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PERFORMANCE OF POWER TILLER OPERATED SEEDER FOR WHEAT CULTIVATION

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Abstract

The experiments were conducted at Wheat Research Centre, Dinajpur with different tillage methods and four seed rates to compare the performance of the seeder and find out the optimum seed rate in respective tilling methods. The results demonstrated that field efficiency of power tiller operated seeder (POTS) and power tiller was significatly higher than that of country plough. Effective field capacity (0.19 ha/hr) of POTS was the highest among other treatments. Fuel consumption of the seeder was 1.4 l/hr. Number of spikes increased significantly with the increase of seed rates. No significant yield difference was found among the seed rates and tilling methods, however, 100 kg/ha with POTS and 120 kg/ha with power tiller two pass was found better. Seeding cost of wheat by power tiller operated seder (225.0 Tk/ha) was 4-7 times less than that of power tiller and country plough.

Introduction

Tillage is the basic operation in farming. Land preparation and sowing are expensive and time-consuming operations for wheat cultivation. Proper placement and distribution of seed and fertilizers into the soil play an important role for good germination and plant establishment resulting better yield (Ganesh Sah, 1999).

The availability of animal draft power is decreasing day by day. Hence, the farmers are becoming more dependent on mechanical power. Now a days, power tillers are available all over the country. Survey results showed that 11%, 17% and 55% of wheat growers used power tillers for cultivating wheat in 1991, 1992 and 1994, respectively (Saunders, 1991 and Meisner, 1994). Wheat sowing period is very limited in Bangladesh. After harvesting of T. Aman (Summer rice), farmers do not have enough time for land preparation with traditional bullock driven plough.

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Delay in planting is one of the main constraints to increasing wheat yields; generally 10-22 days are required for conventional tillage. This conventional tillage includes 4-5 passes plough followed by 10-12 times laddering (Meisner *et al.*, 1997). Power tiller seeder performs tillage operation, seeding in line and laddering simultaneously. During last few years, performance of power tiller seeders was demonstrated at different locations of Bangladesh. At all the sites, the seeder gave encouraging results producing significantly higher yield than that of the conventional tillage (Elahi and Rabbani, 2000). This study was undertaken to assess the level of effectiveness of power tiller seeders over other tillage methods. The main objectives of this study were (i) to compare the seeder performance over conventional methods and (ii) to evaluate the economic performance of the tillage methods.

Materials and Methods

This study was conducted at Wheat Research Centre (WRC), Nashipur, Dinajpur farm in 2001. Four different tillage methods and four seed rates were used to conduct the experiments. The land was fallow after T. Aman harvest and the used variety was Gourab. The treatments were as follows T_1 : Power tiller seeder + no ladder, T_2 : Power tiller one pass + one ladder, T_3 : Power tiller tow pass + one ladder, T_4 : Country plough four pass + 3 ladder. The seed rates were 80, 100, 120, 140 kg/ha. The fertilizer application rates were NPKS @ 100: 60 : 40 : 20 kg/ha. The design was split plot with 3 replications.

The seeder was operated with the different adjustments of seed rates. Tillage operation, seeding in line and laddering were done simultaneously by power tiller operated seeder (POTS). Tillage operation with power tiller and country plough followed by laddering was done as normal practice. Manual line sowing and broadcast sowing were done after ploughing by power tiller and country plough, respectively. First and second irrigations were applied at 21 and 48 days after sowing.

The following data were collected according to Regional Network of Agricultural Machinery (RNAM) test code: (i) Deph of seed placement, (ii) Travel speed, (iii) Effective field capacity, (iv) Field efficiency, (v) Fuel consumption, l/hr, (vi) No. of plants/ m^2, (vii) No. of spikes/ m^2, and (viii) yield/ m^2.

A. Seed calibration: Transparent polythene bags were tagged with each of the six seed delivery tubes. The seeder was operated at pre-measured 20 m travel distance. After every 20 m of run, seed delivery through every tube was

weighed separately and total seed weight was measured. Then, simple calculation was done for seed rate. This method was repeated for acceleration and deacceleration of the lever of seed meter until the desired seed rate occured. A simple equation was used to calculate seed rate.

$$S_d = 10\ Ws/Am$$

Where, S_d=seed rate (kg/ha)

W_s = total wt. of seed (g)

A_m = measured experimental area, m^2 (20m x 1.2m)

B. Travel speed : Pre-measured distance was fixed by two standing sticks. At the time of sowing, fixed distance passing time was recorded by stopwatch and travel speed was computed using the following simple relation:

$$S = 3.6\ d/t$$

Where, S = travel speed (km/hr)

d = pre-measured distance, m (20 m)

t = recorded time (s)

C. Theoretical field capacity: Theoretical field capacity was calculated as

$$TFC = \frac{W \times S}{10}$$

Where, TFC = theoretical field capacity (ha/hr)

W = width of the seeder (m)

S = travel speed (km/hr)

D. Effective field capacity : It is the actual field coverage of the seeder per unit time. Effective field capacity was calculated as follows :

$$EFC = A/T$$

Where, EFC = effective field capacpacity (ha/hr)

A = total area sown by the machine (ha)

T = total recorded time (hr)

E. Field efficiency : It is the percentage of effective field capacity and theoretical field capacity.

$$Fe = \frac{EFC}{TFC} \times 100$$

Where, Fe = Field efficiency (%)

F. Fuel consumption : The fuel tank was filled and re-filled before and after the sowing operation, respectively. Re-filled quantity was the fuel consumption.

$$F_c = Fr/t$$

Where, F_c = fuel consumption (l/hr)

F_r = re-filled quantity of fuel (l)

t = seeding time (hr)

Cost analysis : Cost analysis was done on the basis of fixed cost and variable cost.

A. Fixed cost

i. Depreciation = $(P = S)/L$

Where, P = purchase price, Tk

S = salvage value,

L = life, year

ii. Interest on investment = $\frac{(P+S)}{2} \times I$

Where, i = bank interest rate, %

B. Variable cost

Variable cost was calculated on the basis of (I) repair & maintenance cost, (ii) fuel, oil cost, (iii) operator cost

Results and Discussion

Table 1 shows the field performance of different tillage methods. Efective field capacity was affected by turning time loss, adjustment time loss, time loss by re-filled seed box and operator's personal skill. The results revealed that theoretical field capacity, effective field capacity and field efficiency of country plough were significantly lower than that of power tiller seeder and power tiller. Effective field capacity of power tiller operated seeder (POTS) was slightly higher than that of power tiller. Tillage operation by power tiller showed higher field efficiency (90%) than other tilling methods due to its less turning time loss. Soil moisture content is an important factor for seeder operation as well as seed germination. The fuel consumption of the seeder was 7.4 l/ha which was equivalent to 1.4 l/hr. This was higher than that required for power tiller due to its greater field capacity and operational load.

Table 1. Field performance of different tillage methods.

Name of tillage methods	Depth of seed placement (cm)	Theoretical field capacity (ha/hr)	Effective field capacity (ha/hr)	Field efficiency (%)	Fuel consumption	
					l/hr	l/hr
Power tiller seeder	4	0.24	0.19	79.2	1.4	7.4
Power tiller one pass	2-3	0.20	0.18	90	1.3	7.22
Power tiller two pass	2-3	0.20	0.18	90	1.3	14.44
Country plough	Not estimated	0.04	0.03	75	-	-
Standard error	0.49	0.04	0.03	3.82	0.02	2.37

Field capacity and field efficiency were dependent on operator's skill. Effective field capacity of the POTS for wheat sowing was 0.19ha/hr (Table 1). Field shape, size and soil conditions influenced the field efficiency, because, the turning time loss and travel speed of the seeder depends on it.

The effects of different tillage methods and seed rates on plant population were non-significant. Plant population numerically increased with the increase in seed rate. The highest population was found at treatment T_3 (power tiller two passes) and the lowest at T_4 (country plough). The results were highly significant among the treatments for spikes per unit area. Number of spikes increased with higher seed rates. The highest number of spikes were found at the treatment T_1 (power tiller seeder). Number of spikes at the seed rates of 100 and 120 kg/ha was almost same. Number of spikes were comparatively more at treatment T_1 due to seed placement at uniform depth and for good soil compaction.

Table 2. Interaction effect of different tillage methods and seed rates on yield contributing characters of wheat.

Treatments / Tillage methods	Plant population/ m^2				Spikes/ m^2			
	Seed rate (kg/ha)				Seed rate (kg/ha)			
	80	100	120	140	80	100	120	140
T_1	183	199	201	204	291	295	295	307
T_2	196	203	205	202	257	260	277	290
T_3	190	208	219	213	286	290	308	288
T_4	175	179	198	203	252	255	264	283
CV(%)	9.28				4.60			
Level of significance	ns				*** (LSD : 23.54)			

The effects of different tillage methods and seed rates were statistically non-significant (Table 3). Yield among the tillage methods and seed rates vary from each other. Wheat yield by POTS showed better than that by country plough and power tiller one pass operation because of seed placement at uniform depth, better soil compaction and more number of spikes per unit area. The highest yield was found at power tiller two pass at the seed rate of 120kg/ha, but that was not significantly higher than the yield of power tiller operated seeder and other treatments. Though, the yield did not significantly change with the change of seed rates, 100 kg/ha with POTS and 120kg/ha with power tiller two pass was found better than other treatments. Among the different seed rates, wheat yield by POTS found better at 100 kg/ha.

Table 3. Wheat yields of different tillage methods and seed rates.

Yield (t/ha)

Name of tillage methods	Seed rate (kg/ha)			
	80	100	120	140
Power tiller seeder	4.6	5.3	5.1	4.7
Power tiller one pass	4.3	5.4	5.7	4.2
Power tiller two pass	4.3	5.4	5.7	4.2
Country plough	3.8	4.6	4.7	4.3
CV (%)			14.80	
Level of significance			ns	

Sowing cost of wheat (Table 4) using power tiller seeder was the lowest (Tk 225.0/ha) among the four tillage methods and it was about 4 and 7 times less than the sowing cost using power tiller and ountry plough, respectively. Fig. 1 shows the seeder operation cost per ha for different annual use of the seeder. If annual operational area increases, seeder operational cost will decrease. If the seeder operation area is more than 10 ha the rate of cost decrease will be very small.

Table 4. Cost of wheat cultivation by different tillage methods.

Name of tillage methods	Land preparation cost (Tk/ha)	Seeding cost (Tk/ha)	Total sowing cost (Tk/ha)
Power tiller seeder	225.0	-	225.0
Power tiller one pass	200.0	700.0	900.0
Power tiller two pass	400.0	700.0	1100.0
Country plough	1667.0	70.0	1737.0

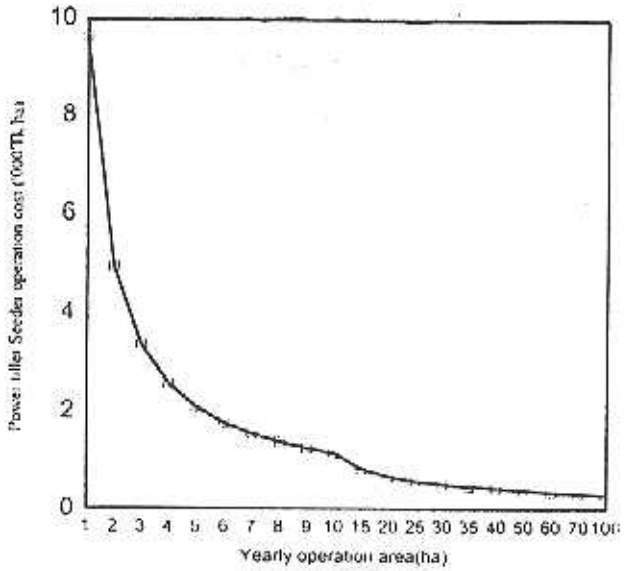

Fig. 1. Cost curve of machinery operation

Conclusion

(i) Field efficiency of country plough was significantly lower than that of POTS and power tiller;

(ii) Effective field capacity (0.19 ha/hr) of the seeder was the highest among the tillage methods;

(iii) Fuel consumption of the seeder was 1.40 l/hr;

(iv) There was no significant yield difference among the seed rates and tilling methods, however, 100 kg/ha with POTS and 120 kg/ha with power tiller two pass were found better.

(v) Cost of wheat sowing by the power tiller seeder (Tk 225/ha) was 4 and 7 times less than that of the power tiller and country plough tillage method, respectively.

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