ABSTRACT

A self-propelled unmanned precision hill-drop wetland paddy (UPHWP) seeder was designed and developed to improve the seed dropping quality and reduce both health hazards and environmental pollution. For precise hill-drop seeding of pre-germinated paddy seeds, a mechatronics based seed metering mechanism was developed. It comprised a rectangular metering plate with a hole in the middle, placed below the hopper outlet, which was actuated by a push-pull type solenoid to drop the seeds in the form of hill. The triggering of solenoid was controlled by a sensor wheel, fitted with an inductive proximity sensor. A rotary agitator was provided in the hopper to reduce choking and bridging of seeds at the hopper outlet. Its performance was evaluated in the laboratory. By applying response surface method, the optimum operating parameters of the seed metering mechanism for IR 36 variety paddy seeds were found to be at a forward speed of 0.84 km/h, hole diameter of 11.18 mm and agitation speed of 37.37 rpm. Performance parameters like missing index (I_{miss}), multiple index (I_{mult}), quality of feed index (I_{qf}), mean hill spacing (Z_m), coefficient of hill distribution uniformity (S_e) and coefficient of seed dropping uniformity in hills (S_h) at the optimised operating condition were obtained as 6.25%, 0%, 93.75%, 23.5 cm, 90.32% and 65.22%, respectively. Based on the laboratory results, a four row self-propelled precision hill-drop wetland paddy (SPHWP) seeder was designed and developed with the developed seed metering mechanism. The capacity of solenoid for actuating the metering plate of the seeder was decided by measuring the actuating force of the metering plate. The propelling unit of the seeder consisted of DC geared motor, chain sprocket, driving shaft, two dog clutches, two wheels and a float. The propelling power and clutch actuating forces of the seeder were measured in the puddled field. Based on the field evaluation results of SPHWP seeder, the capacity of the motor for propelling and linear actuators for actuating the clutches were decided to convert the SPHWP seeder to UPHWP seeder. A 24 V, 180 W DC geared motor was installed for propelling and two numbers of 24 V, 50 mm stroke, 15 mm/s actuating speed, 200 N load capacity linear actuators were fixed for actuating the two dog clutches. A 24 V, 25 mm stroke, 20 mm/s actuating speed, 400 N load capacity linear actuator was used for lifting the sensor wheel while turning of the seeder at the headland. The developed UPHWP seeder was operated by a remote controller. The wireless communication between the transmitter (remote controller) and receiver (seeder) was made by a pair of HC12 module. A camera was fixed on the seeder for the visibility of field operation and forward speed of the seeder to the operator of remote controller. Laboratory experiments of the UPHWP seeder revealed that the variation of performance parameters among the four rows were not significant in all seed filling levels in hoppers. Moreover, 'Good' seeding quality and better seed dropping uniformity in hills were obtained in 1/3rd and 2/3rd filling level in hoppers. So, the hoppers were filled up to 2/3rd level during field operation. Field testing of the UPHWP seeder showed that increase in filling level of hoppers from 1/3rd to 2/3rd, the value of I_{qf}, S_e and seed rate decreased from 100% to 96%, 90.42% to 85.46%, and 28.45 kg/ha to 24.64 kg/ha, respectively whereas the values of I_{miss}, Z_m and S_h increased from 0% to 4%, 23.45 cm to 24.84 cm and 65.8% to 72.45%, respectively. The turning radius was found to be 0.8 m, which was equal to the track width of the seeder and a deviation of ±5% from straight path was found. The range of wireless communication was found to be 121 m. The actual field capacity, theoretical field capacity and field efficiency of the UPHWP seeder were found to be 0.054 ha/h, 0.064 ha/h and 84.37%, respectively. During field operation, higher values of I_{qf}, S_e and S_h were obtained for seeding through UPHWP seeder as compared to the drum seeder at all filling levels, which indicated better seeding quality obtained with UPHWP seeder. The developed UPHWP seeder should be used for sowing of seeds for at least 0.54 ha of land in a year to make the seeding operation economical over the manual seeding.

Keywords: Response surface method, Quality of feed index, Coefficient of hill distribution uniformity, Coefficient of seed dropping uniformity in hills, Remote controller, Solenoid