INFLUENCE OF PLANTER WIDTH, PLANTING SPEED AND FIELD CHARACTERISTICS ON FIELD EFFICIENCY FOR ROW CROP PLANTERS

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Abstract

Cotton producers are looking at increasing planting capacity by either investing in wider planters or planters that are capable of planting at higher speeds. Machine capacity information is crucial for machinery management decisions. Machine capacity is used to predict how equipment will perform in a specific farming operation and it determines the timeliness of that operation. Theoretical field capacity (TFC) is the maximum possible field capacity of a machine operating at 100% of its width for a given speed. For planters, TFC is a function of planter width and planting speed. This capacity cannot be sustained for long periods of time. Secondary functions such as loading seed boxes, turning at end rows, checking seed depth placement, and downtime in the field reduce the time the planter is performing its primary designed function of planting. This study was conducted to investigate the influence of planter width, planting speed and field characteristics on machine efficiency.

Planting data was collected in Tennessee and Oklahoma during the 2016 planting season using three different planter widths. In western, TN, planting data was collected using a John Deere 40-ft wide ExactEmerge planter in 50 fields totaling 1,454 acres, with the majority of these fields smaller than 50 acres. A John Deere 60-ft wide ExactEmerge planter was used in North central, OK and a John Deere 60-ft wide MaxEmerge planter was used in western, OK. These two planters were used in 64 fields totaling 4,673 acres with the majority of these field above 50 acres. In central and western, OK, data was collected with an 80-ft wide John Deere MaxEmerge planter in 25 fields totaling 2,173 acres with the majority of the field above 50 acres.

Data was collected using a Vector GL1000 Compact Data Logger plugged into the Controller Area Network (CAN) Diagnostics Port located in the tractor cab. Messages that were collected from the CAN bus included latitude/longitude, GPS time, ground speed, engine rpm, fuel use, and status of the Selective Control Valve 1 (SCV1). Field efficiency calculations were based on the status of the Selective Control Valve 1 (SCV1) that operated the planter's hydraulic system. When the status of SCV1 valve was open, the planter was assumed to be in the ground planting. If the SCV1 was in the closed position, the planter was assumed to be in the up position and not planting. After data collection was completed, the logger files were uploaded into Vector CANoe software and exported as a MATLAB format. MATLAB software was used to aggregate the data from each CAN bus message into 1-sec intervals. Once data aggregation was completed, data was exported as a comma-separated value (CSV) file. This file was then imported into ArcMap 10.4 for post processing. The three steps used for final data processing included; 1) creating individual field boundaries, 2) associating data within each field boundary, and 3) assigning new classification values to the data points. The variables included in the field efficiency analysis were time planting, time turning, time spent travelling within the field, time spent folding and unfolding the planter, time spent loading seed and time spent checking for proper seed depth. Field efficiency for each individual field was calculated by dividing the observed field capacity by the theoretical field capacity. The speed used to calculate the theoretical field capacity was the average of all data points classified as planting with speed greater than 0.05 mph. The observed field capacity was calculated by dividing the number of acres in the field by the total time spent in the field.

Observed field efficiencies ranged from 35.3 to 81.4 percent for the 40-ft wide planter, 28.6 to 85.7 percent for the 60-ft wide planter and 34.7 to 81.3 percent for the 80-ft wide planter. The average field efficiency across all fields for an individual planter width were 59.6, 70.4 and 65.9 percent for the 40-ft, 60-ft and 80-ft wide planters, respectively. One would expect as planter width increased, the average field efficiency would decrease. This relationship held true for the 60- and 80-ft wide planters, but the average field efficiency for the 40-ft wide planter was observed to be much lower than both the 60- and 80-ft wide planters. This relationship can be attributed to the field size distribution of the Tennessee and Oklahoma fields used in this study. The Oklahoma data set for the 60-ft and 80-ft wider planters contained a much higher proportion of large fields with larger perimeter to area ratios than the Tennessee data set Perimeter to area ratio was observed to have a major influence on field efficiency. As perimeter to area ratio decreased, observed field efficiency decreased for all planter widths. Based on these results, planting the same fields in Oklahoma with a 40-ft wide planter would result in higher field efficiency values than those observed for the 60- and 80-ft wide planters.

Multiple linear regression using the variables of planter width, perimeter to area ratio and planting speed was performed on the entire data set. Perimeter to area ratio was found to be the only variable highly significant, with width only moderately significant. This result was unexpected since both planter width and planting speed influence field efficiency. One possible explanation is the higher proportion of large fields with larger perimeter to area ratios. Two apparent trends were observed when comparing field size versus field efficiency. There was a rapid increase in field efficiency in field sizes up to 50 acres. For field sizes above 50 acres, field efficiency reached a plateau. This result would indicate the data set needs to be modeled differently based on field size. The data set was divided into two separate data sets, fields less than 50 acres and fields above 50 acres. Multiple linear regression using the variables of planter width, perimeter to area ratio and planting speed was performed on both data sets. Planter width and perimeter to area ratio were found to be significant for both the small and large field models. With respect to speed, the coefficient for the large fields was not significant. For the small fields, the coefficient for speed was highly insignificant and positive. The reason speed was not found to be significant might be explained by factors influencing the average planting speeds observed in the data. Observed data for planting speeds for all three planter widths ranged between 5 to 8 mph. Factors such as operator preference, field characteristics (size and shape), field conditions (ruts, residue, and topography) and crop type had an influence on planting speed.