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Original article

Feasibility of variable rate application of diammonium phosphate fertilizer to wheat crop under center pivot irrigation system

Ahmed M. Zeyada [a,*], Khalid A. Al-Gaadi [a,b], ElKamil Tola [b], Ali S. Amrir [c], Rangaswamy Madugundu [b], Samy A. Marey [d,e], Ahmed A. Alameen [b]

[a] Department of Agricultural Engineering, College of Food and Agriculture Sciences, King Saud University, Riyadh 11451, Saudi Arabia
[b] Precision Agriculture Research Chair, Deanship of Scientific Research, King Saud University, Riyadh 11451, Saudi Arabia
[c] Department of Soil and Reclamation, Faculty of Agriculture, Al-Furat University, Syria
[d] Science, Technology and Innovation Unit, King Saud University, Riyadh, Saudi Arabia
[e] Agricultural Engineering Research Institute (AENRI), Agricultural Research Center, P.O. Box 256, Giza, Egypt

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ABSTRACT

A study was conducted, on a 30 ha wheat field under a solar energy powered center pivot irrigation system in a commercial farm located 400 km north of Khartoum, Sudan, to evaluate the feasibility of variable rate fertilizer application of Diammonium Phosphate (DAP) on wheat crop based on variable soil phosphorus content. Soil phosphorus content was divided into three categories (low: 3.75 to 4.50 ppm, medium: 4.51 to 5.25 ppm and high: 5.26 to 6.00 ppm) and a GIS soil phosphorus content map of the experimental field was generated. Three variable application rates (200 kg ha^{-1}, 160 kg ha^{-1} and 120 kg ha^{-1}) of granular DAP fertilizer were determined to fit the low, medium and high soil phosphorus contents, respectively. The the DAP fertilizer rate of 200 kg ha^{-1} was the rate practiced for wheat production in the experimental farm.

The normalized Difference Vegetation Index (NDVI), measured at different wheat growth stages using sentinel-2 satellite images, and wheat grain yield were used to evaluate the response of wheat crop to the variable DAP fertilizer application rates. Excluding the tillering stage, the results showed significant differences in the NDVI values among different soil phosphorus levels and DAP fertilizer application rates at other growth stages, including stem elongation, grain filling and maturity stages. Moreover, wheat yield results showed significant differences among different soil phosphorus contents ($P > F = 0.0001$) and DAP fertilizer application rates ($P > F = 0.0457$). On the average, the highest yield of 2.449 t ha^{-1} was recorded in the field areas treated with the high DAP fertilizer application rate (200 kg ha^{-1}), where the second highest yield of 2.441 t ha^{-1} was observed in field areas under the medium DAP fertilizer application rate (160 kg ha^{-1}); however, no significant differences between these two yield values. Based on these results, the total savings of the DAP fertilizer was estimated to be 792 kg (equivalent to 475.2 $) in the experimental field (30 ha), only when the medium DAP fertilizer rate (160 kg ha^{-1}) was used in the medium and high soil phosphorus zones, saving 15.84 $ ha^{-1} without affecting production.

1. Introduction

Conventional agricultural practices do not take into consideration the spatial variations existing in the fields, but rather treat them as homogeneous units. Ignoring the spatial field variability can result in over-application of agricultural inputs or practices in some areas of the field and under-application in others, which will lead to poor application of inputs and/or practices (Ghosh and Mandal, 2000). Precision agriculture (PA) is an ever-evolving technology that aims at avoiding the poor application of agricultural inputs and practices by using geo-referenced data for better

* Corresponding author.
E-mail address: azeyada@ksu.edu.sa (A.M. Zeyada).
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