

Development and Testing Of Power Tiller Operated Multicrop Seed cum Fertilizer Drill

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Abstract: The present work aimed at bringing about the effective changes in design/performance of earlier designed power tiller operated Multicrop Seed cum Fertilizer drill. The metering mechanism has been modified by using nylon roller suitable for multiple and easy to use. The hitch system was designed to make it compatible with Mitsubishi as well National Power Tiller. A shoe type furrow opener was also designed to work the machine in poorly prepared land also. The working performance of the machine during idle run was satisfactory. The fluctuation in the dog clutch assembly was observed which was quite acceptable. The minimum turning radius was measured to be 1.5 m in the actual field condition. The metering performance of different rollers was found acceptable for sowing Wheat, Maize, Green gram, Bengal gram, Jowar and Rajmah crop. Seed damage was observed to be 2.0, 1.5 and 2.0 percent respectively for maize, green gram and maize crops which is negligible. The wheel slip of power tiller was found to be 2.08 percent and wheel skid of the machine was found to be 16.96 percent. Draft requirement of the machine was measured 55kg and field capacity was 0.137 ha/h with field efficiency of 72 percent.

Key Words: seed cum fertilizer drill, turning radius, seed metering, seed damage, wheel slip and skid, field capacity, field efficiency

I. Introduction

Economic potential and growth of any country rests on the development of Agriculture. During the last three decades India has moved from chronic food scarcity to food surplus in the agricultural sector. This was possible due to the cutting edge of science coupled with the fast adoption of technology by the farmers. It has been observed that the optimum result in food production can be achieved by making sufficient availability of farm power. Taking in to account of animal power, human power, electrical power and mechanical power the average availability of farm power comes to barely 0.1 hp/ha against the actual requirement of 0.8 hp/ha. As the human and animal power cannot be increased in a short span of time the alternative left with only mechanical resource to supplement the further demand. But the small holding of Indian farmers the adoption of tractor and big machineries become beyond their economic threshold. The alternative left to rely on small power sources like power tillers. The launching of Power Tiller in Indian farming system came in to late sixties but could not caught the attention of farmers due to unavailability of matching implements.

Sowing is one of the important agricultural operations for raising crops. Proper application of fertilizer and seed at correct rate, depth has good effect on crop growth as well as on yield. Various studies over the use of seed cum fertilizer drill have shown that the yield of wheat crop may be increased to 15-25 percent and may be up to 40 percent depending upon the variety. The designed machine solve the sowing problems of most of the crops like maize, barley, wheat, pea, green gram, Bengal gram, rajmah and other similar crops.

II. Materials And Methods

Different agronomical and general considerations were taken into account while designing the machines. The agronomical recommendations and physical indices of seeds are presented in Table 1. Different machine components viz wheel shaft, hub, spokes, wheel rim, frame, seed and fertilizer box, hitch system, dog clutch assembly etc were fabricated in the workshop as per design considerations taken into account. The different machine components have been shown in figures.

Table 1: Agronomical Recommendations

S l N o	Crop	Seed rate (kg/h a)	Row spacin g, mm	Seed to seed spacin g, mm	Depth of sowin g, mm	Average grain size, mm			Fertilizer dose, kg/ha			Angle of repose, deg
						Le ng th	Wi dth	Thickn ess	N	P	K	
1	Maize	15-20	600- 750	200- 300	50-70	10	8.3	6.8	120- 150	50- 80	40- 60	25-28

$$= 15.7\text{m}$$

If A is the area covered in 10 revolutions then,

$$A = 15.7 \times 3X$$

$$= 4.71X \text{ m}^2$$

Seed damage was measured by using the formula

% damage = average number of damaged seed / total number of seed

The machine was tested in the field. Draft was measured with the help of hydraulic dynamometer

The **wheel slip** was calculated by recording total number of revolutions at no load and total number of revolutions at load.

$$\text{Wheel slip} = (N_1 - N_2) / N_1$$

N1 = total no of revolution of wheel at load

N2 = total no of revolution of wheel at no load

Wheel skid was measured by operating the seed drill for four revolutions of ground wheel and actual distance covered at load and no load condition.

$$\text{Skid} = (L_1 - L_2) / L_1$$

L1 = Actual distance covered, m

L2 = Theoretical distance covered for the same number of revolutions, m

Field Capacity was measured by operating the machine in the field of area 15m x 10m. Normal working speed of 2.88 km/h was kept and sowing was done by using head land pattern.

Metering roller performance for the different crops was done and the values are depicted in Table 2

Table 2: Metering performance of different rollers and seed damage

Sl No	Crop	Recommended seed rate kg/ha	Seed discharge rate, kg/ha *				Damage%
			Drive I Speed ratio 0.3	Drive II speed ratio 0.7	Drive III Speed ratio 1.4	Drive IV Speed ratio 3.0	
1	Wheat	100-125	106.17	156.05	241.31	337.84	Nil
2	Maize	15-20	21.20	31.84	53.00	106.15	2.0
3	Sunflower	10-15	3.53	3.53	7.07	14.15	Nil
4	Bengal gram	75-100	35.38	53.00	74.00	116.08	Nil
5	Jowar	10-15	15.93	23.88	34.50	47.77	Nil
6	Green gram	20-25	17.0	23.00	37.14	53.02	1.5
7	Pea	100	33.02	42.45	53.07	64.86	2.0

*Each value is an average of three replications

Measurement of **turning radius** was done by operating the machine attached with seed cum fertilizer drill in the field. The power tiller was operated at an average speed and turned sharply in right and left direction to make a circle. The mark left in the field by the ground wheel was measured. The diameter of the circle marked in the field measured. A total five observations were taken and averaged out to obtain turning radius. Measurement of **depth and spacing** of seed and fertilizer was measured with the help of steel scale.

III. Results And Discussion

Working Ability of Different Components under Idle condition

The different components of machine were checked under idle condition before actual testing of seed metering mechanism. The drive wheel of the machine was rotated under both clutched and declutched conditions. The function of clutch coupling was quite satisfactory. The function of power transmission system for operation of seed metering mechanism was tested at all four speed ratio obtained through step pulley.

Metering Performance For Wheat

The metering performance for drilling wheat was tested in the laboratory at 0.3, 0.7, 1.4 and 3.0 drive ratio. The entire test was replicated thrice and average value was taken. The discharge rate came 106.17 kg/ha at speed ratio 0.3. Thus drive ratio I (0.3) was recommended for wheat sowing. The damage was nil during the test.

Metering Performance For Maize

In case of maize the average discharge rate was found to be 21.20 kg/ha at the drive I having speed ratio 0.3. But as per recommendation seed rate for maize crop is in the range of 15-20 kg/ha. The damage was recorded as 2.0 percent.

Metering performance of Sunflower

The metering performance for sunflower was tested at the entire four drive ratio. The recommended seed rate for sunflower ranges between 10-15 kg/ha and it was found at drive IV (speed ratio 3.0). No damage was recorded while testing in laboratory.

Metering performance of Bengal Gram

The metering performance for Bengal Gram was tested and found to be 116.08 kg/ha by using drive III (speed ratio 1.4) which was recommended as the recommended rate ranges between 75-100 kg/ha. Seed damage due to metering roller was observed nil.

Metering performance of Jowar

The required seed for Jowar is 10-15 kg/ha. The recommended seed rate was achieved by using the metering roller at the speed ratio 0.3. The seed damage was recorded nil.

Metering performance of Green Gram

Metering performance test was conducted at the entire four drive ratio. The recommended seed rate for green gram is 20-25 kg/ha and achieved at speed ratio 0.7 (drive III). The seed damage was quite negligible.

Metering Performance of Pea

At the entire four drive ratio the metering performance was recorded. The delivery rate was found to be in the range of 33.02kg/ha to 64.86 kg/ha which does not come within the acceptable range of recommendations as seed rate is 100 kg/ha. The present number of grooves on the metering roller made be doubled the desired seed rate may be obtained.

Performance of Fluted Roller for Metering Fertilizer

The fertilizer metering performance was first evaluated in the laboratory. The fertilizer dropped from each furrow was collected and weighed. The fertilizer rate was increased by increasing the exposed area of the fluted roller. The fertilizer discharge at different opening has been shown in Table-3.

Table 3: Discharge Of Fertilizer At Different Opening

Sl. No	Opening position	No. of revolution	Weight of fertilizer dropped, Kg*			Total	Average rate of metering fertilizer, kg/ha
			Furrow I	Furrow II	Furrow III		
1	2	10	0.007	0.008	0.008	0.023	36.82
2	3	10	0.012	0.012	0.014	0.038	58.17
3	4	10	0.027	0.027	0.027	0.081	78.16
4	5	10	0.038	0.032	0.032	0.102	98.43
5	6	10	0.040	0.040	0.040	0.120	115.95
6	7	10	0.045	0.045	0.060	0.150	140.75
7	8	10	0.055	0.055	0.055	0.165	159.27
8	9	10	0.062	0.062	0.061	0.185	178.52
9	10	10	0.075	0.080	0.075	0.230	221.95

*Each value is an average of three replications

Field Performance Of Machine

While working in the field for sowing wheat crop the wheel slip was found 2.08 percent where as the wheel skid was 16.96 percent at an average forward speed of 2.88 kmph. The average value of draft was found to be 55kg. The actual field capacity was found to be 0.137 ha/h and field efficiency of 72.0 percent.

IV. Conclusion

Based on the above experimentation, the following conclusions were emerged out

- The working performance of the machine during idle run was satisfactory and all the components were functioning well.
- The dog clutch assembly was functioning well and the machine could easily be disengaged during the idle run.
- The depth control linkage was also actuating as per designed need and total range of depth actuation was 65mm.
- The hitching arrangement of seed cum fertilizer drill was found to be balanced.
- The minimum turning radius was measured to be 1.5m.
- The metering performance of different rollers was also found within acceptable range except in case of pea.

- The performance of fluted roller mechanism for metering fertilizer (DAP) was also giving the desired range from 36kg/ha to 221kg/ha.
- Seed damage observed for different seeds was negligible.
- Wheel slip and wheel skid measured was quite acceptable.
- Draft requirement of the machine was measured to be 55kg which is within the acceptable range of power tiller.
- The field capacity and field efficiency was 0.137 ha/h and 72.0 percent respectively.

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