Improving the spike initiation and flowering stage heat tolerance in bread wheat through foliar application of potassium

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ABSTRACT

Background: Coincidence of heat with terminal stages of wheat is chief constraint to accomplish yield potential.

Objectives: The present study was aimed at comparing thermo-sensitivity of terminal stages, optimizing foliar potassium to alleviate heat and exploring association of metabolites with agronomic attributes.

Methodology: The experiment was laid out in randomized complete block design under split arrangement and repeated over two years. Treatments were comprised of heat stress imposition in main plots viz. H_0 = No heat stress; H1 = heat imposition from spike initiation to grain filling initiation and H_2 = heat imposition from flowering initiation to grain filling initiation and foliar potassium (K) in sub plots viz. K_0 = Water spray (control), K_{15} = 15 g L^{-1} K; K_{30} = 30 g L^{-1} K; K_{45} = 45 g L^{-1} K and K60 = 60 g L^{-1} K.

Results: Imposition of 'H_1' proved more deleterious for metabolites, water relations and agronomic attributes compared to 'H_0' and 'H_2'. Application of 45 g L^{-1} K proved beneficial for enhancing the synthesis of phenolics, proline, soluble proteins and for improving water potential under 'H_0'. While, 60 g L^{-1} K induced more promising responses in these attributes under 'H_1' and 'H_2'. Application of 45 and 60 g L^{-1} K proved equally effective for improvement of agronomic traits compared to other doses over H_0, 'H_1' and 'H_2'.

Conclusion: Decisively, more promising responses were observed with 45 g L^{-1} potassium under 'H_0' and 60 g L^{-1} potassium under 'H_1' and 'H_2'. Agronomic attributes were strongly associated with biochemical parameters.

Keywords: Correlation, non-enzymatic antioxidants, osmo-protectants, oxidative stress, phenolics, proline, reproductive stages, water relations

INTRODUCTION

Coincidence of high temperature with reproductive growth stages of wheat is chief constraint in accomplishment of potential yield of wheat around the globe. Rise of temperature is highly detrimental for varying terminal phenological stages of wheat particularly spike initiation and flowering. Heat stress at reproductive stages of wheat causes shriveling of grains, decreases spike length and reduces number of grains. Foliar potassium is a potent tool for boosting of numerous physiochemical processes under stress conditions. Exogenous application of potassium enhances the

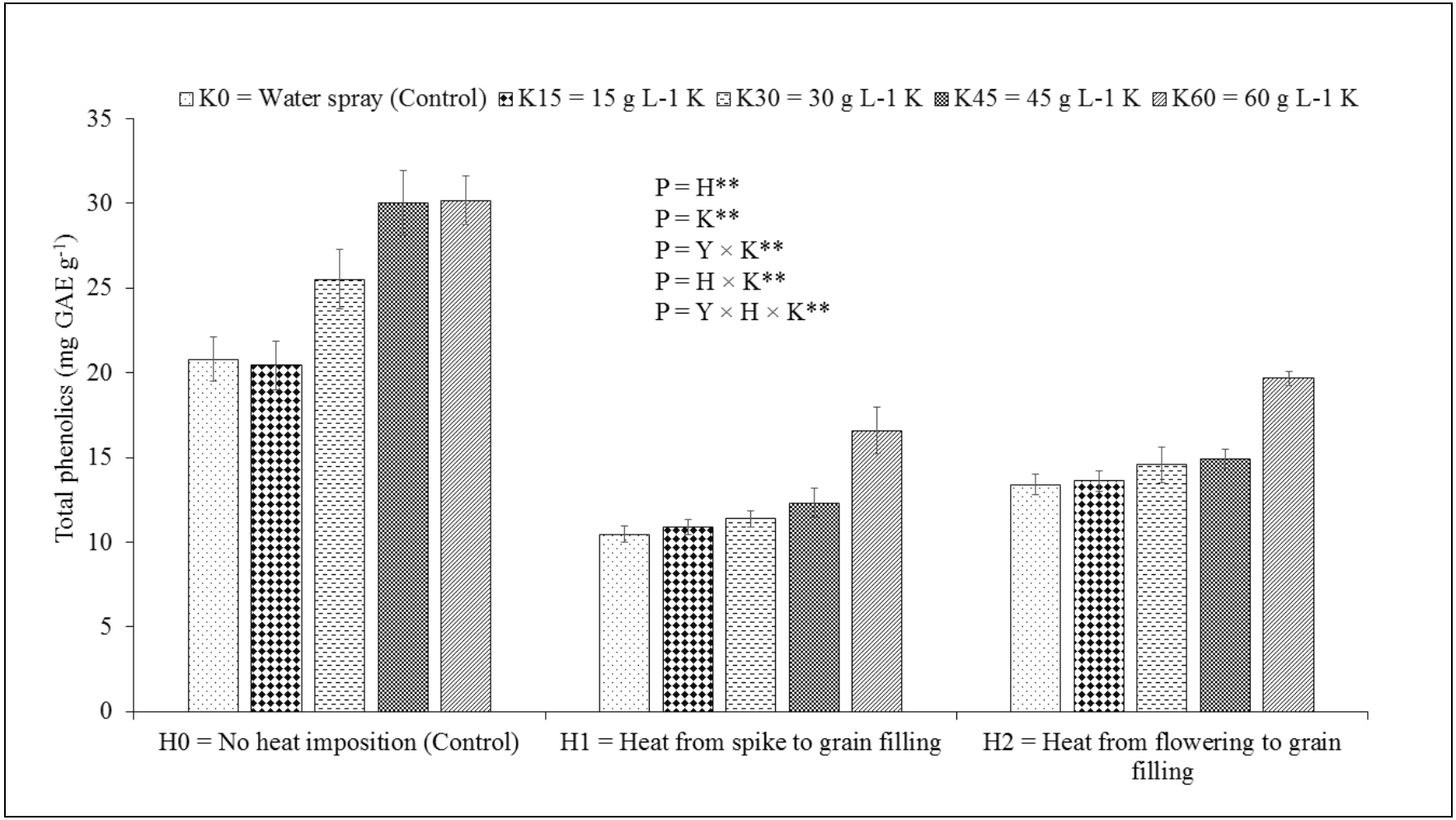
biosynthesis of phenolics under stress environments. Potassium instigated increase in synthesis of osmo-protectants decreases the availability of free water for evaporation under stress and improves capacity of cells to retain water and turgor under stress conditions. Improvement in synthesis of phenolics increases photosynthetic efficiency by upregulating zeaxanthin under heat. Moreover, potassium mediated upregulations in synthesis of phenolics improves the capability of heat dissipation of reaction center of photosystem-II. Moreover, availability of potassium accelerates the partitioning of carbohydrates from phloem to reproductive parts under stress. Therefore, improved synchronization of source-sink relationship due to potassium availability increases growth of reproductive parts and improves productivity

METHODOLOGY

The experiment was conducted at Agronomic Research Area, University of Agriculture Faisalabad Pakistan during 2015-16 and repeated in 2016-17. The experiment was laid out in randomized complete block design under split treatment structure and treatments were replicated three times. Significance ($p \leq 0.05$) of treatments was determined using Fisher's Analysis of variance technique. Means were compared using Tukey's Honestly Significant Difference (Tukey's HSD) test to determine statistical differences among heat and foliar potassium treatments. Total phenolic contents were quantified using Folin-ciocalteu reagent method. Total soluble proteins were determined by extracting leaf tissues in potassium phosphate buffer having pH 4.

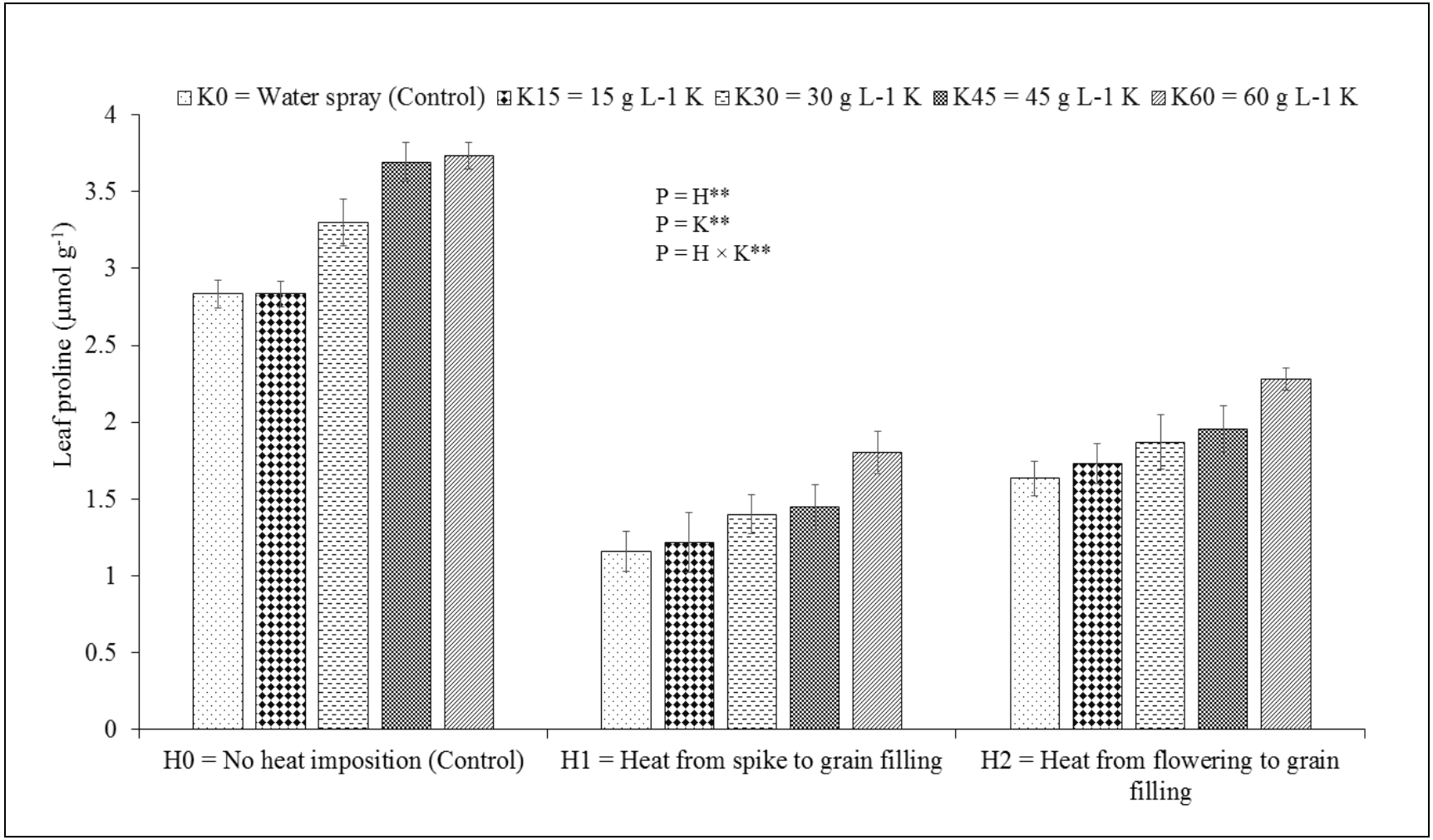
RESULTS

Fig. 1 Effect of foliar applied potassium on total phenolics of heat stressed wheat



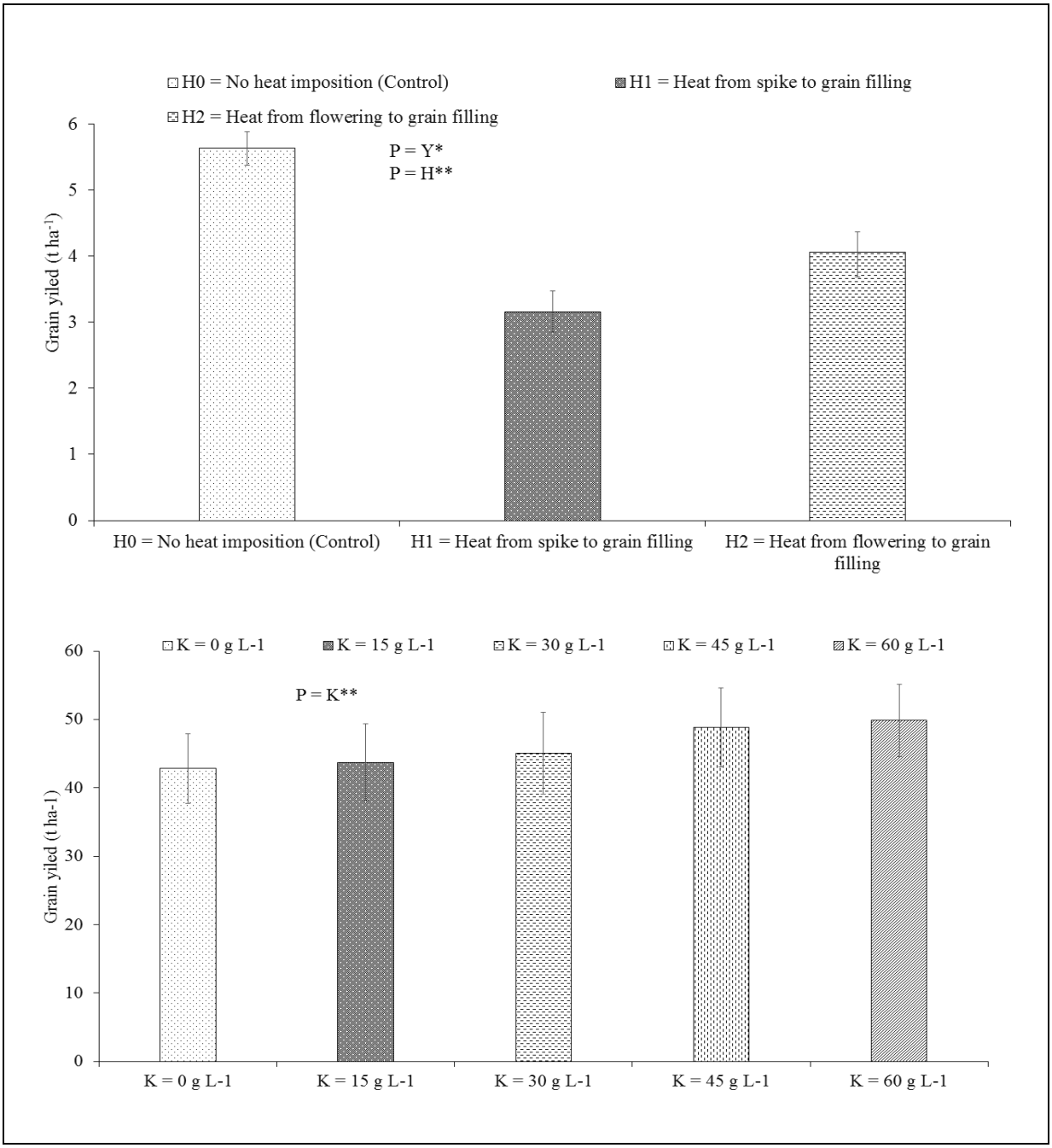
** = Significant ($P \leq 0.01$); Y = Years; H = Heat stress; K = Foliar potassium

Fig. 2 Effect of foliar applied potassium on leaf proline of heat stressed wheat



** = Significant ($P \leq 0.01$); H = Heat stress; K = Foliar potassium

Fig. 3 Effect of foliar applied potassium and heat stress on grain yield of wheat



** = Significant ($P \leq 0.01$); K = Foliar potassium

CONCLUSION

More promising responses were observed with 45 g L^{-1} potassium under 'H_0' and 60 g L^{-1} potassium under 'H_1' and 'H_2'. Agronomic attributes were strongly associated with biochemical parameters.

REFERENCES

Muhammad Shahid, Muhammad Farrukh Saleem, Amna Saleem, Muhammad Sarwar and Arshad Hussain. 2022. Improving the spike initiation and flowering stage heat tolerance in bread wheat through foliar application of potassium. Journal of Plant Growth Regulation. https://doi.org/10.1007/s00344-022-10758-3.