

Pneumatic System for Granular Fertilizer Flow Rate Control

¹Z. Talha, ²E. Tola, ³K.A. Al-Gaadi and ⁴A. F. Kheiralla

¹White Nile Sugar Company, P.O. Box 11218, Khartoum, Sudan

²Precision Agriculture Research Chair (PARC), College of Food and Agricultural Sciences,
King Saud University, P.O. Box 2460, Riyadh 11451, Saudi Arabia

³Department of Agricultural Engineering, Precision Agriculture Research Chair,
College of Food and Agricultural Sciences,

King Saud University, P.O. Box 2460, Riyadh 11451, Saudi Arabia

⁴Department of Agricultural Engineering, Faculty of Engineering,
University of Khartoum, P.O. Box 321 Khartoum, Sudan

Abstract: Variable-rate technology is an essential part of precision farming that can solve the economical and environmental problems associated with traditional farming practices. Utilization of the technology has been limited by the lack of the development of variable-rate applicators. In this study, a control system for mechanical fertilizer rate adjustment was designed and developed. The control system equipped with pneumatic drive was composed of a double acting cylinder, a double solenoid operated valve 5/2, a computer, a microcontroller, a rotary encoder and other operating parts. The developed control system performance and discharge characteristics were evaluated in the laboratory. The main results of this study could be summarized as follows: (i) the automatic setting of the target fertilizer application rate could be performed efficiently and (ii) the developed system could be precisely used for granular fertilizer variable rate application, with an overall error (from the target fertilizer rate) in the range of $\pm 6\%$. This work will be a useful contribution in the area of variable rate technology as it enhances the application of pneumatic drives for their low cost and design simplicity.

Key words: Precision Agriculture • Variable Rate Technology • Pneumatic Drive • Granular Fertilizer

INTRODUCTION

Traditional farming practices relied on massive application of agricultural chemicals to increase yields. Mass application of chemicals in agriculture resulted in contamination of the environment and agricultural products. Recent increase of consumer demands for safe agricultural products requires sustainable farming practices approaches. The conventional uniform application of fertilizers disregards the productive potential of the various areas within the field. Consequently, some areas are under-fertilized and the others are over fertilized. Increasing the rate of fertilizer generally increases crop yield up to an optimum level, but more fertilizer is less utilized or mobilized.

Precision farming refers to treating within-field variability with spatially variable input application rates using a set of technologies to identify the variability and its causes and prescribes and applies inputs to match spatially variable crop and soil needs. Variable-rate

application (VRA) of granular fertilizer material is a common practice in precision agriculture. Granular fertilizers need to be accurately delivered at the prescribed application rates to accomplish the desired outcome of correcting within-field variations in plant nutrients. Granular applicators equipped with VRA have gained popularity in recent years as a result of increased interest in variable-rate application. Swisher *et al.* [1] designed an optical sensor to measure flow rates of granular fertilizer in air streams for feedback control of a variable-rate spreader. Uniform-rate (UR) tests were conducted to assess the accuracy of VRA from four granular applicators: two spinner-disc spreaders and two pneumatic applicators. That experiment showed potential application errors with variable-rate application and the need for proper calibration to maintain acceptable performance. Furthermore, the study demonstrated the need for a VRT equipment testing standard [2]. Yu *et al.* [3] reported on a control system for variable-rate application of granular fertilizer in paddy farming.