ABSTRACT

Variable Rate Technology (VRT) has emerged as a prominent solution for enhanced productivity by addressing the variability of nutrient availability in a field. This research is focused on techniques for variable rate application of granular fertilizer as a basal dose. An electronic control unit (ECU) in open source micro-controller and digital nutrient map integrated variable rate applicator was developed for fertilizer application (VRFA). The technology handles spatial data to generate prescription maps and applies required fertilizer for targeted yield with the help of differential global positioning system (DGPS), ECU, feed back sensor and DC motor coupled to the fertilizer metering unit. The spline interpolation technique supported by 16 soil samples in grid pattern was the most appropriate for top soil macro-nutrient (NPK) mapping in 1 ha area. The combination of soil test crop response (STCR), nutrient balance and dissimilar subtraction algorithm were employed to decide the fertilizer application rate. ANN model closely predicted the performance parameters of fertilizer metering system with the lowest root mean square error (RMSE). The flute diameter of 12 mm and bottom flap opening of 10 mm were recommended for variable rate application. Grid identification algorithm was developed to decode "$GPRMC" string of valid NMEA for coordinate, direction and speed. The control software and VRFA graphical user interface (GUI) interfaced GPS location, application rate, speed and grid identification code. A 9-row tractor operated VRFA was developed and evaluated for precise application of urea, SSP and MOP fertilizers. The actual fertilizer application rate was non-significantly affected by the fertilizer type but was significantly ($p < 0.01$) affected by the prescribed fertilizer application rate, grid size (10 m × 10 m) and forward speed (2 km/h). Single grid application error (SGAE) for urea, SSP and MOP fertilizers ranged between 2.52–5.79%, 3.03–6.96% and 4.06–9.83, respectively. The total application error (TAE) for application of urea, SSP and MOP fertilizers were 4.11, 5.08 and 7.24%, respectively. The effective field capacity of VRFA was observed to be 0.21 ha/h at forward speed of 2.0 km/h. The VRFA gave N, P, K fertilizer savings of 24.5, 16.6, and 9.0 kg/ha over uniform rate application in the field.

Keywords: Electronic control unit; DGPS; Digital nutrient map; Interpolation; ANN, Optimization; Variable rate fertilizer applicator.