

Performance Evaluation of a Cup-Belt Potato Planter at Different Operation Conditions and Tuber Shapes

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Abstract: A field study was conducted to investigate the performance of an auto-feed cup-belt potato planter under different operation conditions with different tuber shapes. The operation conditions included in the study encompassed three forward ground speeds (1.8, 2.25 and 3.0 km/h), four ratios of forward speed to feeding mechanism speed (1.22, 1.39, 1.78 and 2.00) and two feeding gate heights (80 and 100 mm). The whole and cut tubers were utilized to provide different shapes of the tubers that relatively had the same size considering the tuber longest dimension. The performance of the planter was evaluated based on the coefficient of variation (CV), the multiple index (MULTI), the miss index (MISI), the quality of feed index (QFI) and the precision index (PREC). Results of the study revealed that the tuber shape was statistically found to have a significant effect on the CV and the QFI only. For whole and cut tubers, the CV and the MISI were proportional to the forward speed; however, inversely proportional to the gate height and speed ratio. The highest CV and MISI values of 68.4% and 16.42%, respectively, were observed for cut tubers at 3.0 km/h, 1.22 and 80 mm for ground speed, speed ratio and gate height, respectively. On the other hand, the QFI, in case of the whole and cut tubers, as well as MULTI, for cut tubers, were found to be, on the average, inversely proportional to the ground speed and proportional to the speed ratio and gate height. Lower MULTI values were found to generally associate with the cut tubers. The maximum MULTI of 7.76% was observed in the whole tuber data set at 1.8 km/h, 2.00 and 100 mm for ground speed, speed ratio and gate height, respectively. However, the maximum QFI value of 91.66% was associated with the cut tubers at 1.8, 1.78 and 100 mm for ground speed, speed ratio and gate height, respectively. In addition to the tuber shape, gate height and speed ratio showed a negligible effect on the CV of the accepted tuber spacing (PREC). The PREC was found to be proportional to the ground speed, where the value of this index increased from 14.89 to 19.81% as the ground speed increased from 1.8 to 3.0 km/h for the whole tubers at 1.22 and 80 mm for speed ratio and gate height, respectively.

Key words: Potato planter • Operation conditions • Performance evaluation • Tuber shape • Multiple index • Miss index • Quality of feed index • Precision index

INTRODUCTION

Potato is viewed as one of the most important vegetable crops in the world. In Saudi Arabia, a potato production development program was established in 1974 to study the possibilities of increasing the potato cultivated area and explore the problems that may hinder the spread of its cultivation. In 2010, the potato plantation reached over 17,665 ha in Saudi Arabia, with an annual production of about 444,138 tons [1]. Potato planting is considered as a very crucial and critical operation because it directly affects the yield and the farming cost, as the

price of potato tubers mounts to about 60% of the total potato production cost [2].

The performance of several potato planters has been investigated by many researches and studies. Ghonimy and Rostom [2] found that potato yield reached up to 20.95 t/ha when a cup-belt prototype planter was used compared to 19.52 t/ha with a cup-chain prototype planter. They also stated that the automatic cup-feeding system exhibited the best performance compared to the automatic chain and the semi-automatic tray feeding systems. In addition, they concluded that higher coefficient of variation was found with auto-feed cup planter compared

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