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Short Communication

Impact of Basal and Split Potassium Application on Yield Parameters of Two Wheat Varieties

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Abstract. Traditionally, potassium is applied in a single dose as a basal application on wheat crop which is unavailable to plants for later stages of growth due its luxury consumption by plants during initial stages of growth, adsorption to colloids, absorption by soil microbes and leaching loses. However, potassium application in an appropriate manner by altering its mode of application can greatly influence crop yield. Therefore, the experiment was conducted to study the impact of basal and split potassium application on yield and attributing traits of two wheat varieties at the experimental field of barley and Wheat Research Institute Tandojam, Pakistan during 2018-19. Two wheat varieties, namely TD-1 and Kiran-95 were sown in two factor randomized complete block design (main plot = varieties, sub plots = treatments) with three replications. The treatments were as follows: T_1 = No K application, T_2 = K application at 60 Kg K_2O/ ha at the time of sowing, T_3 = K applications in two splits, *i.e.* 30 Kg K_2O/ha at sowing and 30 Kg K_2O/ha at tillering stage. The K application in two splits showed greater response as compared to basal application alone. In case of varieties, TD-1 performed well relatively in all parameters. Moreover, the highest number of tillers 12.13 per plants, number of grains 611.75 per plant, seed index (51.5), grain yield 2661.80 Kg/ha, straw yield 4503.30 Kg/ha, K content in grains (0.56%) and K content in straw (0.96%) was observed in split K application. For higher crop production therefore, K should be applied in two splits application.

Keywords: basal and split application, potassium, yield parameters, wheat

Wheat (*Triticum aestivum* L.) is one of the most important and productive cereal crop of the world. It is the basic source of daily energy requirement and plays a significant role in food security of the world (Maha *et al*., 2019). Wheat is cultivated on 22 million acres in Pakistan with production of 26.394 million tonnes.

Potassium (K) is the most central macronutrient after nitrogen (N) and phosphorus (P), which is critically required for sustaining crop yield production. Commonly, potassium content in plants is higher than all other macronutrients except carbon, oxygen, hydrogen and occasionally nitrogen (SQO, 2015). It is one of the important elements for plant growth, metabolism and adds significantly to the survival of plants in numerous stresses (Pettigrew, 2008). Under rigorous cropping system with inadequate K fertilization, soil K reservoirs have started depleting which results in yield losses and abundant economic risk to farmers (Srinivasarao *et al*., 2011). In the absence of potash, the physiological stress will be more damaging for plants (Annadurai *et al*., 2000). Application of K considerably enhances the uptake of nitrogen and phosphorous in straw as well as grains of wheat (Saifullah *et al*., 2002). Besides, it also increases concentration of potassium and zinc in the grain (Hussain *et al*., 2020). The hasty uptake of nitrogen as negatively charged ions (NO_3^-) is generally balanced by an analogous taken up of positively charged potash ions (K^+) which sustains the electrical neutrality in plants. Therefore, balanced potash application is crucial for the quality production of wheat crop (PDA, 2012). In general, crops take more K from soils than the present amount as water-soluble and exchangeable (Wani *et al*., 2009). Generally, crops take all K from soluble and exchangeable forms. The surplus amount of K is taken up by plant from applied inorganic fertilizers (Yadav *et al*., 1993).

The mobile soil testing laboratories of Fauji Fertilizer Company extensively analyzed the available K status in soils and concluded more than 30% of soils are deficient in available K application (Akhtar *et al*., 2003). In a single dose potassium application it may not be available to plants in later stages due to luxury consumption by

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crop at initial stage, competition between micro-organisms and plants and leaching losses (Annadurai *et al*., 2000). Moreover, K applied as a single dosage may cause salinization and cationic imbalance with respect to calcium and magnesium concentration (Filgueira, 2008; Echer, 2007).

On the other hand, potassium application in an appropriate manner by altering its mode of application in crop yield (Saleem *et al*., 2011). Also, application of K in splits stimulates nitrogen uptake, increases protein content and wet gluten in wheat grains rather than basal application alone (Yu *et al*., 2007). The use of K fertilizers effect on vegetative growth of plants (Romheld and Kirkby, 2010). Similarly, application of K in splits is highly useful for increasing grain yield, quality along with improving net nutrient balance in soil (Pandy *et al*., 2019). Potassium in splits also enhances the grain yield by 8.8% than that of full dose as a basal application (Vijayakumar *et al*., 2019). The K helps to boost the amount of sucrose, amassing of starch in the grains as well as final production (Liang and Yu, 2004). However, in Pakistan, conventionally potassium is applied in a single application as a basal dose in wheat crop. Regretfully, little work has been done on influence of split K application on wheat crop. There was a huge gap left to determine the effect of K application in splits. Hence, this study was conducted to know the impact of basal and split potassium nutrition on the yield parameters of two wheat varieties. The soil was clay loam in texture, slightly alkaline in reaction which is shown in Table 1.

Effect of variety. Genetically diverse wheat genotypes perform different doses of potassium (Mahfuza *et al*., 2008). TD-1 and Kiran-95 genotypes demonstrated strong trends with the different modes of K applications. Similarly, both the varieties demonstrated a bit dissimilar response. TD-1 variety comparatively displayed more response to split application of K. These results were also supported by (Sterns *et al*., 2001).

Table 1. Physico-chemical properties of soil

Characteristics	Value
pH	8.3
EC (dS/m)	1.43
Organic matter (%)	0.64
Lime content (%)	7.2
Potassium – ABDTPA (mg/Kg)	87
Sand	42.50
Silt	26.50
Clay	31
Textural class	Clay loam

Effect of split application of potassium. The results indicated that split application of K greatly affected both the varieties TD-1 and Kiran-95. On the basis of yield performance potassium application at the rate of 60 Kg/ha in two splits, *i.e*. K_2O 30 Kg/ha at the time of sowing and 30 Kg K_2O/ha at tillering was recorded to be the best for getting maximum yield of two wheat varieties. These findings are supported by (Qiang *et al*., 2014; Wang *et al*., 2008; Zou *et al*., 2006) and they concluded that split application of K can be used to increase yield or improve the quality of wheat. Additionally, this collected data properly matched with the findings of (Romheld and Kirkby, 2010; Roberts, 2008) who stressed that the application of K in splits during the growth period has proven to be beneficial by lowering risk of K losses through leaching and also raises the K use efficiency of fertilizers applied. Likewise, (Singh and Singh, 2013) supported the above studies and stated that split K applications have beneficial effects on growth and yield of crops as compared to single dose applied either at sowing or tillering stage.

On the other hand, potassium at the rate of 60 Kg/ha as a single basal application resulted in low production. This signifies that the application of potassium in a single dose is not suitable for getting maximum crop yield. Because of potassium may not be available to plants in later stages due to luxury consumption by crop at initial stage, adsorption with soil collides, absorption by soil microbes and leaching losses. The similar trends were reported by (Saleem *et al*., 2011; Annadurai *et al*., 2000). Furthermore, the lowest yield was observed in both the varieties under control (0 Kg K_2O/ha). The similar results were reported by (Srinivasarao *et al*., 2011; Annadurai *et al*., 2000).

Number of tillers/plant. The maximum number of grains per plant were recorded in variety TD-1 (12.13) in treatments which received K in two splits while, the minimum number of tillers per plant (6.10) were recorded at 0 Kg K_2O/ha (control) in Kiran-95 (Fig. 1). Generally, split application of potassium performed well in both the varieties followed by a basal application of K once only. These results were supported by (Qiang *et al*., 2014; Singh and Singh, 2013) who reported that the application K in splits increases yield of wheat and improves its quality.

Number of grains/plant. The maximum number of grains per plant were recorded in plants which received 60 Kg K_2O/ha in two splits followed by 60 Kg K_2O/ha as a basal application once only, while the minimum number of grains per plant were recorded in control.

(Vijayakumar *et al*., 2019; Wang *et al*., 2008; Zou *et al*., 2006) observed that split application of K improves quality of wheat grain as well as enhances yield. According to varietal differences the maximum number of grains per plant were recorded in variety TD-1 (611.75) and Kiran-95 (475.30) respectively (Fig. 2).

Seed index (1000 grains weight, g). Application of K in splits helps to boost the amount of sucrose, encourages the amassing starch in the grains as well as increases the final production (Liang and Yu, 2004). The treatments which received 60 Kg K_2O/ha in two splits recorded the highest seed index followed by 60 Kg K_2O/ha as a basal application once only while the minimum number of grains were recorded in control (Fig. 3). However, variety TD-1 resulted in higher seed index (51.60 g) than Kiran-95 (48.30 g). Potassium is critically important for metabolism, activation of several enzymes and affects starch synthesis. Thus, K availability has an intense effect on grain development (Annaduraiet *al*., 2000). Due to low K uptake from the soil grains produced in the control treatment were light in weight (Tahir *et al*., 2008) observed that the seed index of wheat increases by adding K fertilizers.

Grain yield (Kg/ha). Potassium in splits also enhances the grain yield by 8.8% than that of full dose as a basal application (Vijayakumar *et al*., 2019). The maximum grain yield Kg/ha was recorded in treatments which received 60 Kg K_2O/ha in two splits followed by 60 Kg K_2O/ha as a basal application once only whereas the minimum grain yield Kg/ha were recorded in control (Fig. 4). (Yu *et al*., 2007) determined potassium in splits stimulates nitrogen uptake, increases protein content and wet gluten in wheat grains as compared to basal application alone. According to varietal differences the maximum grain yield was observed in variety TD-1 (5261.80) followed by Kiran-95 (4939.70).

Straw yield (Kg/ha). When potassium is applied in a single dose it may not meet the crop demand during the later stages of development (Filgueira, 2008; Echer, 2007). Fig. 5 the maximum straw yield Kg/ha was recorded in variety TD-1 (4503.30) in treatments which received 60 Kg K_2O/ha in two splits while the minimum straw yield Kg/ha was recorded in control in variety Kiran-95. However, split, application of potassium performed well in both the varieties followed by a basal application of K once only. These results were in line with the findings of (Pandy *et al*., 2019) potassium application in splits significantly increases grain yield as well as straw wheat crop.

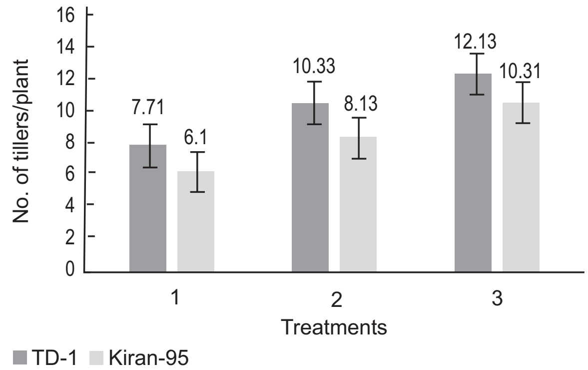

Fig. 1. Number of tillers/plant as affected by modes of potassium application.

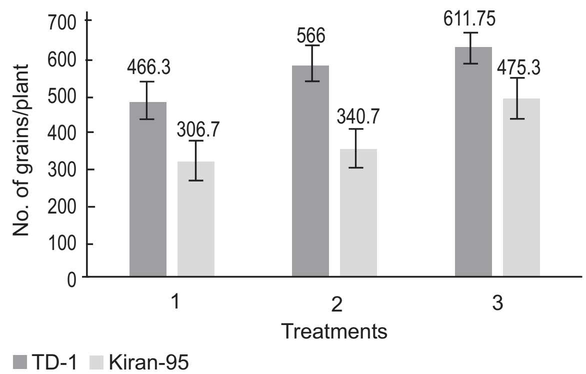

Fig. 2. Number of grains/plant as affected by modes of potassium application.

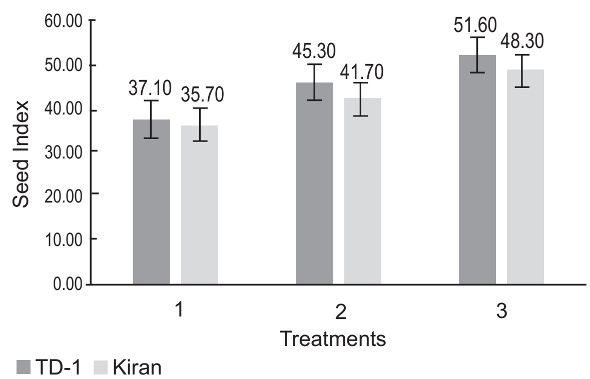

Fig. 3. Seed index (1000 grain weight (g) as affected by modes of potassium application grain yield (Kg/ha).

Potassium content in grains (%). The rapid uptake of NO_3^- ions is normally balanced by an analogous uptake of positively charged potash ions (K^+) which sustains the electrical neutrality in plants. Hence, potash application is crucial for increasing K content in wheat crop

(PDA, 2012). The maximum potassium content in grain (%) of wheat crop was recorded in treatments which received 60 Kg K_2O/ha in two splits followed by 60 Kg K_2O/ha as a basal application once only while the minimum straw yield Kg/ha was recorded in control (Fig. 6). According to varietal differences the potassium content in grains (%)was observed in variety TD-1, while, the minimum in control of variety of Kiran-95. (Romheld and Kirkby, 2010) observed that K fertilizers in splits reduces the risk of its losses through leaching and at the same time it raises the K use efficiency fertilizers.

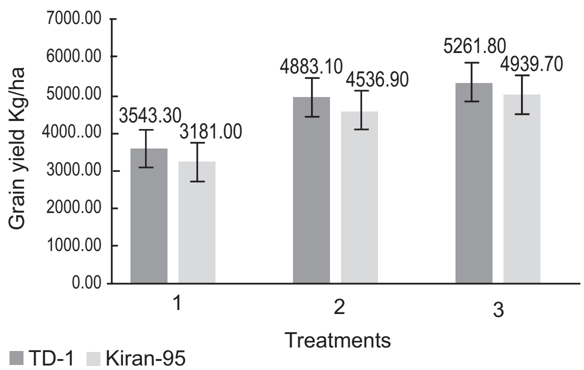

Fig. 4. Grain yield (Kg/ha) as affected by modes of potassium application straw yield (Kg/ ha).

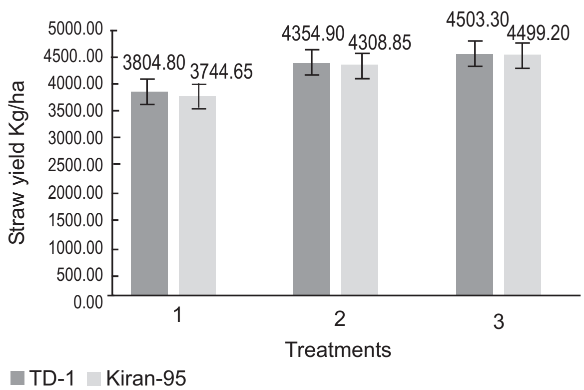

Fig. 5. Straw yield (Kg/ha) as affected by modes of potassium application.

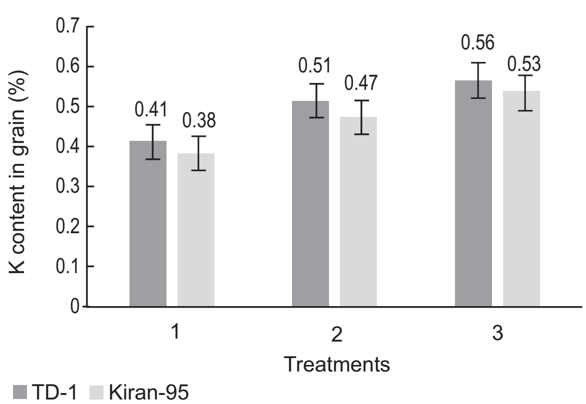

Fig. 6. Potassium content in grains (%) as affected by modes of potassium application.

Potassium in straw (%). The similar trend was observed in straw yield as was observed in grain yield due the interaction effect of variety and K split application. Fig. 7 the maximum potassium in straw (%) of wheat crop was recorded in treatments which received 60 Kg K_2O/ha in two splits followed by 60 Kg K_2O/ha as a basal application once only, while the minimum straw yield Kg/ha were recorded in control. However, TD-1 variety comparatively accumulated more K content.

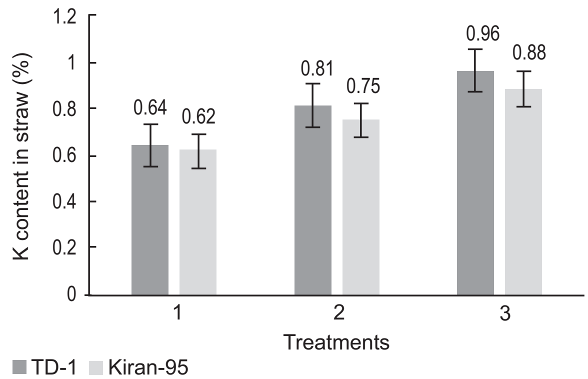

Fig. 7. Potassium content in straw (%) as affected by modes of potassium application.

Conclusion

The K application in two splits showed great response as compared to basal application alone. Therefore, these genotypes proved that they have strong tendency with the different modes of K applications. In case of varieties, TD-1 outdid Kiran-95 in terms of grain yield, straw yield, number of tillers per plant, number of grains per plant, seed index and K percentage in grains and straw. On the other hand, the two selected local wheat varieties namely, TD-1 and Kiran-95 illustrated different responses. Variety TD-1 exhibited more response from split K applications in terms of growth and final yield as compared to Kiran-95.

Conflict of Interest. The authors declare that they have no conflict of interest.

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