Field Evaluation of Experimental Plot Drill

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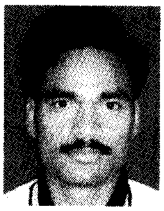
by



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Abstract

Mechanization of field operations on experimental plots is considered a key input to agricultural research. However, with the introduction of mechanized, accurate and reliable planting systems, even small yield gains made in varietal improvement may easily be noticed. The use of machines facilitates precision and timeliness in operation and reduces drudgery, which are all critical to the productivity of crops. The tractor drawn Oyjord plot drill (Wintersteiger) was evaluated for seed placement uniformity at four operational speeds (4, 5, 6 and 7 km/h) and two types of seeds [Rapeseed (Brassica juncea L.) and Pea (Pisum sativum L.)] with three levels of seed rate in each case. The experimental work was carried out at the Crop Research Centre of GBPUA&T, Pantanagar. The plot drill seed uniformity was described with respect to coefficient of uniformity and standard deviation. Results showed that an average seed drop could not be achieved in to ground wheel skid. Seed rate and speed of operation did not have significant effect on coefficient of uniformity between rows for rapeseed (Brassica juncea L.), while speed of operation had a highly significant (1 %) effect for peas (Pisum sativum L.). At 4 km/h, standard deviation was minimum (0.10, 0.14 and 0.19 at 2.5, 3.0 and 3.5 kg/ha seed rate for rapeseed (Brassica juncea L.) and 0.09, 0.10 and 0.17 at 80, 85 and 90 kg/ha seed rate for pea, respectively). The plot seed drill covered more distance than the selected test run, as per manufacturer's calibration table, where the percent variation in distance coverage was almost equal to the ground wheel skid. Therefore, in order to obtain correct seed rate, the quantity of seed for a particular distance had to be increased or distance shown in the calibration table had to be decreased in accordance with the ground wheel skid.

Introduction

Uniformity in seed spacing has been demonstrated to be a significant factor in quality and yield for crops. With uniform spacing, the roots can grow to an optimum size and fill the row space without being pushed out of the row by a neighboring root. This ensures that all of each root can be gathered from the row by the harvester. With uneven plant spacing, some roots may be too small to be gathered by the harvester, or some roots may be too large, and may be damaged by the topping implements, or the lifting wheels of the harvester (Jaggard, 1990). Traditional methods of crop planting have involved planting of excess seed and later on thinning of the resulting plants to obtain the desired plant population at uniform plant spacing. Advancements in plant establishment practices such as seed bed preparation, high quality seed, and precision planters, have provided higher and more consistent seedling emergence. As a result, crops are planted at the desired population, in contrast with planting excess seed and thinning to a desired stand population. The precision seeding offers numerous advantages to the researchers, which include lower thinning costs, reduced competition between the young plants and reduction of shock to plants during thinning (Inman, 1968). Hence, mechanization of field operations on experimental plots is considered a key input to agricultural research. However, with the introduction of mechanized, accurate and reliable planting systems, even small yield gains made in varietal improvement efforts may easily be noticed. The use of machines facilitates precision and timeliness in operation and reduces drudgery, which are all critical to the productivity of crops. Keeping these factors in view, the coefficient of uniformity for the Oyjord plot drill for two types of seed and four levels of speed was determined for evaluating the field performance of the experimental plot drill.

Materials and Methods

The experiment was conducted in the field with sandy loam soil by using the tractor drawn Oyjord Plot multi-crop seed drill at the Crop Research Centre of GBPUA & T, Pantnagar, India. The experiment included two types of seed; pea (Pisum sativum L.) and rapeseed (Brassica juncea L.), with 3 seed rates for each type of seed and 4 speeds (4, 5, 6 and 7 km/h). The experimental plot was tilled with a tractor drawn rotavator and leveled by leveler. The experimental variables were:

Independent Variables

Types of seed and seed rates;

- Pea (Pisum sativum L.); P 5: 80, 85 and 90 kg/ha
- Rapeseed (Brassica juncea L.); PYS 2919: 2.5, 3.0 and 3.5 kg/ha

Operational speed; 4 levels (4, 5, 6 and 7 km/h)

Dependent Variables

Seed distribution pattern: Number of seed dropped

Mechanical seed damage

Variation in distance covered

Ground wheel skid

Experimental Details

No. of Replications; 5

Fixed length: 15.21 m

Spacing: − + 4 rows 30 cm apart for both seeds.

Oyjord Plot Drill

The Oyjord plot drill had provision for sowing the seeds continuously with varying plot lengths between 1.23 to 20.81 m with the help of a variator (**Table 1**). The basic concept of the Oyjord system was star feed, which continuously fed on a rotating distributor for equal distribution of material in the corresponding seed tubes. The exact estimated quantity of seed was placed in the funnel, which rested over the cone. In conjunction with the plot length, when a lever was actuated, the seeds were uniformly distributed in all the cells of the distributor. During the operation, the star feeder rotated and the individual cells pushed the seed into the slit through a nozzle and the seed fell over the rotating distributor. A slanting notch over the rotary distributor distributed the seed equally in the desired number of rows and the seed ultimately fell in the furrow opened by double disc type furrow openers. The rotating distributor was mounted on a swivel arm beneath the cell wheel distributor and was powered by an electric motor. The rotating distributor distributed the seed by centrifugal force. A brass nozzle was located beneath cell wheel distributor, which could be easily changed according to the requirement of different seed.

For cereals and large grain seeds : Nozzle 22 mm Φ

For rape and fine-grain seeds : Nozzle 15 mm Φ

The seed outlet in the furrow opener was designed so that seed velocity was reduced considerably, which reduced seed bouncing. With the provision of the variator provided on the star feeder, it was possible to vary the plot length. The machine could be effectively utilized for planting breeder experiments that changed seed varieties in inter plots without stopping the machine intermittently at the end of a plot. The plot seed drill is shown in **Fig. 1**.

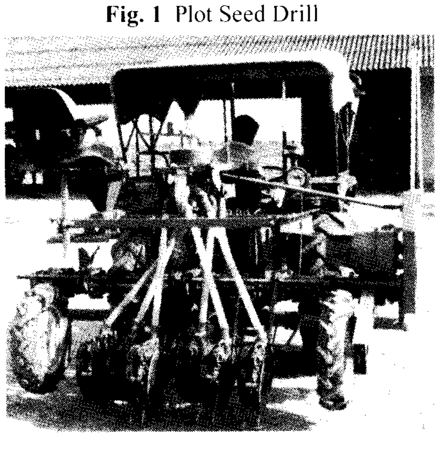
Experimental Methodology

Observations were taken on the number of seed drop, mechanical seed damage, variation in seed distance and ground wheel skid of the plot seed drill. For evaluation of the seed drill, 146.02 g of pea (Pisum

Table 1 Calibration table (Plot length, cm)

Minor gear number	Major gear number 1	2	3
1	2,081	769	304
2	2,001	765	293
3	1,921	734	281
4	1,841	704	269
5	1,761	673	257
6	1,681	643	246
7	1,601	612	234
8	1,521	582	222
9	1,441	551	211
10	1,361	520	199
11	1,288	493	188
12	1,238	473	181
13	1,189	455	174
14	1,140	436	167
15	1,091	417	159
16	1,041	398	152
17	991	379	145
18	942	360	138
19	892	341	130
20	843	322	123

Fig. 1 Plot Seed Drill



sativum L.) seed (seed rate 80 kg/ha) were placed in the funnel. The seed drill was mounted on a tractor and operated at 4.0 km/h forward speed for a distance of 15.21 m. Out of total run (15.21 m), 5 spans of 1 m length were taken at random. The number of seed dropped in each 1 m length at 10 cm intervals in each row was determined. The average value of five spans corresponding to each row and each segment, i.e. 10 cm interval, were taken. The coefficient of uniformity was calculated within each segment in each row and a split plot design was used to analyze for the effect of seed rate and speed of operation. The tests were conducted at 4, 5, 6 and 7 km/h speed of operation. After completing these tests with pea (Pisum sativum L.) seed, similar data were collected for rapeseed (Brassica juncea L.). The variation in seed dropping distance from the predetermined 15.21 m was also recorded in each case. For seed distribution pattern, Christiansen's coefficient of uniformity was calculated by using following relationships:

$$Average,\ X_a = \frac{\sum (X)}{n} \quad \text{.................(1)}$$

Christiansen's coefficient of uniformity (CU), %

$$= 1 - \frac{\sum | x - x_a |}{n X_a} \times 100 \quad \text{.......(2)}$$

where

X_a = Average number of seed dropped in a segment.,

n = Number of the segments

The wheel skid was calculated by the following relationship.

Ground wheel skid, %

$$= \frac{d_{th} - d_a}{d_a} \times 100 \quad \text{....................(3)}$$

where

d_{th} = 15 × π × Diameter of the ground wheel assuming half penetration of lugs into the soil, cm

d_a = actual distance covered in 15 revolution of ground wheel, cm

Results and Discussion

Seed distribution pattern for rapeseed (*Brassica juncea L.*)

The average seed drop in each segment could be 2.06, 2.45 and 2.88 at 2.5, 3.0 and 3.5 kg/ha seed rate, respectively (**Fig. 2**). But in any case, this was not achieved due to skid of the ground wheel of the plot seed drill. The average seed drop in each segment at 2.5 kg/ha was 1.85, 1.88, 1.93 and 1.87 at 4, 5, 6 and 7 km/h with standard deviations of 0.10, 0.13, 0.15 and 0.15, respectively. The average seed drop at 3.0 kg/ha seed rate in each segment was lowest (2.05) and highest (2.10) at 4 and 6 or 7 km/h, respectively, while standard deviation was highest (0.17) at 5 and 6 km/h and lowest (0.14) at 4 km/h. The average seed drop in each segment at 3.5 km/h was lowest (2.32) and highest (2.40) at 4 and 5 km/h while the high and low standard deviations were 0.19 and 0.21 at 4 and 7 km/h, respectively. The average seed drop and standard deviation in each segment are shown in **Table 2**. From **Table 2**, it is clear that standard deviation increased with increasing seed rate and speed of operation. The average seed drop might be achieved if ground wheel skid were taken into consideration, i.e., quantity of seed must be increased. Distance covered by seed drill was more and which was equal to ground wheel skid. The seed rate and speed of operation was well matched to achieve required seed rate with less variability within rows (**Fig. 2**). The coefficient of uniformity between the rows for seed rates 2.5, 3.0 and 3.5 kg/ha ranged from 87.14 to 94.74, 87.18 to 95.00 and 79.07 to 95.83 %, respectively, at 4 km/h. For 5 km/h, the coefficient of uniformity between the rows varied from 80.00 to 95.71, 82.05 to 93.62 and 83.33 to 96 % at 2.5, 3.0 and 3.5 kg/ha seed rates, respectively. The coefficient of uniformity between rows varied from 82.35 to 96.51 %, 81.08 to 93.62 % and 88.37 to 96.34 % at 2.5, 3.0 and 3.5 kg/ha, respectively, at 6 km/h speed. The coefficient of uniformity between rows ranged from 79.73 to 95.45 %, 80.95 to 96.34 % and 86.36 to 95 % at 7 km/h speed for seed rates of 2.5, 3.0 and 3.5 kg/ha, respectively. Analyses of variance for coefficient of uniformity between rows are shown in **Table 3**. The ANOVA table reveals that coefficients of uniformity between rows were not significant with seed rate and speed of operation.

Seed Distribution Pattern for Peas (*Pisum Sativum L.*)

Seed distribution pattern of peas (*Pisum sativum L.*) for different speeds of operation and different seed rates is shown in **Fig. 3**. The

Table 2 Average seed drop and standard deviation in segment of 10 cm

Type of seed and seed rate (kg/ha)		Speed of operation, km/h								S.D. between speed
		4		5		6		7		
		Mean	S. D.	Mean	S. D.	Mean	S. D.	Mean	S. D.	
Rapeseed (Brassica juncea L.)	2.5	1.85	0.10	1.88	0.13	1.93	0.15	1.87	0.15	0.032
	3.0	2.05	0.14	2.06	0.17	2.10	0.17	2.10	0.15	0.025
	3.5	2.32	0.19	2.40	0.20	2.26	0.20	2.21	0.21	0.081
Pea (Pisum sativum L.)	80	1.40	0.09	1.44	0.12	1.47	0.14	1.46	0.14	0.030
	85	1.48	0.10	1.49	0.15	1.53	0.14	1.57	0.18	0.040
	90	1.58	0.17	1.65	0.18	1.61	0.16	1.58	0.21	0.035

average seed drop in each segment within row at 80 kg/ha was highest (1.47) followed by 1.46, 1.44 and 1.40 at 6, 7, 5 and 4 km/h, respectively. Standard deviation was lowest (0.09) at 4 km/h. The average seed drop and standard deviation in each segment are shown in **Table 2**. The average seed drop at 85 kg/ha was highest (1.57) and standard deviation was highest (0.21) at 7 km/h followed by 6, 5 and 4 km/h, respectively. The average seed drop in each segment at 90 kg/ha was 1.58, 1.65, 1.61 and 1.58 at 4, 5, 6 and 7 km/h, respectively, while standard deviations were 0.17, 0.10, 0.16 and 0.21 at 4, 5, 6 and 7 km/h, respectively. From the **Table 2** it is clear that average number of seed dropped and standard deviation in each segment were increased with increase of seed rate and speed of operation. At 4 km/h, the coefficient of uniformity between rows ranged from 88.46 to 94.83 %, 85.71 to 92.86 % and 71.43 to 95.71 % at 80, 85 and 90 kg/ha seed rates. Similarly, at 5 km/h, and 80, 85 and 90 kg/ha seed rates the coefficient of uniformity was varied from 80.00 to 94.44 %, 82.76 to 94.83 % and 80 to 94.12 %, respectively. At 6 km/h for 80, 85 and 90 kg/ha seed rates, coefficient of uniformity between the rows varied from 80.00 to 95.45 %, 78.57 to 94.12 % and 89.39 to 94.83 %, respectively. The coefficient of uniformity between rows at 7 km/h was 78.57 to 94.00 %, 77.42 to 94.83 % and 70.27 to 95.00 % at 80, 85 and 90 kg/ha seed rates, respectively. The statistical analysis between rows is presented in Table 4 and indicates that the seed rates and speed of operation have non-significant effect on coefficient of uniformity. Interactions between seed rate and speed of operation, also, have non-significant effect on the coefficient of uniformity between rows.

Ground Wheel Skid

The wheel skid increased with increasing operational speed. The average wheel skid at 4, 5, 6 and 7 km/h was 5.59, 6.79, 7.61 and 8.51 %, respectively, in the field. The statistical analysis (**Table 5**) showed that the speed of operation had significant effect on the skid of the ground wheel at 1 % level of significance.

Variation in Seeding Distance and Seed Damage

The variation in seeding distance covered by the plot seed drill in comparison to the distance claimed by the manufacturer was observed for different speeds and various types of seeds. A test run of 15.21

Fig.2 Distribution of average number of seed dropped for rapeseed (Brassica juncea L.) at distances from reference point

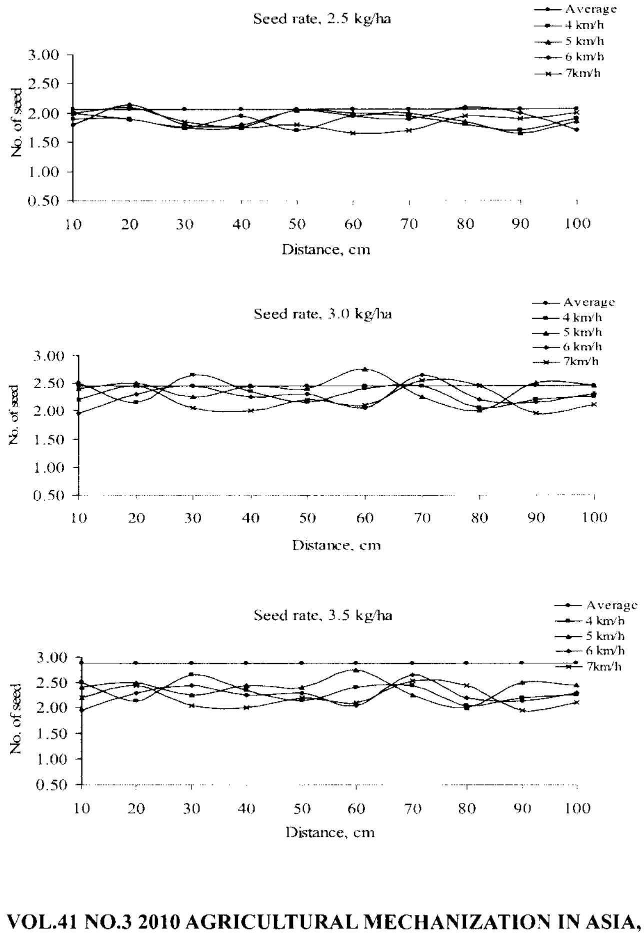
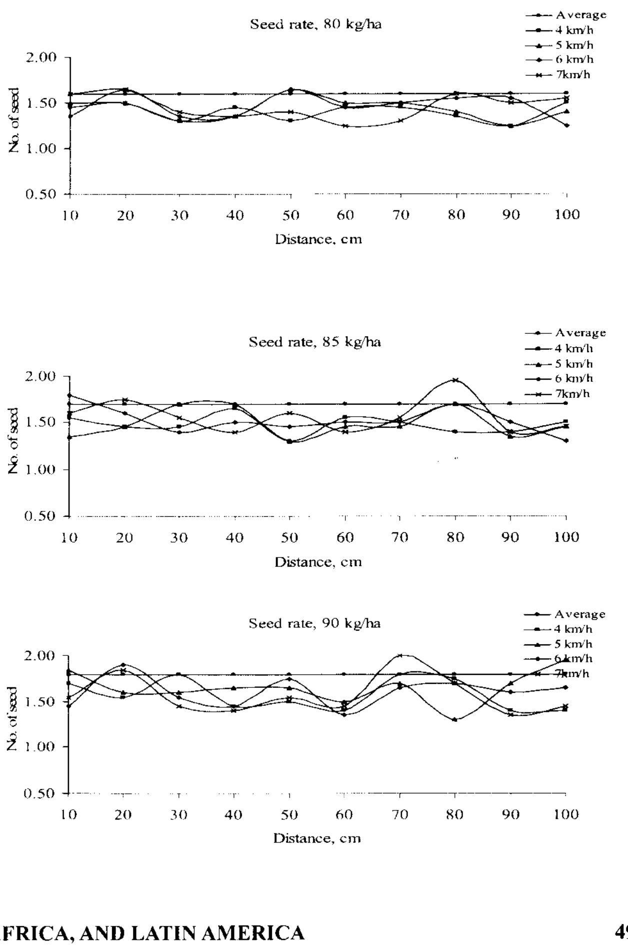


Fig.3 Distribution of average number of seed dropped for pea (Pisum sativum L.) at distances from reference point



m was selected to operate the seed drill in the field experiment. However, some variation in seeding distance coverage was observed in all cases. Variation in distance covered by seed drill was minimum at 4 km/h speed and increased with increasing the speed for all types of seeds. The average distance coverage for rapeseed (*Brassica juncea L.*) seed was 78, 101, 110 and 128 cm more at 4, 5, 6 and 7 km/h speeds, respectively, for a pre-selected test run of 15.21 m. The variation in seeding distance for peas was 90, 102, 114 and 134 cm at 4, 5, 6 and 7 km/h, respectively. The percent variation in seeding distance coverage was almost equal to the ground wheel skid percentage. From above data, the seeding distance calibration table made available by the manufacturer of the plot seed drill did not include ground wheel skid while estimating seeding distance to be covered at different lever positions. It was, therefore, necessary to determine the correct ground wheel skid before conducting an actual experiment in the field. Later on, the quantity of seed determined for a particular distance must be increased or distance shown in the table must be decreased in accordance with the ground wheel skid. The samples were collected from different furrow openers to determine the mechanical seed damage. No mechanical damage of seed was observed. This indicated that the seed metering device used in the machine worked satisfactorily with-

Fig 4 Effect of operational speed on ground wheel skid

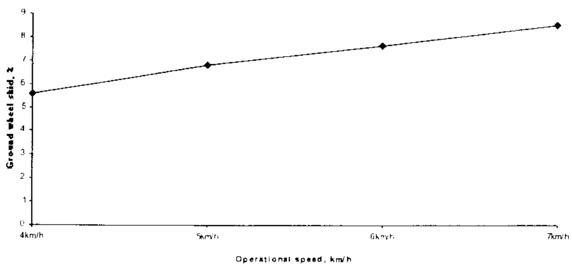


Table 3 Analysis of Variance of C.U. between rows in rapeseed (Brassica juncea L.)

Source	D. F.	S. S.	M. E. S.	F value	Remark
Segment	9	140.5417	15.6157		
Seed rate (M)	2	14.9750	7.4875	0.4981	non significant
Error (a)	18	270.5458	15.0303		
Speed (S)	3	29.9750	9.9917	0.6535	non significant
M x S	6	50.5250	8.4208	0.5508	non significant
Error (b)	81	1238.375	15.2886		
Total	119	1744.938			

SEM1 = 0.6130 SEM = 0.7139 SED1 = 0.8669 SED2 = 1.0096 SED3 = 1.7486 SED4 = 1.7449

Table 4 Analysis of Variance of C.U. between rows in pea (Pisum sativum L.) crop

Source	D. F.	S. S.	M. E. S.	F value	Remark
Segment	9	252.4583	28.0509		
Seed rate (M)	2	24.2750	12.1375	0.4168	non significant
Error (a)	18	524.2042	29.1225		
Speed (S)	3	115.5417	38.5139	1.7096	non significant
M x S	6	226.1583	37.6931	1.6732	non significant
Error (b)	81	1824.738	22.5276		
Total	119				

SEM1 = 0.6130 SEM2 = 0.8666 SED1 = 1.2067 SED2 = 1.2255 SED3 = 2.1226 SED4 = 2.1989

Table 5 Analysis of Variance for ground wheel skid

Source	D. F.	S. S.	M. E. S.	F value	Remark
Replication	2	0.05541992	0.02770996	0.2535841	non significant
Speed (S)	3	11.15253	3.717509	6.167254	Highly significant
Error (b)	6	0.6556396	0.1092733		
Total	11	11.86359			

SEM = .1908518 CV = 4.694972

out mechanical damage of seeds.

Conclusions

The coefficient of uniformity between rows and number of seed drop were decrease with increase in seed rates as well as operational speeds. The average ground wheel skid was 5.59, 6.79, 7.61 and 8.51 % at 4, 5, 6 and 7 km/h speeds of operation of the plot seed drill, respectively. The plot seed drill covered more distance than the selected test run as per manufacturer's calibration table where the percent variation in distance coverage was almost equal to the ground wheel skid. Therefore, in order to obtain correct seed rate, the quantity of seed determined for a particular distance had to be increased or distance shown in the table had to be decreased in accordance with the ground wheel skid.

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Dates and Deadlines

Abstract submission deadline	November 12th 2010
Notification of acceptance	January 2011
Paper submission deadline	May 30th 2011
Early bird registration	Up to June 1st 2011
Symposium date	18 – 21st September 2011

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