ABSTRACT

Sugarcane is a vegetatively propagated crop, cultivated in more than 80 countries. However, its process of production is still a major economic challenge in terms of the seed rate, seed preparation and cultivation. The present investigation was specifically planned to design and develop a machine vision based mechatronic system for sugarcane bud identification and cutting, and a tractor operated sugarcane bud planting machine integrated with an autonomous fungicide application system.

The developed sugarcane planting system consists of a machine vision based bud cutting machine and a tractor operated bud planting machine. The bud cutting machine involves three sub-mechanisms such as sugarcane feeding system, a machine vision system for identification of sugarcane buds and a mechatronic system for cutting of the identified bud. The first sub-mechanism feeds the whole-cane stalk towards the imaging and cutting zone. The second sub-mechanism identifies the bud location on a cane stalk by means of machine vision, which directs the third sub-mechanism to regulate the decision for cutting action. The third sub-mechanism is the assembly of mechatronically integrated cutting tools that removes the bud portion from whole cane. A sugarcane bud planting machine was developed to plant the buds at 150 mm deep furrow at a plant and row spacing of 1.2×0.3 m. To protect the seed from soil born disease, a sensor based spraying system has been designed and integrated with the planter to apply a predefined amount of fungicide over the bud and the surrounding soil.

The results indicated that the developed machine vision based sugarcane bud cutting machine was able to cut the buds from whole cane stalks with a throughput capacity and bud cutting efficiency were observed to be 1418 buds/h and 93.17% respectively, at an arm radial speed of 120 mm/s, blade rotary speed of 800 rpm and cane stalk feed speed of 100 mm/s. A total time per bud cut was found to be 2.6 s, including image processing delay, delay time and cutting time. The overall power consumption by the system was found to be 600 W.The performance of the sugarcane bud planting machine was evaluated under laboratory and field conditions. The results indicated that a higher quality feed index of 89% with the value of miss index and multiple index of 4.32 and 6.33% respectively were found at a forward speed of 2.5 km/h. The desired bud density was found to be 28354 buds/ha at a speed of 2.5 km/h. The average draft of the planter was found to be ranging from 3234 to 3906 N at the forward speed ranged from 1.5 to 3.5 km/h. However, the forward speed of operation was found to be 2.5 km/h at which the planting system should be operated for its best performance with regard to miss index, quality feed index and bud density. The actual field capacity and field efficiency were observed to be 0.34 ha/h and 56.11 % at a forward speed of 2.5 km/h. An actuation time of 240 ms was selected to apply the desired amount of liquid per bud of 8-10 ml. A significant chemical saving was found to be 48% with the sensor based application at the selected speed. The mean germination percent was observed to be 52.2 % for the buds planted with the developed system.

Key words: Sugarcane bud cutting, machine vision, mechatronics in agriculture, autonomous chemical application, sugarcane planter.