EXPLORING THE IMPACT OF DIFFERENT UREA FOLIAR SPRAY CONCENTRATIONS ON YIELD AND YIELD CHARACTERISTICS OF TRITICALE

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Abstract

Urea applied directly to the soil is mostly lost through volatilization and leaching. Foliar spraying is thus a potential method to increase the effectiveness of nitrogen utilization, which raises crop output. To ascertain the impact of various urea foliar application concentrations on triticale production and yield components, a field experiment was carried out. During the Rabi season of 2020–2021, An investigation was conducted at the Research Farm of Agriculture University Peshawar. The experiment followed a structured design with three replications of (RCBD). The factor encompassed twelve distinct foliar concentrations of urea dissolved in water. These concentrations were subsequently applied to the crop during its tillering and booting stages. The concentration levels were designated as follows: T1 (control) at 0%, T2 at 1%, T3 at 2%, T4 at 3%, T5 at 4%, T6 at 5%, T7 at 6%, T8 at 7%, T9 at 8%, T10 at 9%, T11 at 10%, and T12 at 11%. The results revealed that the maximum plant height (128.10 cm), spike length (16.80 cm), spikelets spike^{-1} (28.78), grains spike^{-1}(63.13), 1000 grains weight (53.24 g),biological yield (12466 kg ha^{-1}), grain yield (5423.2 kg ha^{-1}), harvest index (43.50) and seed protein contents (18.11 %) were observed at 6% urea foliar application. Based on the above result it is concluded that urea foliar application @ of 6% found best to be used for improving yield without any harmful impact.

Key words: Triticale, Folliar Spray, Urea, Yield

Introduction

When fertilizing crops, foliar application of plant nutrients offers potential advantages over soil application since it may improve fertilizer usage efficiency and relieve physiological stress (Gray and Aik, 1984). According to Veesar et al. (2017), crops only use 20–50% of nitrogen fertilizer that is applied directly to the soil; the remaining nitrogen is lost through volatilization and leaching. Foliar application of nitrogen fertilizer is a successful method for maximizing crop accessibility to nitrogen and minimizing fertilizer loss. Studies on the foliar application of fertilizers for certain crops, such as cereals, were conducted in the early 1980s. (Girma et al., 2007).However, this can result in a considerable and quick build-up of NH_4+ in tissues, which can produce leaf damage that is usually referred to as "scorching," "burning," or "tipping" and visible damage in the form of stunted roots and leaf damage in farms (Gooding and Davies, 1992; Phillips and Mullins, 2004). Spraying urea to open flowers has also been associated with negative outcomes (Brown, 2001; Nelson and Meinhardt, 2011), which may be due to the urea's disruption of pollen tube growth directionality and decreased efficacy of fertilization. A lack of grain yield effect, on the other hand, has also been noted in numerous field studies. When high rates of urea are applied under leaves, excessive foliar damage may reduce grain yield (Phillips and Mullins, 2004).Various factors cause burning effect including timing and temperature. For instance, when liquid fertilizer is applied between the hours of 8 a.m. and 5 p.m., foliar burn damage is typically severe and can be reduced when these periods are avoided (Poole et al., 1983). Triticale (*Triticosecale W.*), the initial cereal produced through human intervention, emerges following the hybridization of wheat (*Triticumaestivum L.*) and rye (*Secalecereale L.*) (Igne et al., 2007) and a member of the gramineae family. The primary goal of the crossing was to produce a cereal with the desired traits of both rye, which grows quickly and is resilient to both biotic and abiotic challenges, and wheat, which is superior in yield and grain quality (Villegas et al., 2010). Triticale contains 19.71% more protein per seed than other cereals like wheat, rice, maize, and oat seed, according to seed analysis (Hale et al., 1985). As opposed to earlier varieties, new perspective triticale lines and varieties have more and better filled grains, higher yields, test weights, and flour contents, but less protein and lysine (Dekic et al., 2009; Milovanovic et al., 2011). With a total production of 17.1 million tons, triticale was grown on 3 million hectares of land globally. Triticale is mostly produced in Poland and Germany (FAO, 2014). There have been significant increases in interest in triticale in Pakistan, despite the lack of accurate figures on its production or area.

Materials and Methods

To examine the impact of various urea foliar spray concentrations on triticale yield and yield characteristics, a field trial was conducted at the of The University of Agriculture Peshawar during the winter of 2020–21. Semi-arid subtropical climate was identified as the location's climate. The Agronomy Research Farm is situated 350 meters above sea level in the Peshawar valley at 34.01º N latitude, 71.35º E longitude. Loamy clay made up the soil. Three repeats were set up in an RCB design. With a seed rate of 120 kg ha^{-1}, the seed were spread in rows with a spacing of 30 cm between each row. NPK was administered at a basal dose of 120:90:60. A solution for foliar spraying of urea was prepared by adding urea fertilizer to 200 ml (weight/volume) of water, with concentrations ranging from 0% to 11%. At the tillering and booting stages, the crop received the necessary amount of foliar spray of urea at specified proportions. Tillers are extra stems that grow off of the main stem or shoot of the plant. 200 cc of pure water was used for the control treatment. At the tillering stage, one irrigation was used. All other agronomic and cultural techniques were successfully used in conjunction with all treatments. The following variables were analysed: harvest index, seed protein content (%), plant height (cm), spike length (cm), spikelet spike^{-1}, grains spike^{-1}, 1000 grain weight (g), biological yield (kg ha^{-1}), grain yield (kg ha^{-1}), and spikelet spike^{-1} length (cm).

Table 1. Treatments and their levels for various plots.

Treatments	Urea dose in water (200 ml).
T1 = 0%	Sole water spray of 200 ml
T2 = 1%	2 gram urea in 200 ml water
T3 = 2%	4 gram urea in 200 ml water
T4 = 3%	6 gram urea in 200 ml water
T5 = 4%	8 gram urea in 200 ml water
T6 = 5%	10 gram urea in 200 ml water
T7 = 6%	12 gram urea in 200 ml water
T8 = 7%	14 gram urea in 200 ml water
T9 = 8%	16 gram urea in 200 ml water
T10 = 9%	18 gram urea in 200 ml water
T11 = 10%	20 gram urea in 200 ml water
T12 = 11%	22 ram urea in 200 ml water

Results

Plant height (cm) significantly affected by different concentrations of urea foliar spray. Results indicated that the highest plantswere recorded at 6% (128.10 cm) and 7% (125.09 cm) concentrations of urea foliar spray applied at tillering and booting stage. However, the lowest plants (111.91 cm) were observed where foliar spray of urea was used at the rate of 11% as mentioned in Table 2. Spike length (cm) significantly influenced by various concentrations of urea foliar spray. Maximum spike length was recorded at 6% (16.80 cm), followed by 5% (15.82 cm) and 7% (15.88 cm) concentrations, while the minimum spike length (13.31 cm) was observed, where foliar spray of urea was applied at the rate of 11%. in terms of spikelets spike^{-1},it was significantly affected by different concentrations of urea foliar spray. Higher number ofspikelets spike^{-1} were observed at 5% (27.90), 6% (28.78) and 7% (27.99), while lower number ofspikelets spike^{-1} (24.11) were observed where foliar spray of urea was applied at the rate of 11%. Grains spike^{-1} significantly affected by various concentrations of urea foliar spray. Higher number of grains spike^{-1} (59.66), (63.13), (60.18) were obtained, when foliar spray of 5%, 6% and7% urea were applied at tillering and booting stage, while lower grains spike^{-1} (45.07) were observed, when urea was sprayed onto the leaves at a rate of 11%. Moreover, Thousand grains weight significantly influenced by different concentrations of urea foliar spray. Maximumthousand grains weight (52.01), (53.24), (52.16) were obtained, when foliar spray of 5%, 6% and7% urea were applied at tillering and booting stage, while minimumthousand grains weight (42.39) were noticed, when foliar spray of urea was applied at the rate of 11%. Biological yield was positively influenced by different concentrations of urea foliar spray. Higher biological yield was observed at 5% (12188 kg ha^{-1}), 6% (12466 kg ha^{-1}) and7% (12214 kg ha^{-1}) urea were introduced at tillering and booting stage, while lowerbiological yield (10293 kg ha^{-1}) were obtained when foliar spray of urea was applied at the rate of 11% as depicted in Table 3.Similarly, the effect of different urea foliar spray doses on grain yield were considerable. Higher grain yields were achieved at 5% (5212.7 kg ha^{-1}), 6% (5423.2 kg ha^{-1}) and 7% (5244 kg ha^{-1}), whereas decreased grain yields were seen where foliar urea spraying at a rate of 11% was applied (3823.9 kg ha^{-1}). Harvest index was also significantly influenced by different concentrations of urea foliar spray.Maximum harvest indexwas recorded at 4% (41.86 %), 5% (42.79 %),6% (43.50 %) and 7% (42.93 %)

concentrations, while the minimum harvest index (37.15 %) was observed, where foliar spray of urea was applied at the rate of 11%. Lastly, the quality component, Seed protein (%) was significantly affected by various concentrations of urea foliar spray. Maximum seed protein contents were observed at 3% (16.67 %), 4% (17.05 %), 5% (17.98 %), 6% (18.11 %),7% (18.08 %) and 8% (16.59 %), while minimumseed protein contents (15.08 %) was observed from control. These fallouts are scientifically verified by Farooqi et al. (2019) as they observed an increase in assimilate accumulation and enhanced proteins with foliar applied N.

Discussion

The improvement in plant height appears to be attributed to nitrogen's capacity to enhance the growth of leafy green vegetation, leading to increased accumulation of dry matter. This expansion results in a higher production of photo assimilates. Our findings align with Farooqi et al.'s research in 2012, where they asserted that applying urea through foliar spraying substantially elevated plant height. This conclusion gains further support from Veesar et al.'s study in 2017, which also indicated that nitrogen foliar spraying contributed to taller plants. Matilo et al. (2006) and Wagan et al. (2017) similarly reported positive effects on plant height through both soil application and foliar spray of nitrogen.However, it's worth noting that excessive treatment, such as the 11% application rate, resulted in stunted growth and tipping. Additionally, our research demonstrates the beneficial impact of foliar urea spraying on spike length during the tillering stage, echoing the findings of Saeed et al. in 2012. Similar to Farooqi et al. (2012), our results showcase the potential for significant spike lengthening by adding 2% boron to an 8% urea foliar spray. Furthermore, Khan et al. (2009) observed that urea foliar spraying increased spike length. This trend is substantiated by Patel and Patel (1994), who suggested that administering urea could extend the length of green gram pods.The number of spikelets spike^{-1} was notably affected by varying concentrations of urea foliar spray. Increased spikelet counts per spike were observed at concentrations of 5% (27.90), 6% (28.78), and 7% (27.99), while a reduced count of spikelets spike^{-1} (24.11) was recorded when the foliar spray rate was 11%. This observation is in line with Wagan et al. (2017), which additionally supported the effectiveness of combining foliar urea application with basal doses to substantially enhance spikelets per spike.These findings align with research by Barbottin et al. (2005), underlining the significance of foliar urea for grain development. Similar conclusions were reached by Rahman et al. (2014), who found that foliar nitrogen spraying led to improved crop responses. Gooding and Devies (1992) also supported these results, demonstrating the positive impact of foliar nitrogen treatment on wheat crop performance. Gul et al. (2010) further suggested that combining foliar urea application with the addition of zinc and potassium through foliar application positively influenced grains spike^{-1}. Bhuyan et al. (2012) similarly illustrated that using the bed planting method alongside foliar nitrogen fertilization increased the number of grains per panicle.Thousand grains weight was also affected by different concentrations of urea foliar spray. Optimal thousand grains weight was achieved when applying foliar spray rates of 5%, 6%, and 7% during the tillering and booting stages. This result could be attributed to the variation in treatment concentrations. Yaseen et al. (2010) supported our findings by demonstrating that foliar spray of urea and micronutrients significantly enhanced 1000-grains weight. Farooqi et al. (2019) similarly emphasized the substantial impact of urea foliar spray on thousand grain yield, further corroborating these outcomes. Biological yield is directly linked to the ultimate grain yield of wheat. Monitoring changes in biological yield throughout the growing season helps researchers and farmers predict the potential grain yield and adjust management practices accordingly. Enhanced biological yield was evident when applying urea at concentrations of 5%, 6%, and 7% during the tillering and booting stages. This could potentially be attributed to differences in plant density and unevenness in the distribution of tillers per plant. Our results are consistent with the studies of Wagan et al. (2017) and Khan et al. (2009), both of which affirmed that foliar application of urea led to a significant increase in wheat yield. Similarly, The impact of varying doses of urea foliar spray on grain yield was substantial. This observation finds support in the work of Yaseen et al. (2010), who demonstrated that foliar application of urea and micronutrients resulted in up to a 4% increase in wheat grain production compared to the control. Our findings align with Yildirim et al. (2007), who highlighted successful urea spraying on broccoli cultivars for improved growth and production. Matilo et al. (2006) further reinforced this notion by confirming that both foliar urea spray and soil application could enhance grain yield. Harvest index was notably affected by different concentrations of urea foliar spray. The highest harvest indices were recorded at concentrations of 4% (41.86%), 5% (42.79%), 6% (43.50%), and 7% (42.93%), while the lowest index (37.15%) was observed with an 11% urea foliar spray rate. This observation is strongly supported by Khan et al. (2005), who found that foliar nitrogen spray had significant effects on wheat's harvest index. Seed protein content (%) was significantly influenced by various concentrations of urea foliar spray. These results align with Farooqi et al. (2019), who observed increased assimilate accumulation and enhanced protein levels with foliar-applied nitrogen. Our findings are consistent with Tea et al. (2007), who also noticed improved seed protein content through nitrogen foliar application compared to traditional methods.

Table 2. Mean table of plant height, spike length, spikelet spike^{-1} and grains spike^{-1} of triticale as affected by urea foliar.

Treatments	PH	SL	SS	GS	TWG
T1 (water spraycontrol)	114.10 efg	13.92 de	24.89bcde	51.47 de	44.71 cdef
T2 (1% urea foliar Spray)	114.73 efg	13.99 de	25.04bcde	52.53 cde	45.18 cdef
T3 (2% urea foliar Spray)	116.20 defg	14.49 cd	26.58 abcd	55.13 bcd	46.73 cde
T4 (3% urea foliar Spray)	118.27 cde	14.85 c	6.95 ab	56.30 bcd	48.62 bcd
T5 (4% urea foliar Spray)	120.30 bcd	14.88 c	27.05 ab	56.80 bc	48.84 bc
T6 (5% urea foliar Spray)	121.46 bc	15.82 b	27.90 a	59.66 ab	52.01 ab
T7 (6% urea foliar Spray)	128.10 a	16.80 a	28.78 a	63.13 a	53.24 a
T8 (7% urea foliar Spray)	125.09 ab	15.88 b	27.99 a	60.18 ab	52.16 ab
T9 (8% urea foliar Spray)	118.0 cdef	14.48 cd	26.80 abc	55.80 bcd	48.38 bcd
T10 (9% urea foliar Spray)	113.2 fg	13.71 de	24.59 cde	47.87 ef	44.39 def
T11(10% urea foliar Spray)	112.83 g	13.62 e	24.33 de	45.53 f	43.80 ef
T12 (11% urea foliar Spray)	111.91 g	13.31 e	24.11 e	45.07 f	42.39 f
LSD $_{(0.05)}$	4.94	0.81	2.32	5.29	4.24

Same following latters represent non-significant differences according to LSD$_{(0.05)}$. *Abbreviations.* PH= Plant height, SL= Spike length (cm), SS= Seed spike^{-1}, GS= Grain spike^{-1}, TGW= Thousand grain weight (g)

Table 3. Mean table of thousand grain yield, biological yield, grain yield, harvest index and seed protein content of triticale as influenced by urea foliar.

Treatment	BY	GY	HI	SPC
T1 (water spray)	11147 de	4425.1 e	39.84 cde	16.01 c
T2 (1% urea foliar Spray)	11584 cd	4685.5 d	40.44 cd	16.53 bc
T3 (2% urea foliar Spray)	11704 c	4774.9 d	40.79 bc	16.70 bc
T4 (3% urea foliar Spray)	11889 bc	4901.9 cd	41.23 bc	17.00 abc
T5 (4% urea foliar Spray)	11987 bc	5016.9 bc	1.85 abc	17.38 ab
T6 (5% urea foliar Spray)	12188 ab	5212.7 ab	42.78 ab	17.64 ab
T7 (6% urea foliar Spray)	12466 a	5423.2 a	43.50 a	17.98 a
T8 (7% urea foliar Spray)	12214 ab	5244.0 a	42.93 ab	17.92 a
T9 (8% urea foliar Spray)	11808 bc	4856.5 cd	41.11 bc	16.92 abc
T10 (9% urea foliar Spray)	10718 ef	4116.9 f	38.40 def	16.87 abc
T11 (10% urea foliar Spray)	10608 f	4034.5 fg	38.02 ef	16.74 bc
T12 (11% urea foliar Spray)	10293 f	3823.9 g	37.15 f	16.67 bc
$LSD_{(0.05)}$	475	221.9	2.21	1.15

Same following latters represent non-significant differences according to $LSD_{(0.05)}$. *Abbreviations*. BY= Biological yield (kg ha^{-1}), GY= Grain yield (kg ha^{-1}), HI= Harvest index (%), Spikelet $spike^{-1}$.

Conclusion

The empirical findings unmistakably indicate that the application of urea foliar spray exerted a substantial influence on crucial parameters including plant height (cm), spike length (cm), spikelets $spike^{-1}$, grains $spike^{-1}$, 1000-grain weight (g), biological yield (kg ha^{-1}), grain yield (kg ha^{-1}), harvest index, and seed protein content (%). Among all treatments, urea foliar application @ 6% improved triticale yield and yield components without any harmful impacts.

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