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Development of Electronic Metering Mechanism for Precision Planting of Seeds

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A B S T R A C T

Precision agriculture is the application of technologies and principles to manage spatial and temporal variability associated with all aspects of agricultural production for the purpose of improving crop performance and environmental quality. With this objective an electronic metering system was developed by the use of inclined plate type metering mechanism. The metering unit was synchronized with the forward speed with the help of proximity sensor and micro controller. The developed metering unit was tested in the laboratory for Ground nut at various forward speeds of 2.5, 3 and 3.5 Km/h. The seed to seed spacing, seed rate and seed breakage was calculated over greased seed belt and the results were statistically analyzed. The optimum condition for operation was found to be 2.5 km/h at a metering plate speed 50 rpm.

Keywords

Precision, Proximity sensor, Microcontroller.

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Introduction

Precision agriculture is the application of technologies and principles to manage spatial and temporal variability associated with all aspects of agricultural production for the purpose of improving crop performance and environmental quality. Success in precision agriculture is related to how well it can be applied to assess, manage, and evaluate the space-time continuum in crop production.

This theme was used here to assess the current and potential capabilities of precision agriculture. The precision planting of crops is progressing in the country, however there is no indigenous precision planting machines available in the country.

Some imported substitutes are available but being too costly are beyond the reach of common farmers. For crop production, seeds are normally required to be sown in the well prepared seed bed, maintaining row to row and plant to plant spacing. It is also required to drop the seed at desired depth for perfect germination. Various types of planters and seed drills have been developed but the problem still persists, like the missing of seeds, over filling, etc. Electronic planters work with a sensor based electronic metering system, which adds precision to the work. The sensor system incorporated in the metering unit helps in proper metering of seeds and maintains the seed to seed spacing, resulting in minimization of losses. The seed rate can be easily controlled with the rpm controller and can be used for a variety of seeds with a change in the seed metering plate. Previously various effort has been done to implement precision in the work by introducing electronics and sensors, Drake 1993 described the development of a two row-planting machine mounted on a 100 hp four-wheel drive tractor.

The planter incorporates electronic programming for spacing and fertilizer application. Durairaj *et al.,* (1994) developed a bullock drawn seed drill with a simple electronic metering system. It had an electronically controlled check valve system that facilitated precision planting of seeds. Field tests indicated negligible variation in plant spacing from the required spacing and seed damage was minimum with an acceptable germination percentage and crop stand.

Rehman and Singh 2002 developed a sensor for seed flow from seed metering mechanism. A sensor based on a light interference technique had been developed for sensing the seed flow from the metering mechanism of the planter. Aware, *et al.,* Aug & Nov 2008 in the metering unit of planters, by introducing LED systems for metering systems. Karthikeyan (2004). But the problems like slippage and skidding of ground wheel still persists. So keeping these points in view a project was undertaken to develop an electronic metering unit which would be devoid of ground wheel and mechanical transmission. Li *et al.,* (2013) the development of precision seeding technique, precision seeding has become the main feature and developing direction of modern seeding technologies. Precision seeding can save seeds and effectively control the sowing depth, sowing densities and the sowing distance. According to statics, the output of precision seeding increases by 10 per cent - 30 per cent compared with that of the conventional drill. V.V. Aware 2014 A microprocessor based electronic metering mechanism was design and developed for three row planter to meter the cowpea seeds. The previously developed mechanical metering mechanism exhibited various losses in mechanical linkages and hence proved to be less precise. The metering mechanism was based on the op to electric rotary sensing. The input was given to the micro controller in the form of electric pulses from the sensor and the switches, which defined the spacing of the seed. The performance of developed planter was tested in the laboratory. For the given input of 15 cm, the output seed spacing obtained was 16.2 cm.

Materials and Methods

Construction of Electronic Metering Mechanism

An electronic metering unit was developed by the use of inclined plate seed metering mechanism. The hopper was fabricated by using a MS sheet of 3 mm thickness. A 46 cm × 20 cm MS sheet was bent at an angle of 85° to form the base. Another two MS sheet, triangular in shape of base 30 cm and height 23 cm were welded from sides to form the complete hopper. A circular hole of 18 cm was cut to set the metering unit. Another MS sheet of 23 cm×22 cm was set over the opening to guide the seed into the metering unit.

The number of grooves required was calculated by selecting the optimum speed of rotation of metering plate as 60 rpm, as above that the seeds gain enough of kinetic energy, problems of higher cell fill and breakage of seeds occur. The speed of operation for planter was limited to 2.5 km/h. The dimensions of the cells were as follows, Length- 1.5cm, Breadth-0.6 cm, Thickness-0.6 cm, No of cells-8. The metering plates were rotated by the use of a variable speed, high torque DC motor. The speed of the motor was taken to a maximum range of 100 rpm so that maximum torque can be obtained. The speed of the motor was made adjustable by the use of a 100 Ω, 150 Watt potentiometer. The metering unit was devoid of ground wheel and chain and sprocket systems. In this metering unit, the purpose of ground wheel was resolved by the use of a proximity sensor. The sensor senses the RPM of the rear wheel of the tractor and transmits the impulse to the microcontroller.

The microcontroller was so programmed that it reduces the rpm with a decrease in tractor speed and vice versa. By this method seeds can be efficiently metered and planted with ease. The complete flow chart of working and the circuit diagram of the electronic unit are shown in figures 1 and 2, respectively.

Experimental Operating procedure

The electronic metering unit was mounted over a grease belt 3555 mm long and the tests were carried out. The grease belt was mounted on two rollers separated by a distance of 3235 mm. The complete setup is shown in figure 3.

The rollers were driven by a 1hp variable speed DC motor whose speed was varied to control the forward speed. The greased belt was driven at three speed levels of 2km/h, 2.5km/h and 3 km/h. The motor was rotated at three levels of 40, 50 and 60 rpm. The hopper after filling up with seeds was run for a particular time interval of half a minute and the readings were noted. The seed to seed spacing, seed rate and seed breakage were measured. The experimental parameters are presented in table 1.

Results and Discussion

Laboratory test were carried out to determine the seed to seed spacing and seed rate of the developed metering mechanism. Tests were carried out on greased seed belt at different motor rpm and forward speed. Seed rate for ground nut was considered as 110-112 kg/ha.

It was observed that the average seed to seed spacing was 10.1, 8.01 and 6.6 cm respectively at travel speed of 2 Km/h of metering plate1 for 40, 50 and 60 rpm. The figure 4 shows the seeds dropped over the seed belt.

It was observed that the average seed to seed to seed spacing was 12.62, 10.01, 8.26 cm respectively a travel speed of 2.5 km/h of metering plate1 for 40, 50 and 60 rpm and an average seed to seed spacing of 15.15, 12.01 and 10.01 cm respectively at travel speed of 3 km/h of metering plate1 for 40, 50 and 60 rpm. It was observed that with an increase in rpm at a constant speed the seed to seed spacing decreased and shown in figure 5 (Anantachar and Guruswamy, 2009). The seed to seed spacing decreased due to the fact that with an increase in rpm and a constant forward speed the seeds dropped per unit length increased and for the same reason the seed rate increased

It was observed that the average seed rate was 110, 138.70 and 168.55 kg/ha respectively at travel speed of 2 Km/h of metering plate1 for 40, 50 and 60 rpm. It was observed that the average seed rate was 88.04, 111, 134.51 kg/ha respectively at travel speed of 2.5 km/h of metering plate1 for 40, 50 and 60 rpm and an average seed rate of 73.30, 91.30, 111 kg/ha respectively at travel speed of 3 km/h of metering plate1 for 40, 50 and 60 rpm. It was observed that with an increase in rpm at a constant speed the seed rate increased. The breakage of seeds was found maximum with plate 1 at 2 km/h forward speed with 60 rpm and plate 2 at 2 km/h at 40 rpm. The data was analyzed in terms of ANOVA on the effect of metering plate, travel speed and rpm on seed to seed spacing, seed rate and breakage of seeds. The result showed that plate 1 gives better seed to seed spacing than metering plate 2 as in table 2.

Table.1 Variables for testing of electronic metering mechanism

Sl. No.	Parameters	No of levels	Level Values
	Independent Variables		
1	Speed (km/h)	3	2, 2.5, 3(Ground nut)
2	Rotation of seed plate (rpm)	3	40,50,60 (Groundnut)
3	Seed plate	2	Plate 1, 2
	Dependent Variables		
1	Seed to seed spacing (cm)		
2	Seed Rate (kg/ha)		
3	Seed Damages (per cent)		

Table.2 Effect of metering plates, speed and motor rpm on seed to seed spacing, seed rate, seed breakage for groundnut seed

Treatment	Spacing	Seed Rate	Seed Breakage
A1: Metering Plate 1	10.33	113.832	1.556
A2: Metering Plate 2	10.82	108.583	1.556
SE(m)	0.035	0.337	0.176
CD 5%	0.102	0.967	NS
B1: Forward speed 2km/h	8.436	135.666	1.500
B2: Forward speed 2.5km/h	10.590	108.179	1.333
B3: Forward speed 3km/h	12.722	89.777	1.833
SE(m)	0.043	0.413	0.215
CD 5%	0.124	1.184	NS
C1: motor rpm 40 rpm	12.959	88.205	2.000
C2: motor rpm 50 rpm	10.188	112.071	1.000
C3: motor rpm 60 rpm	8.600	133.346	1.667
SE(m)	0.043	0.413	0.215
CD 5%	0.124	1.184	0.617

Table.3 Interaction effects of speed and motor rpm on spacing, seed rate and seed breakage for groundnut seed

Treatment	Spacing	Seed Rate	Seed Breakage
B_1C_1	10.325	107.665	2.500
B_1C_2	8.180	135.888	0.500
B_1C_3	6.802	163.443	1.500
B_2C_1	13.048	85.247	1.500
B_2C_2	10.148	109.512	0.500
B_2C_3	8.573	129.778	2.000
B_3C_1	15.503	71.703	2.000
B_3C_2	12.237	90.813	2.000
B_3C_3	10.425	106.815	1.500
SEm ±	0.075	0.715	0.373
CD 5%	0.215	2.051	NS

Fig.1 Flow chart of the electronic circuit

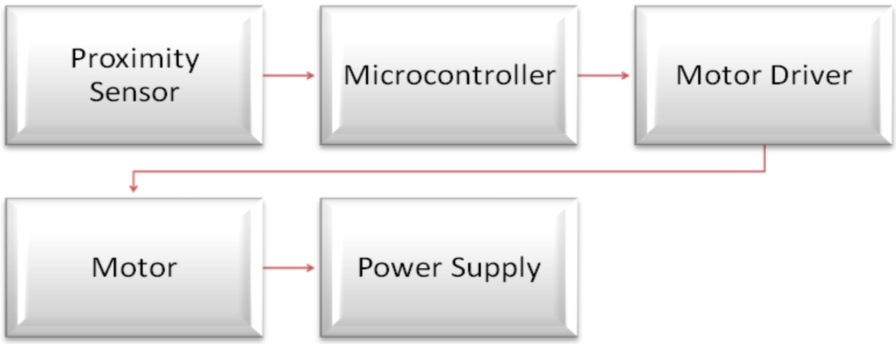


Fig.2 Electronic circuit diagram for metering mechanism

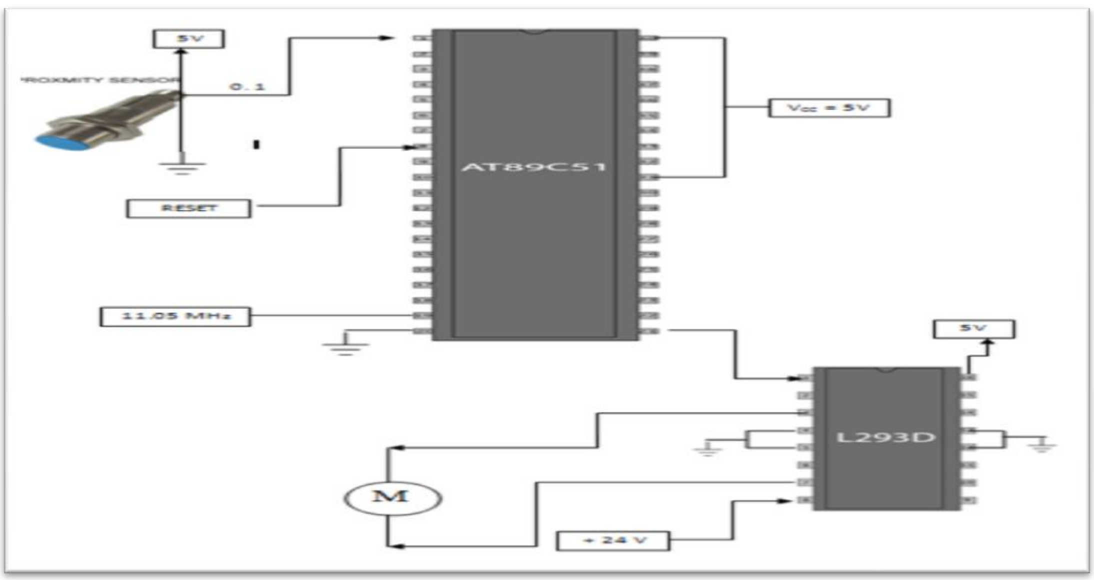
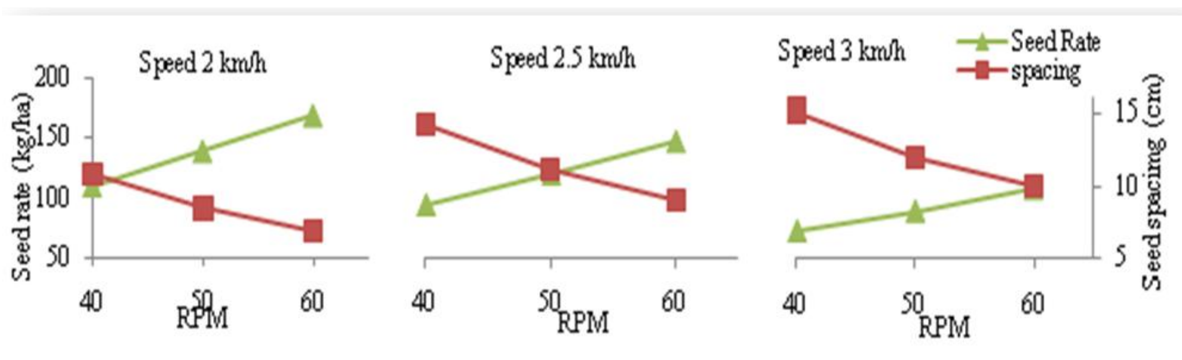


Fig.3 Laboratory setup

Fig.4 Groundnut seeds on grease belt

Fig.5 Seed to seed spacing and seed rate variation of ground nut at various rpm and forward speed



There was significant increase in seed to seed spacing with an increase in rpm of metering unit. The increase in rpm from 40 to 60 had increased the seed to seed spacing by 50.80 per cent and decreased the seed rate by 51 per cent. The seed to seed spacing was significantly influenced by the forward speed. The seed to seed spacing was lower at 3 km/h than at 2 km/h. The results depict that the seed rate was significantly lower at plate 2 than plate 1. Interaction effect of rpm and speed is presented in table 3. The seed to seed spacing was seen minimum of 6.802 cm (rpm 40 and 3 km/h) in comparison to a maximum of 15.503 cm (60 rpm and 2 km/h). The interaction had significant influence on seed to speed spacing. The seed rate has a maximum value of 163.44 kg/ha (40 rpm and 3 km/h) in comparison to a minimum value of 71.7 kg/ha (60 rpm and 2 km/h).

The interaction table suggests that it had a significant influence on the change of seed rate of groundnut seeds. The optimum condition for sowing of groundnut was found to be 50 rpm of metering plate speed at a forward speed of 2.5 km/h. The seed breakage was also found low at this combination.

The designed unit was run in the laboratory conditions and it was concluded that with an increase in conveyor belt speed, the rpm of the motor in the metering unit increased and vice versa. The seed to seed spacing was found to decrease with an increase in metering plate speed and the seed rate increased with the increase in metering plate rpm. The optimum metering plate speed with the forward speed was found to be 50 rpm at a forward speed 2.5 km/h. The seed breakage was found to be minimum at a lower metering plate rpm.

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