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Research Article

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EFFECT OF FOLIAR APPLIED UREA ON GROWTH AND YIELD OF WHEAT (*TRITICUM AESTIVUM* L.)

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ABSTRACT

Owing to climate change and continuous crop cultivation, soils are deteriorating with essential nutrients, and consequently, crop yield decreases day by day. Thus, it is necessary to ensure the availability of nitrogen according to the requirement of the crop through the foliar application of urea; because it is proven more efficient when compared with soil-applied method, especially in wheat crop. Therefore, the study was designed to examine the effect of urea in foliar application under different concentrations on various growth stages of wheat under field conditions during 2020-2021. The wheat variety Benazir-2013 was selected because it is high-yielding, rust-resistant, and can be cultivated in all ecological zones of Sindh. Due to these prominent characteristics, nowadays, it is a better choice for growers. For the foliar application of urea, the concentrations were formulated as T_1: Control, T_2: Recommended dose of fertilizer RDF + 1% Urea on tillering stage, T_3: RDF + 1% Urea at stem elongation, T_4: RDF +1.5% Urea at tillering stage, T_5: RDF + 1.5% Urea at stem elongation, T_6: RDF + 2% Urea at tillering stage and T_7: RDF + 2% Urea at stem elongation. Results of the study showed that maximum Plant height (94.7 cm), number of tillers (460.3 m^{-2}), Spike length (16.7 cm), number of grains $spike^{-1}$ (65.8), Seed index (65.8 g), Biological yield (11.6 t ha^{-1}) and Grain yield (5.0 t ha^{-1}) was perceived by (T_6: RDF + 2% Urea at tillering stage) followed by (T_7: RDF + 2% Urea at stem elongation) with Plant height (90.4 cm), number of tillers (430.0 m^{-2}), Spike length (14.8 cm), Grains $spike^{-1}$ (58.3), Seed index (53.5 g), Biological yield (11.1 t ha^{-1}) and Grain yield (4.8 kg ha^{-1}). Meanwhile, the lowest values were recorded for all yield traits under T_1: Control. However, T_2, T_3, T_4, and T5 were also recorded significantly compared to the (T_1) control. Hence, it is suggested that RDF + 2% urea at the tillering stage should be applied in wheat variety Benazir-2013 to achieve the maximum yield.

Keywords: Wheat, growth stages, urea, foliar application, yield.

INTRODUCTION

Wheat ***(****Triticum aestivum* L.) is cultivated in many countries as to complete the food requirements of the population. Similarly it is foremost cereal crop and prime source of food in Pakistan. According to FAO 2021, the expected demand for wheat by 2050 is about 840 million tons, whereas the current production is approximately 750 million tons. To convene the requirement of food grains for rising population, deteriorating yield and quality are foremost challenges.

According to research findings, fertilizers are accountable for increase in crop production because they perform significant role in the development of plant (Marschner, 2012). Generally, Pakistani soils are (N) deficient and complemented with inorganic fertilizers to improve the production. However, the existing efficient use of nutrients is relatively lower especially for Nitrogen which is observed 30-50 % (Vision, 2030).

Foliar nutrient application is found to be the fastest way to overcome nutritional deficiencies at critical periods of flowering and grain-filling stages of the crop (Kolota and Osinska, 2001), while the use of nutrients through soil cannot be replaced completely. The purpose of foliar application is only to stimulate the growth and development process during critical stages of crop as yield could be enhanced. Foliar fertilizer application is an actual way of quick availability of nutrient at the critical stage of flowering and grain filling (Bagchi et al., 2020). It is proved more suitable, capable and inexpensive than soil application (Balusamy and Meyyazhagan, 2000).

The efficiency of nitrogen at the early stage of crop is very important to grow the leaves and initial flowering. Generally wheat crop is affected mainly due to nitrogen deficiency during vegetative stages therefore optimum use of nitrogen at proper time will increase total yield (Lu et al., 2016). Studies also reported that the foliar application of nutrients had significant effect on plant growth and production (Ahmed et al., 2011, Mohamed et al., 2011 and Wazir

et al., 2011). It ensures the nutrient accessibility for utmost produce (Arif, 2006).

Therefore, the present study was designed to establish the proper concentration of foliar applied urea with recommended dose of Fertilizer (RDF) for wheat variety Benazir-2013 in the field conditions. These findings will be valuable to researchers as well as for wheat growers.

MATERIALS AND METHODS

The study was conducted at experimental field of Agronomy department, Sindh Agriculture University Tandojam. Randomized complete block design (RCBD) with three replications was used to carry out the experiment. The net plot size (4m × 3m = 12m^2) was laid out. Wheat variety Benazir-2013 was tested against the treatments at different concentrations of foliar applied urea with RDF 168+84+60 NPK kg ha^{-1}. The treatments were formulated as T_1: Control, T_2: RDF + 1% Urea on tillering stage, T_3: RDF + 1% Urea at stem elongation, T_4: RDF +1.5% Urea at tillering stage, T_5: RDF + 1.5% Urea at stem elongation, T_6: RDF + 2% Urea at tillering stage and T_7: RDF + 2% Urea at stem elongation.

Experimental soil: The pre-experiment soil analysis was carried out at soil fertility section Agriculture research institute Tandojam. According to results, the soil was clay loam in texture, non saline, EC (0.94 dS/m), alkaline in reaction pH 8.2 and calcareous ($CaCO_3$ 9.6%). low in organic matter (0.55%), available phosphorus 3.05 mg kg^{-1}, total nitrogen content was 0.05% and high in exchangeable potassium (160 mg kg^{-1}).

Land preparation: Initially crosswise dry ploughings with mould board plough followed by land leveler were applied. After soaking dose as land came in condition, it was ploughed with cultivator followed by rotavator and then experimental layout was prepared.

Sowing time and method: The seed of wheat variety Benazir-2013 was received from wheat research station, Agriculture Research Institute Tandojam. As per recommended seed rate of 125 kg ha-1 seed was calculated for experimental units and sown with single coulter hand drill on 02-11-2020 maintaining row to row distance of 22.5cm.

Fertilizer and Irrigation application: All Phosphorus (Single Super Phosphate), Potash (Sulphate of Potash) and 1/3rd of N (Urea) was applied at the time of sowing and remaining 1/3rd of N at 1st irrigation and 1/3rd of N at 2nd irrigation was applied. For the preparation of (1 %, 1.5 % and 2 %) Urea concentrations, 10, 15 and 20 g of Urea were used for foliar application. Each concentration was initially mixed with one liter of water and shaked until urea was dissolved. The first irrigation was applied after 21 days of sowing; subsequent irrigations were applied according to the requirement until the crop reached at physiological maturity. Over all six irrigations were applied.

Weeding: Narrow and broad leaf weeds were controlled by applying recommended post-emergence herbicide of wheat crop.

Crop harvesting: The crop was harvested by cutting at soil level with sickle on 29-03-2021.

Procedure for data collection

Plant height (cm): Five plants were selected randomly from each treatment and data was noted at maturity from bottom up to top of the spike by measuring tape.

Number of Tillers m^{-2}: Total number of tillers in a one meter square area was recorded at the time of maturity from each plot and averaged.

Length of Spike (cm): Five spikes from each treatment were selected randomly, the length of all spikes was measured in centimeters with measuring tape and average was worked out.

Number of Grains spike^{-1}: After threshing of each randomly selected spike, grains were counted manually and averaged.

Seed index: One thousand grains were collected randomly from each plot and weighed.

Biological yield (t ha^{-1}): Biological yield was noted by harvesting of all dry matter above the soil surface from each plot. After harvest bundles were made and air-dried. Then air-dried bundles were weighed with spring balance using the following formula.

That was calculated according to the given procedure.

Seed yield (t ha^{-1}): The harvest of each plot was sun dried and threshed with wheat thresher. The grains were cleaned and weighed using the following formula:

$$\text{Biol. yield (kg ha}^{-1}) = \frac{\text{Yield plot}^{-1}}{\text{Plot size (m}^2)} \quad \text{X } 10000$$

$$\text{Seed yield (kg ha}^{-1}) = \frac{\text{Grain yield (plot}^{-1})}{\text{Plot size (m}^2)} \quad \text{X } 10000$$

Statistical analysis: Collected data was analyzed statistically using analysis of variance (ANOVA) technique, treatment means were compared with LSD test at 5% probability using statistix 8.1 software.

RESULTS AND DISCUSSION

Plant height (cm): Results regarding the effect of foliar applied Urea on plant height are depicted in **Figure 1**. According to Data, the highest plant height (94.7 cm) perceived under T_6: RDF + 2% Urea at tillering stage, followed by T_7: RDF + 2% Urea (90.4 cm) at the stem elongation. Whereas, the T_5: RDF + 1.5% Urea at stem elongation, T_4: RDF +1.5% Urea at tillering, T_3: RDF + 1% Urea at stem elongation and T_2: RDF + 1% Urea at tillering stage were observed 85.8, 81.4, 76.3, and 72.4 cm plant height respectively. However, the smallest plant height (68.1 cm) was recorded with T_1: Control. .The reasons of differences in plant height might be due to the foliar applied Urea at the tillering stage which played significant role in the formation of cell wall (Umar et al., 2019). Our findings are concord with the study of Wagan et al., 2017 who also observed increase in plant height with the foliar application of 5% urea at tillering stage. Similarly Veesar et al., 2017 noted 88 cm plant height in the wheat variety TJ-83 with the application of 1% Urea at the tillering stage. It is also a fact that increased plant height is a major cause of lodging in wheat crop, which depends upon the varietal character, soil fertility and climatic conditions. Generally the optimum range of wheat plant height is considered from 60 to 120 cm (Yousaf et al., 2008). However the results of our study are observed within the range.

Tillers m^{-2}: The ability of producing tillers is the major attribute of wheat crop, higher number of tillers produces maximum grain yield. Results regarding the number of tillers (m^{-2}) are presented in **Figure 2**. The maximum number of tillers (460.3 m^{-2}) was observed with the application of T_6: RDF + 2% Urea at tillering stage followed by T_7: RDF + 2% Urea at stem elongation that were noted (430.0 m^{-2}). Whereas, use of T_5: RDF + 1.5% Urea at stem elongation, T_4: RDF +1.5% Urea at tillering stage, T_3: RDF + 1% Urea at stem elongation and T_2: RDF + 1% Urea on tillering stage were observed, 401.0, 370.3, 329.7 and 279.3 number of tillers m^{-2} respectively, however the minimum (227.2) number of tillers m^{-2} was recorded under T_1: Control. Further, it is noted from the results, that the foliar application of Urea at tillering stage increased the number of tillers in crop. Similarly, Farooqi et al., 2019 reported that the total number of tillers m^{-2} was increased with 8% foliar applied urea, simultaneously Veesar et al., 2017 also observed more number of tillers $plant^{-1}$ with the foliar application of 1% Urea at the tillering stage. The reason behind the increase in number of tillers m^{-2} is the application of Nitrogen, because it is key part of chlorophyll, enzymes and protein (Kousar et al., 2015). The sufficient availability of nitrogen encourages the vegetative growth including the development of additional tillers

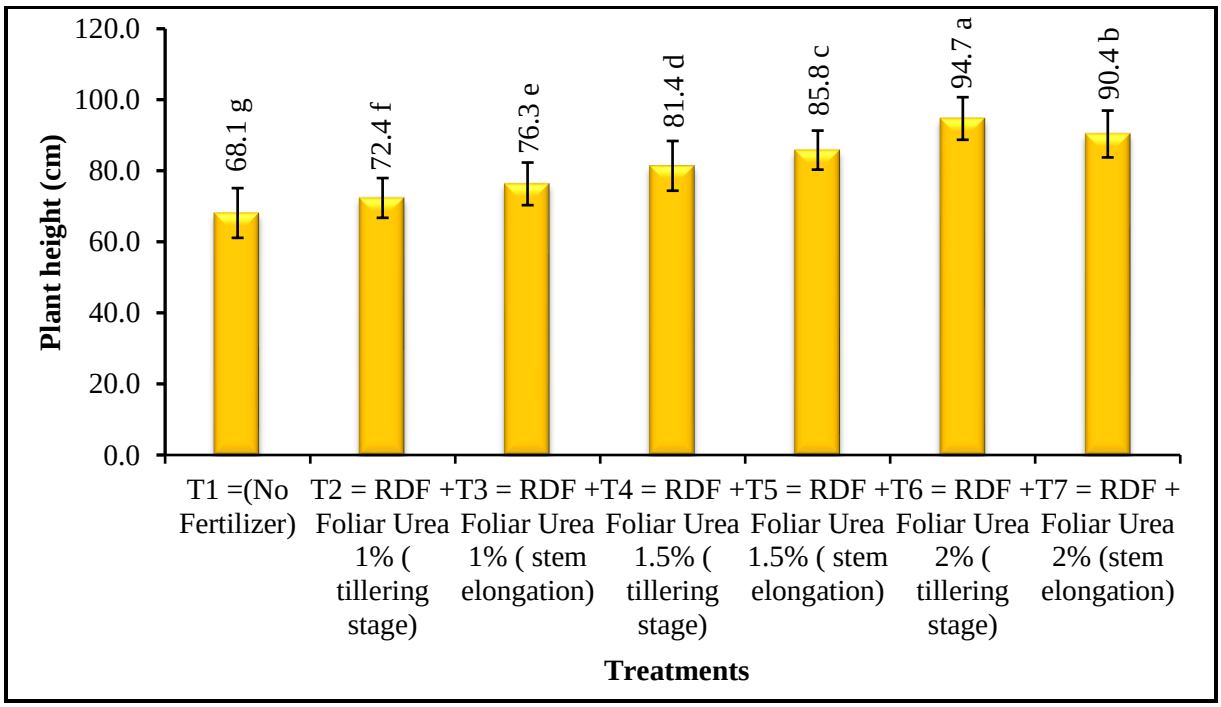

Figure 1. Plant height (cm) as affected by various concentrations of foliar applied urea in wheat variety Benazir-2013.

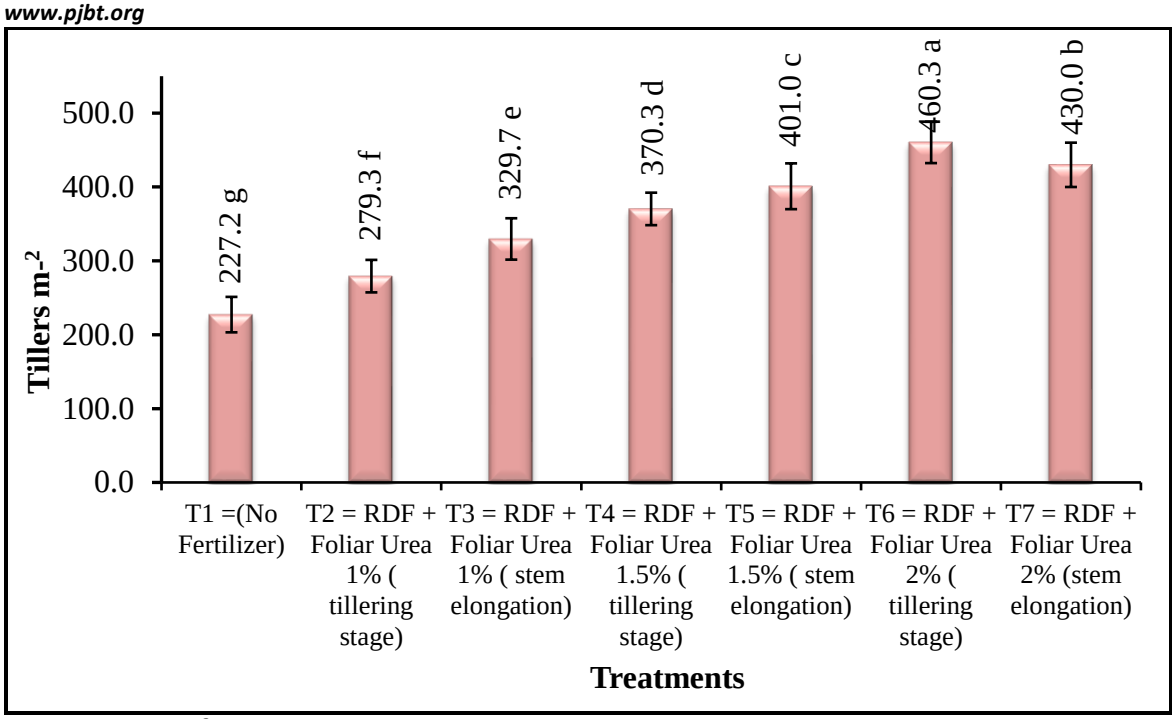

Figure 2. Tillers (m^{-2}) as affected by various concentrations of foliar applied urea in wheat variety Benazir-2013.

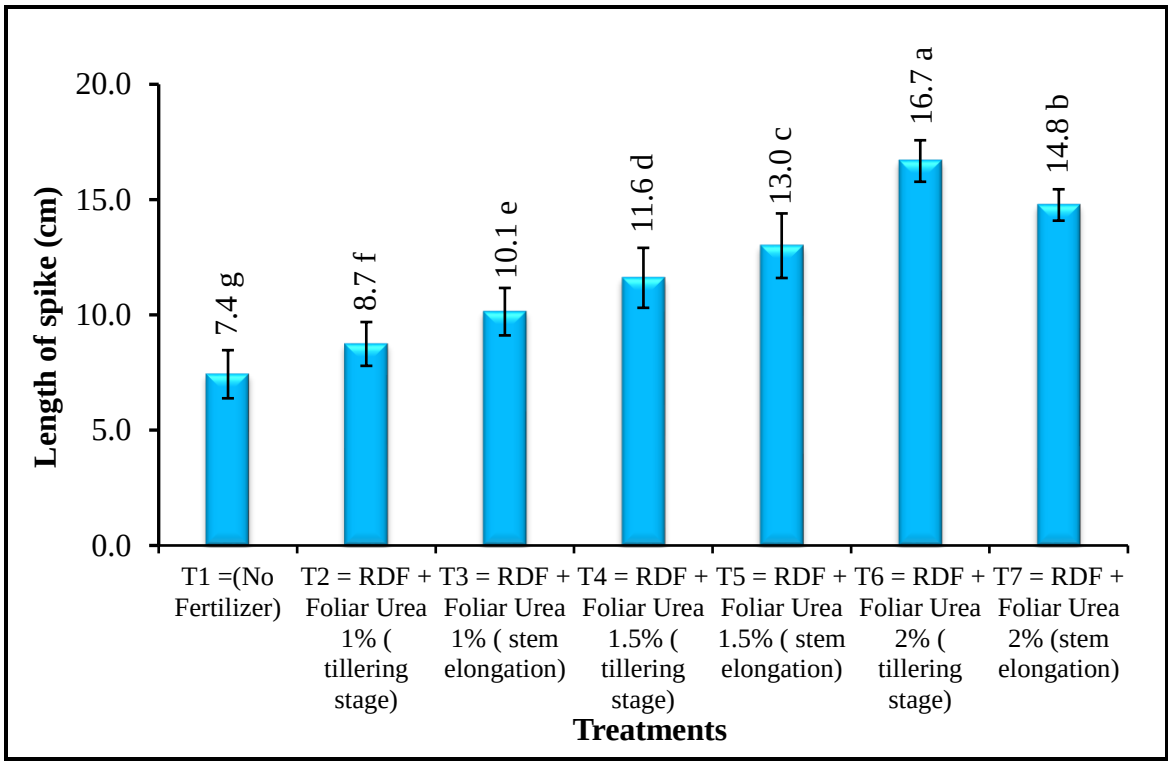

Figure 3. Length of spike (cm) as affected by various concentrations of foliar applied urea in wheat variety Benazir-2013.

Length of spike (cm): The data for spike length is presented in Figure 3. Results showed that the use of T_6: RDF + 2% Urea at tillering stage recorded highest (16.7 cm) spike length, while declining trend was observed in spike length under T_7: RDF + 2% Urea at stem elongation, T_5: RDF + 1.5% Urea at stem elongation and T_3: RDF + 1% Urea at stem elongation,14.8, 13.0 and 10.1 cm respectively. However 11.6 cm and 8.7 cm spike length was noted by T_4: RDF +1.5% Urea at tillering stage and T_2: RDF + 1% Urea on tillering stage. Although the minimum Spike length (7.4 cm) was observed at T_1: Control. These results are correlated with the findings of Parvez et al., 2009 who observed 11.2 cm spike length by 4% foliar applied urea. However Nazia et al., 2019 reported 9.4 cm spike length with application of RDF + 1% foliar applied Urea in wheat variety TD-1. Our results also establishes the findings of

Khaled et al., 2021 who also observed 12.67 cm spike length with the application of 70% urea of RDF soil applied+ 2% urea foliar applied in BARI Gom-28 wheat variety at tillering stage .

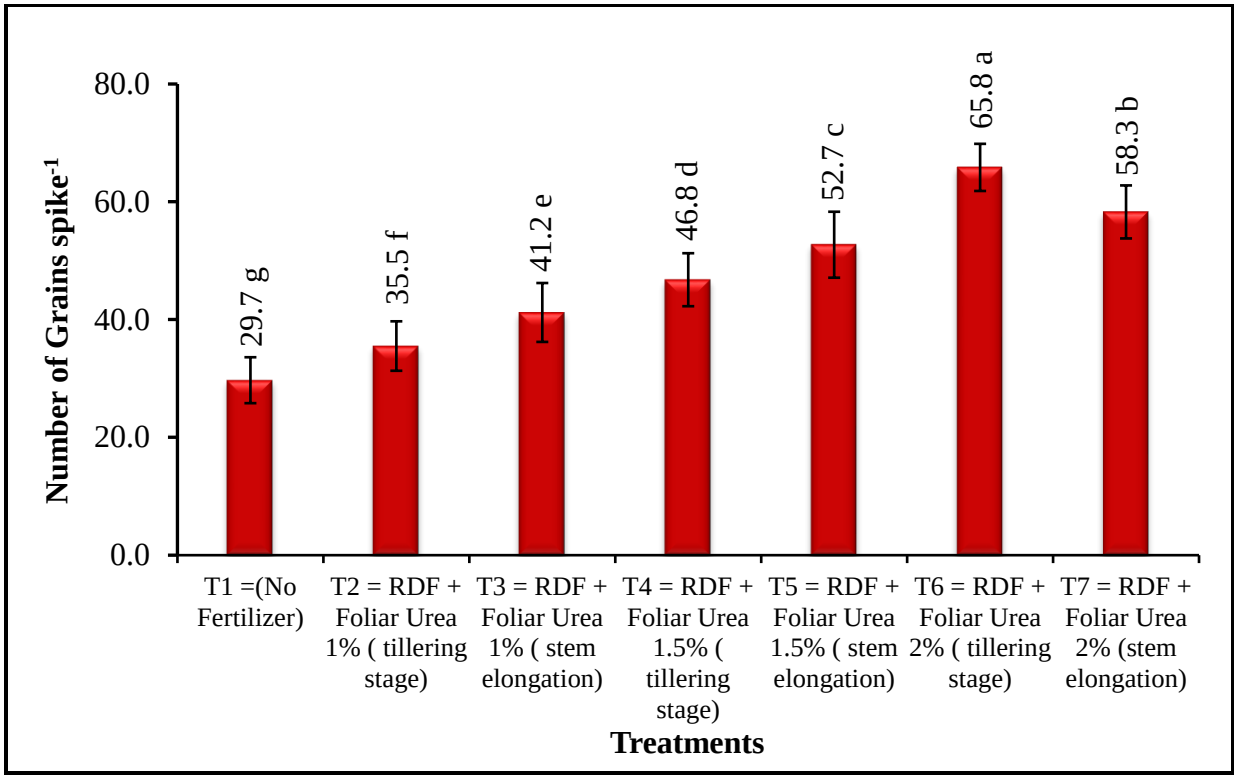

Figure 4. Number of Grains Spike^{-1} as affected by various concentrations of foliar applied urea in wheat variety Benazir-2013**.**

Number of grains spike^{-1}: Results regarding the number of grains spike^{-1} are shown in Figure 4. The maximum number of grains spike^{-1} (65.8) was observed by $T_{6:}$ RDF + 2% Urea at tillering stage while this trend decreased slightly to (58.3) when $T_{7:}$ RDF + 2% Urea were applied at stem elongation phase. Similarly, decreasing trend in the number of grains spike^{-1} was observed in $T_{5:}$ RDF + 1.5% Urea at stem elongation, $T_{4:}$ RDF +1.5% Urea at tillering stage, $T_{3:}$ RDF + 1% Urea at stem elongation and $T_{2:}$ RDF + 1% Urea at tillering stage, 52.7, 46.8, 41.2 and 35.5 respectively. However, the minimum number of grains spike^{-1} (29.7) was recorded in $T_{1:}$ Control. This variation may be occurred due to availability of nitrogen at later growth stages of crop (Vikas et al., 2020). The results of our study are in line with the findings of (Parvez et al., 2009) who also noted 67.5 grains spike^{-1} with the application of 4% Urea in the wheat variety Kiran 95. Our study's results agree with the findings of Rahman et al., 2014 who observed 48 grains spike^{-1}with the application of 2% Urea in the BARI Gom-26 wheat variety.

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Seed index (1000 grain weight g): This parameter measures the grain quality on the overall grain weight basis. The data regarding influence of varying foliar concentrations on seed index is presented in Figure 5. Results indicated that the highest seed index (65.8 g) was observed under T6: RDF + 2% Urea at the tillering stage. However, $T_{7:}$ RDF + 2% Urea at stem elongation, $T_{5:}$ RDF + 1.5% Urea at stem elongation, $T_{4:}$ RDF +1.5% Urea at tillering stage, $T_{3:}$ RDF + 1% Urea at stem elongation and $T_{2:}$ RDF + 1% Urea at tillering stage were recorded 53.5, 47.9, 41.5, 34.7 and 26.2 g, Seed index respectively. Meanwhile, the minimum seed index (20.6 g) was recorded at $T_{1:}$ Control. However, Rahman et al., 2014 noted 46.32g thousand seed weight with the application of 1% urea spray on the wheat variety BARI Gom-26. Similarly, Buczek et al., 2017 observed that thousand grain weight was significantly increased up to 44.3 g by the foliar application of 1.5% urea in Hybred wheat variety. Khaled et al., 2021 also noted 43.25g thousand seed weight with the application of foliar applied Urea at tillering stage in BARI Gom-28 wheat variety

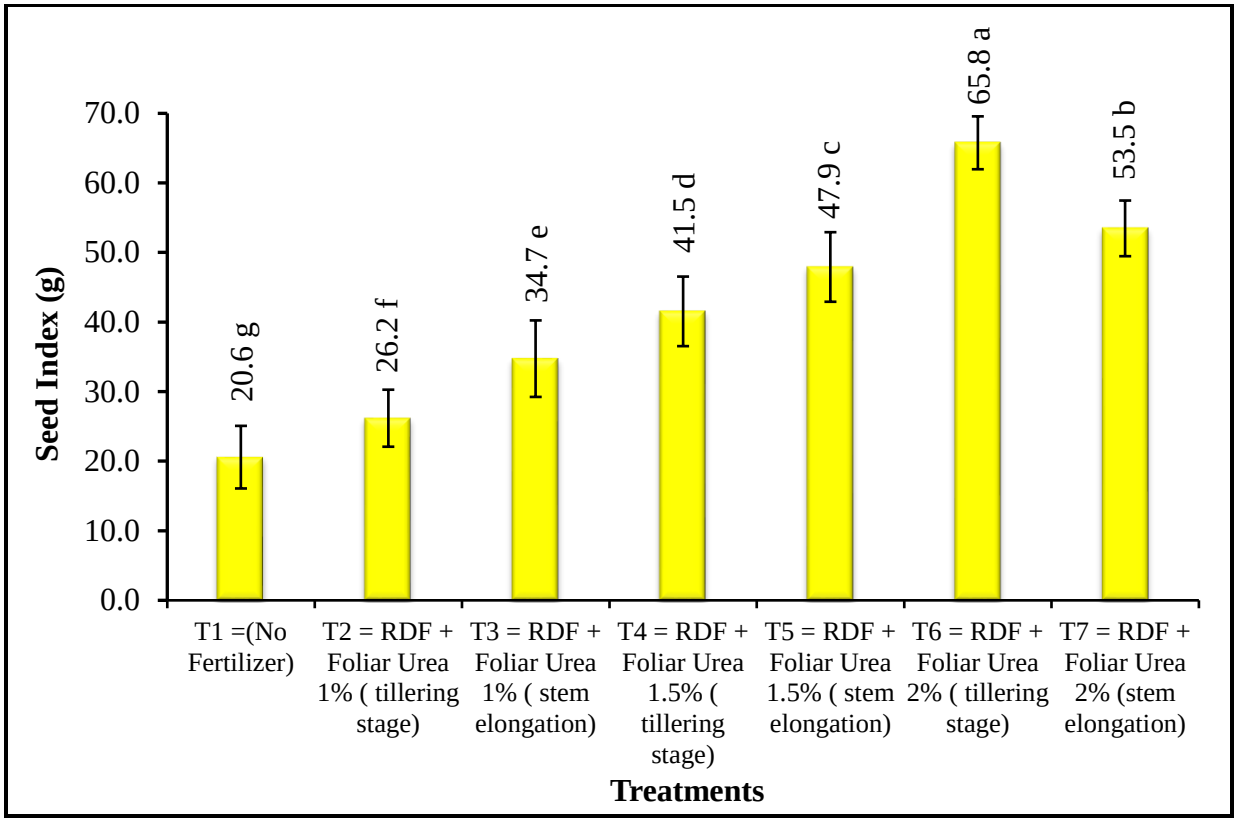

Figure 5. Seed Index (1000-grain wt, g) as affected by various concentrations of foliar applied urea in wheat variety Benazir-2013.

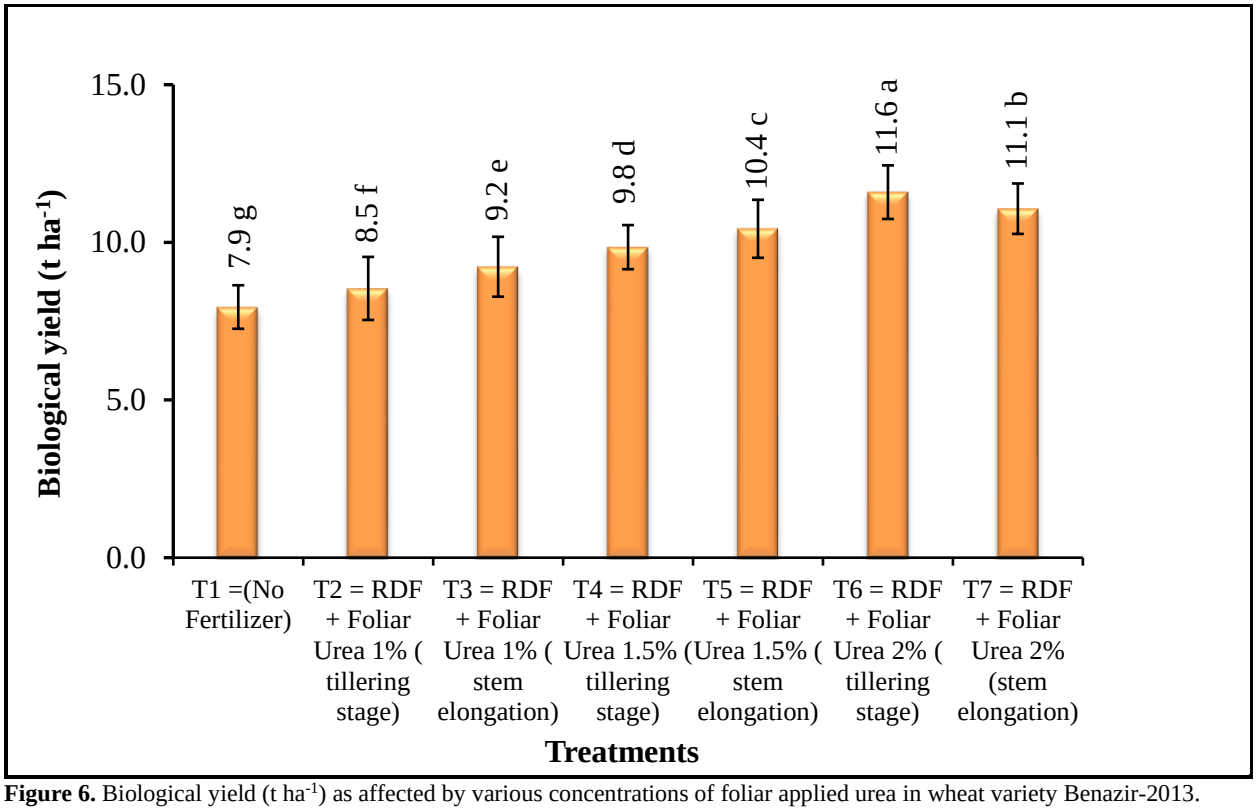

Figure 6. Biological yield (t ha^{-1}) as affected by various concentrations of foliar applied urea in wheat variety Benazir-2013.

Biological yield (t ha^{-1}): The data presented in Figure 6 revealed that the highest biological yield 11.6 t ha^{-1} was noted with $T_{6:}$ RDF + 2% Urea at tillering stage followed by $T_{7:}$ RDF + 2% Urea at stem elongation 11.1 t ha^{-1} , $T_{5:}$ RDF + 1.5% Urea at stem elongation 10.4 t ha^{-1},$T_{4:}$ RDF +1.5% Urea at tillering stage 9.8 t ha^{-1}, $T_{3:}$ RDF + 1% Urea at stem elongation 9.2 t ha^{-1} and $T_{2:}$ RDF + 1% Urea at tillering stage 8.5 t ha^{-1} . However, the lowest biological yield (7.9 t ha^{-1}) was recorded with $T_{1:}$ Control . The increase in biological yield under $T_{6:}$ RDF + 2% Urea at tillering stage is due to the effect of foliar application of Urea on vegetative growth phase (Arabhanvi and Hulihalli, 2018), ultimately more tillering and overall biomass production was observed. The enhancement in biological production may also be occurred due to the increase in photosynthetic rate, because nitrogen is the crucial element for chlorophyll and the pigment is responsible for photosynthesis, therefore higher leaf area amplified more dry matter produce (Osman et al., 2013).

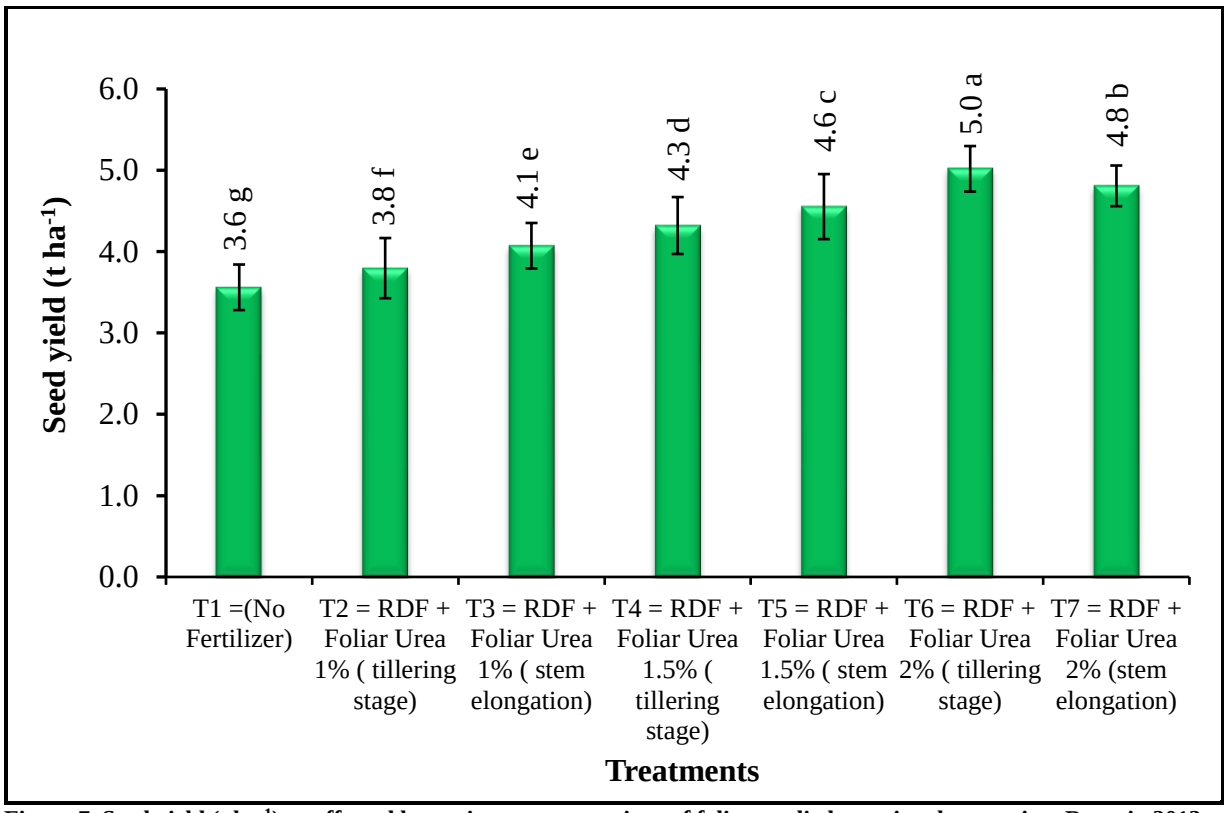

Figure 7. Seed yield (t ha^{-1}) as affected by various concentrations of foliar applied urea in wheat variety Benazir-2013.

Seed yield (kg ha^{-1}): Seed production potential of cultivar depends on the genetic makeup, including other cultural practices such as rate of fertilizer and its application method (Alam & Jahan, 2013). The results about seed yield kg ha^{-1} are shown in Figure 7. The maximum seed yield (5.0 t ha^{-1}) was observed with $T_{6:}$ RDF + 2% Urea at tillering stage ; while the decreasing trend in seed yield 4.8, 4.6, 4.3, 4.1, 3.8 and 3.6 t ha^{-1} was recorded by the application of $T_{7:}$ RDF + 2% Urea at stem elongation, $T_{5:}$ RDF + 1.5% Urea at stem elongation, $T_{4:}$ RDF +1.5% Urea at tillering stage , $T_{3:}$ RDF + 1% Urea at stem elongation and $T_{2:}$ RDF + 1% Urea at tillering stage and $T_{1:}$ Control respectively. It is observed from the study that proper nutrient application at critical reproductive stages resulted significant impact on yield performance of crop (Anadhakrishnaveni et al., 2004). Farooq et al., 2012 also noted increased seed yield (5.47 t ha^{1}) with the 8% foliar applied urea at tillering stage in the wheat variety Ujhala. Similarly Ratan Lal et al., 2020 recorded 6.26 t ha^{-1} grain yield with RDF + 1% foliar spray of urea at flowering stage of wheat variety Raj.-4037.

It can be concluded that the recommended dose of fertilizer with a 2% concentration of foliar urea at the tillering stage performed better in all yield-contributing traits of wheat variety Benazir-2013. It is also noted that the highest seed yield (5.0 t ha-1) was achieved by the recommended dose of Fertilizer (RDF) 168+84+60 NPK kg ha-1 (soil applied) in combination with 2% Urea foliar applied at the tillering stage. It is therefore, suggested that this concentration of fertilizer could be used for achieving desired yield, particularly from the Benazir-2013

variety of wheat. It was also pragmatic that foliar applied nitrogen notably improved the performance of tested variety.

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