with challenging agro-climatic conditions, where soil-applied nitrogen may be less effective. The recommended dose of fertilizer (RDF) and three different urea levels at the rate of 0.5 %, 1.5%, and 2.5% was applied. The results showed that the urea foliar application on the growth and yield of wheat crops was significant ($P<0.05$). The result revealed that RDF + foliar-applied urea at 2.5% increased the number of tillers 12.33 plant^{-1} when applied at the tillering stage, while booting stages, there was an increase in yield contributed characteristics i.e. 83.50 cm plant height, 10.69 cm spike length, 44.80 spikelet spike^{-1},46.00 grains spike^{-1}, 54.98 g seed index, 14544 kg ha^{-1} biological yield and 6171 kg ha^{-1} grain yield. Meanwhile, the RDF + foliar-applied urea at 1.5% concentration at the tillering stage affected the numbers of the tiller as compared to 2.5% concentration. while applied at booting stages which lowers the yield-related parameters The foliar urea concentration RDF + foliar-applied urea at 0.5% concentration at tillering stages decreases in tillers 9.20 plant^{-1} was recorded as compared to 1.5%, while at booting stage decreases in yield contributed parameters. The control plots, (Recommended dose of NPK fertilizers applied without application of foliar urea show the least performance. It was concluded that applying RDF + foliar-applied urea at 2.5% concentration at tillering and booting stages affects wheat crop growth and yield traits.

Keywords: Boating; Foliar; Stages; Tillering; Urea; Wheat

Introduction

Wheat (*Triticum aestivum* L.), a worldwide cultivated cereal grain belonging to the plant family Poaceous, originates in the Ethiopian highlands. Nearly half of the world's population depends on this cereal for food [1, 2]; while more than 60 percent of Pakistan's people rely entirely on wheat for their daily diet [3]. The wheat yield in Pakistan during the 2022-2023 crop year was 28.18 million tonnes, a 7.5% increase from the previous year. The area of land used to cultivate wheat in 2022-2023 was 9,043,000 hectares, which was a 0.7% increase from the prior year [4].

For plant growth and increase in crop yield, micronutrients are also important, as plants require a proper balance of all the essential nutrients for normal growth and optimum yield [5, 6]. Adequate utilization of nutrients by plants depends upon the application method of these nutrients, and as nitrogen (N) is the most needed nutrient for plant life it is essential to apply N by proper time and method of application [7]. Similarly, foliar fertilization is very useful to fulfil the plant requirement for various macro and micronutrients. Foliar fertilizers immediately deliver nutrients to the tissues and organs of the crop. This is a practice of applying liquid fertilizers to leaves. The leaves are green factories where photosynthesis produces compounds needed for growth. These are absorbed right at the site they are used to acting fast. For instance, 80 percent of the nutrients applied through conventional fertilizers may get fixed up in the soil but up to 80 percent of the foliar-added nutrients are directly absorbed. [8] reported foliar application of nutrients along with straight soil-applied NPK that maximized net returns to the growers; while [9] applied various concentrations of different organic and inorganic solutions in foliar form and reported enhanced crop growth and yield.

Foliar application of urea has been demonstrated to be an effective method of nitrogen (N) fertilization [10]. The positive effects of foliar urea application on the growth and yield of plants have been reported for a wide range of climates [11]. Also [12] reported that plant height and yield increased with increasing rates of N either applied through soil or given as foliar application. The [13] applied urea solution to wheat at 0, 2, 4, 6, 8, and 10% concentrations as foliar and grain yield was increased by 32% when 4% urea solution was applied as foliar spray; while further increase in the concentrations of urea spray was not found to be useful and economical as it declined the grain yield by 25% or even more probably due to its toxicity. Moreover [14] showed that grain N increased with increasing pre-plant N rate. The factors constraining the high wheat yield per unit area involve improper planting identity and inefficient application of inputs and nutrient application by the average wheat grower did not apply these nutrients efficiently [11] reported that pre-anthesis foliar feeding with urea resulted in higher yields as compared to with later applications, and early foliar urea feeding increased the harvest index from 42.4% to 46.9% at 32 kg N ha^{-1}.

Materials and Methods

The present study was conducted at 'student farm' SAU Tandojam during 2022-23 using three replications randomized complete block design (RCBD) having factorial arrangements in a plot size of 3m × 4m ($12m^2$). The seed of wheat variety TD-1 was sown with the help of a single-row hand drill. The experiment comprised of 4 treatments **(**T_1= Control (Recommended dose of NPK fertilizers=RDF, T_2= RDF + foliar-applied urea at 0.5%, T_3 = RDF + foliar-applied urea at 1.5%, T_4= RDF + foliar-applied urea at 2.5% concentrations. The foliar application of urea was applied at the tillering and booting stages. The data was collected and analyzed by (the analysis of Variance) ANOVA technique using Statistix8.1

computer software [15]. All the cultural practices and irrigation were applied at the proper time.

Results

Plant height (cm)

The crop growth is generally assessed on the basis of the height of the plants. The effect of urea foliar application at different growth stages of wheat was investigated and the results in regards to plant height (cm) of wheat variety TD-1 are given in (Table 1). The results indicated that the plant height was maximum (83.50 cm) when the wheat crop was given RDF + foliar applied urea at 2.5% concentration at tillering and booting stages, and the plant height decreased to 81.56 cm when the RDF + foliar applied urea at 1.5% concentration at tillering and booting stages and further decreased to 80.78 cm when the crop was given RDF + foliar applied urea at 0.5% concentration at tillering and booting stages. However, the minimum plant height of 79.61 cm was recorded in control (Recommended dose of NPK fertilizers=RDF). The LSD test suggested that differences in plant height under RDF + foliar-applied urea at 2.5% concentration at tillering and booting stages were statistically significant ($P<0.05$).

Tillers plant^{-1}

Tillering in wheat is one of the major traits to influence crop yields. The results in regards to tillers plant^{-1} of wheat as influenced by urea foliar application at different growth stages of wheat variety TD-1 are presented in (Table 1). The results indicated that the tillers plant^{-1} was maximum (12.33) when the wheat crop was given RDF + foliar-applied urea at 2.5% concentration at tillering and booting stages, and the tillers plant^{-1} decreased to 10.40 when the RDF + foliar-applied urea at 1.5% concentration at tillering and booting stages and further lower to 9.20 when the crop was given RDF + foliar-applied urea at 0.5% concentration at tillering and booting stages. However, the minimum tillers plant^{-1} of 7.37 was recorded in control (Recommended dose of NPK fertilizers=RDF). The (least significant difference) LSD test suggested that differences in tillers plant^{-1} under RDF + foliar-applied urea at 2.5% concentration at tillering and booting stages were statistically significant ($P<0.05$).

Spike length (cm)

Spike length is considered the key factor influencing the yield of wheat. The results related to spike length (cm) of wheat variety TD-1 as influenced by urea foliar application at different growth stages are given in (Table 1). The results indicated that the spike length was maximum (10.69 cm) when the wheat crop was given RDF + foliar-applied urea at 2.5% concentration at tillering and booting stages, and the spike length up to 9.32 cm when the RDF + foliar-applied urea at 1.5% concentration at tillering and booting stages and further decreased to 8.89 cm when the crop was given RDF + foliar-applied urea at 0.5% concentration at tillering and booting stages. However, the minimum spike length of 8.17 cm was recorded in control (Recommended dose of NPK fertilizers=RDF). The LSD test suggested that differences in spike length under RDF + foliar-applied urea at 2.5% concentration at tillering and booting stages were statistically significant ($P<0.05$).

Spikelet's spike^{-1}

The results related to spikelet spike^{-1} of wheat variety TD-1 as influenced by urea foliar application at different growth stages are given in (Table 1). The results indicated that the spikelet spike^{-1} was maximum (44.80) when the wheat crop was given RDF + foliar-applied urea at 2.5% concentration at tillering and booting stages, and the spikelet's spike^{-1} decreased to 42.44 when the RDF + foliar-applied urea at 1.5% concentration at tillering and booting stages and further decreased to 40.04 when the crop was given RDF + foliar-applied urea at 0.5% concentration at tillering

and booting stages. However, the minimum spikelet spike^{-1} of 38.01 was recorded in control (Recommended dose of NPK fertilizers=RDF). The LSD test suggested that differences in spikelet spike^{-1} under RDF + foliar-applied urea at 2.5% concentration at tillering and booting stages were statistically significant (P<0.05).

Grains spike^{-1}

The results related to grains spike^{-1} of wheat variety TD-1 as influenced by urea foliar application at different growth stages are given in (Table 1). The results indicated that the grains spike^{-1} was maximum (46.00) when the wheat crop was given RDF + foliar-applied urea at 2.5% concentration at tillering and booting stages, and grains spike^{-1} decreased to 42.33 when the RDF + foliar-applied urea at 1.5% concentration at tillering and booting stages and further decreased to 41.00 when the crop was given RDF + foliar-applied urea at 0.5% concentration at tillering and booting stages. However, the minimum grains spike^{-1} of 39.00 was recorded in control (Recommended dose of NPK fertilizers=RDF). The LSD (least significant test) suggested that differences in grains spike^{-1} under RDF + foliar-applied urea at 2.5% concentration at tillering and booting stages were statistically significant (P<0.05).

Seed index (1000 grains weight g): The results related to seed index of wheat variety TD-1 as influenced by urea foliar application at different growth stages are given in (Table 1). The results indicated that the seed index was maximum (54.98 g) when the wheat crop was given RDF + foliar-applied urea at 2.5% concentration at tillering and booting stages, and the seed index decreased to 52.78 g when the RDF + foliar-applied urea at 1.5% concentration at tillering and booting stages and further decreased to 48.56 g when the crop was given RDF + foliar-applied urea at 0.5% concentration at tillering and booting stages. However, the minimum seed index of 45.02 g was recorded in control (Recommended dose of NPK fertilizers=RDF). The LSD test suggested that differences in seed index under RDF + foliar applied urea at 2.5% concentration at tillering and booting stages were statistically significant (P<0.05).

Biological yield (kg ha^{-1})

Biological yield ha^{-1} (kg ha^{-1}) is the ultimate output of the research effort and all studied parameters contribute to biological yield directly and indirectly. The results related to the biological yield of wheat variety TD-1 as influenced by urea foliar application at different growth stages are given in (Table 1). The results indicated that the biological yield was maximum (14544 kg ha^{-1}) when the wheat crop was given RDF + foliar-applied urea at 2.5% concentration at tillering and booting stages, and the biological yield decreased to 13721 kg ha^{-1} when the RDF + foliar was applied urea at 1.5% concentration at tillering and booting stages and further decreased to 12342 kg ha^{-1} when the crop was given RDF + foliar-applied urea at 0.5% concentration at tillering and booting stages. However, the minimum biological yield of 10848 kg ha^{-1} was recorded in control (Recommended dose of NPK fertilizers=RDF). The LSD test suggested that differences in biological yield under RDF + foliar-applied urea at 2.5% concentration at tillering and booting stages were statistically significant (P<0.05).

Grain yield (kg ha^{-1})

Grain yield ha^{-1} (kg ha^{-1}) is the ultimate output of the research effort and all studied parameters contribute to grain yield directly and indirectly. The results related to grain yield of wheat variety TD-1 as influenced by urea foliar application at different growth stages are given in (Table 1). The results indicated that the grain yield was maximum (6171 kg ha^{-1}) when the wheat crop was given RDF + foliar-applied urea at 2.5% concentration at tillering and booting stages, and the grain yield decreased to 6097 kg ha^{-1}

when the RDF + foliar was applied urea at 1.5% concentration at tillering and booting stages and further decreased to 5324 kg ha^{-1} when the crop was given RDF + foliar-applied urea at 0.5% concentration at tillering and booting stages. However, the minimum grain yield of 4277 kg ha^{-1} was recorded in control (Recommended dose of NPK fertilizers=RDF). The LSD test suggested that differences in grain yield under RDF + foliar-applied urea at 2.5% concentration at tillering and booting stages were statistically significant (P<0.05).

Table 1. The effect of foliar application of urea on different yield characteristics

Treatments	Plant height (cm)	Tiller plant^{-1}	Spike length (cm)	Spikelet's spike^{-1}	Grains spike^{-1}	Seed index (1000 grains	Biological yield (kg ha^{-1})	Grain yield (kg ha^{-1})
T_1=Control (Recommended dose of NPK fertilizers=RDF)	79.61	7.37	8.17	38.01	39.00	45.02	10848	4277
T_2=RDF+ foliar applied urea at 0.5%	80.78	9.20	8.89	40.04	41.00	48.56	12342	5324
T_3=RDF+ foliar applied urea at 1.5%	81.56	10.40	9.32	42.44	42.33	52.78	13721	6097
T_4=RDF+ foliar applied urea at 2.5%	83.50	12.33	10.69	44.80	46.00	54.98	14544	6171
S.E.±	0.6987			LSD 0.05		1.7097		

Discussion

Drought and water stress are common problems of Pakistan's agriculture, and the wheat crop is mainly hampered due to these problems. Under such conditions, the foliar application of urea at different crop growth stages has been found beneficial.

The results showed that the foliar application of urea on the growth and yield attributes of wheat variety TD-1 was significant at (P<0.05) except plant height (cm), tillers plant^{-1}, spike length (cm), spikelet spike^{-1}, grains spike^{-1}, seed index (1000 grains weight g), biological yield (kg ha^{-1}) and grain yield (kg ha^{-1}). The wheat crop with the application of RDF + foliar-applied urea at 2.5% concentration at tillering and booting stages ranked first with 83.50 cm plant height, 12.33 tillers plant^{-1}, 10.69 cm spike length, 44.80 spikelets spike^{-1}, 46.00 grains spike^{-1}, 54.98 g seed index (1000 grains weight g), 14544 kg ha^{-1} biological yield and 6171 kg ha^{-1} grain yield. RDF + foliar-applied urea at 1.5% concentration at tillering and booting stages also affected the wheat crop significantly. They ranked 2nd with 81.56 cm plant height, 10.40 tillers plant^{-1}, 9.32 cm spike length, 42.44 spikelet spike^{-1}, 42.33 grains spike^{-1}, 52.78 g seed index (1000 grains weight g), 13721 kg ha^{-1} biological yield and 6097 kg ha^{-1} grain yield. The crop supplied with RDF + foliar-applied urea at 0.5% concentration at tillering and booting stages ranked 3rd in performance with 80.78 cm plant height, 9.20 tillers plant^{-1}, 8.89 cm spike length, 40.04 spikelet spike^{-1}, 41.00 grains spike^{-1}, 48.56 g seed index (1000 grains weight g), 12342 kg ha^{-1} biological yield and 5324 kg ha^{-1} grain yield. As compared to the foliar application of urea the control plots, (Recommended dose of NPK fertilizers=RDF) ranked least in performance with 79.61 cm plant height, 7.37 tillers plant^{-1}, 8.17 cm spike length, 38.01 spikelet spike^{-1}, 39.00 grains spike^{-1}, 45.02 g seed index (1000 grains weight g), 10848 kg ha^{-1} biological yield and 4277 kg ha^{-1} grain yield. It was concluded that the effect of urea foliar application on the growth

and yield traits of wheat was remarkable and the crop performance was maximized when RDF + foliar urea was applied at 2.5% concentration at tillering and booting stages. Various researchers further confirm these results. Likewise [16] reported that the highest N supply decreases the dry weight and length of the basal internodes of wheat. In deficient plants, the weight of the shoot and ear were reduced, and there was a lower lodging risk, possibly because the high levels of nitrogen reduced the strength of the stem and thus increased crop lodging [17] reported that foliar application of urea affected wheat crops significantly and this effect was also evident for grain yield, spike fertility, and grain protein content. Moreover [9] reported that N at the rate of 200 kg ha^{-1} produced greater plant height, leaves $plant^{-1}$, tillers, ear length and weight, dry weight, grains ear^{-1}, spikelet $ear^{-1,}$ and biological yield. [18] also reported that grain yield components improved by foliar nitrogen feedings such as tillers $plant^{-1}$, grain $spike^{-1,}$ and grain yield when applied at flag leaf stage and spike emergence; and mean grain yield when applied at and after anthesis. The beneficial effect of nitrogen application on wheat tillers, spikes, plant height, spike length, spike lets, grains $spike^{-1}$, and grain and straw yields was recorded. Furthermore, [19] reported that nitrogen fertilization with foliar urea at flag leaf emergence is a common strategy to improve both grain yield and quality in wheat. However, the genotypic differences were recorded in response to propiconazole and urea sprayings. [20, 21] recorded that the positive effects on cultivars of chemicals were attributed to the high leaf photosynthesis rate. Once foliar-applied urea is absorbed by the leaves, it is converted to ammonia, by the enzyme urease and ammonia is incorporated into glutamate by the enzyme glutamine synthetase. The propiconazole and foliar urea treatment and high leaf urease enzyme activity were observed after foliar urea application [22-24]. Furthermore, [25] reported that the added foliar nitrogen increases grain protein content in wheat. Moreover, [26] evaluated the effects of urea foliar application rates at different growth stages of wheat on protein and yield of winter wheat and demonstrated that urea application time had significant effects on grain weight, number of seeds per spike, plant height, and protein content. Furthermore, total dry weight, grain weight, harvest index, 1000-seed weight, plant height, and protein content were significantly affected by amounts of urea foliar application. The effects of time × rate of urea foliar application on grain yield, 1000-seed weight, and plant height were significant. [11] reported that late foliar application with urea could decrease nitrogen use efficiency.

Conclusion

It was concluded that the effect of urea foliar application on the growth and yield traits of wheat was remarkable ($P<0.05$) and the crop performance maximized when given RDF + foliar-applied urea at 2.5% concentration at tillering and booting stages.

Authors' contributions

Conceived and designed the experiments: S Yasin & IA Tunio, Performed the experiments: IA Tunio & TH Tunio, Analyzed the data: S Kumar, Contributed materials/ analysis/ tools: A Panhwar & JM Keerio, Wrote the paper: S Yasin.

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