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Effect of different tillage systems on wheat (*Triticum aestivum*) crop

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ABSTRACT

An experiment was conducted for two consecutive years to study the effect of different levels of tillage on wheat (*Triticum aestivum* L. emend. Fiori & Paol.) after paddy (*Oryza sativa* L.) harvest. The tillage systems included one zero-tillage or direct drilling treatment and five tillage treatments varying from one harrowing to six harrowing. Two cultivator and one planking were common in all tillage treatments. The experiment was laid out in randomized block design (RBD) with three replications. Bulk density and clod mean-weight diameter decreased with increase in the number of tillage operations, which varied from 1.49 to 1.23 g/cc and 13.8 mm to 12.5 mm respectively. In the first year of experiment the zero-tillage yield was on a par with that of tillage treatments and the yields were statistically non-significant in different treatments. However, during the second year of trial the difference in yield and tiller count was statistically significant. Based on 2-year data, it could be inferred that there was no consistency in results of zero-tillage being on a par with that of tillage treatments. Reduced tillage with two harrowings followed by two cultivator and one planking treatment was better from economic return point of view.

Key words : Tillage, Zero-tillage, Wheat, Seed-bed preparation

Minimum tillage has gained importance in recent years owing to need of farmers to reduce production costs, which can be achieved in part by reducing the intensity of tillage operation.

Paddy-wheat cropping system is predominant in India. The quantum of tillage for wheat cultivation is important because the puddling of soil disturbs the soil structure. Several studies in tillage research have investigated the optimum level of tillage (Oni and Adeoti, 1986; Kyambo and Lal, 1986; Malhi *et al.*, 1988; Singh and Panesar, 1991).

In paddy-wheat crop rotation hardly 15-20 days time is available between harvest and timely sowing of wheat crop, which puts tremendous pressure on farmers for expediting seed-bed preparation. Moreover, delayed sowing and poor-quality seed-bed affect germination and ultimately the crop yield (Ball, 1989). The energy input, time and cost of seed-bed preparation for wheat in paddy soils is high. Also, with greater intensity of tillage, the repeated movement of traffic on soil causes mechanical compaction and deterioration of soil structure (Erickson *et al.*, 1974; Oni and Adeoti 1986).

Thus, keeping the above points in view, the present study was undertaken to observe the effect of different levels of tillage on production of wheat.

MATERIALS AND METHODS

An experiment was conducted for two consecutive years, 1995-96 and 1996-97, in sandy loam soil to study the effect of different levels of tillage on soil and crop parameters of wheat after manually harvested paddy crop.

The experimental plot was divided into 18 plots of 9 × 18 m size to include six treatments. The experiment was laid out in randomized block design (RBD) with three replications. The most commonly used implements by the farmers in the Meerut region of northern India are disc harrow and cultivator. Therefore the combinations of these implements were selected for the experimental study. The different tillage treatments were: T_1 = direct drilling or zero-tillage; T_2 = one pass of disc harrow + two passes of cultivator + one planking; T_3 = two passes of harrow + two passes of cultivator + one planking; T_4 = three passes of harrow + two passes of cultivator + one planking; T_5 = four passes of harrow + two passes of cultivator + one planking; and T_6 = six passes of harrow + two passes of cultivator + one planking. The wheat variety 'PBW 226' was sown in the first week of December in both the years at a seed rate of 125 kg/ha. The fertiliser was broadcast @ 120 kg N/ha, 60 kg P_2O_5 and 40 kg K_2O per hectare. The entire dose of phosphorus and potassium and 50% nitrogen was applied at the time of sowing. The remaining 50% nitrogen was applied 25-30 days after sowing. Subsequent cultural practices were kept the same for all the treatments. Standard techniques were followed to determine bulk density and clod mean-weight diameter. Different crop parameters such as germination count and tiller count were noted after 21 and 45 days of sowing respectively. The crop-yield data were noted randomly using a metre-square from three different locations in each plot. Analysis of variance was done to determine the significance of tillage treatments on crop parameters.

RESULTS AND DISCUSSION

Tillage effect on soil properties

The bulk density and average clod size

Table 1. Effect of different levels of tillage on soil parameters

Treatment	Soil parameter	
	Bulk density (g/cc)	Clod mean-weight diameter (mm)
T_1	1.49	-
T_2	1.36	-
T_3	1.31	13.8
T_4	1.27	13.49
T_5	1.25	12.86
T_6	1.23	12.53

were used as an indirect index for soil tilth. The values of bulk density and clod mean-weight diameter were averaged for 2 years in different treatments (Table 1). In general, the bulk density decreased with increase in the number of passes. The bulk-density values in treatments T_1, T_2, T_3, T_4, T_5 and T_6 were : 1.49, 1.36, 1.31, 1.27, 1.25 and 1.23 g/cc respectively. Moreover, it can also be inferred that the single pass caused less reduction in bulk density. Similarly, the clod mean-weight diameter also decreased with number of passes. The largest average clod size was in the treatment T_3 (13.8 mm), followed in decreasing order by T_4 (13.49 mm), T_5 (12.86 mm) and T_6 (12.53 mm). Since the clod size was large enough for sieve analysis in treatment T_2, the data were not taken.

Tillage effect on crop response

The data for wheat crop yield and yield-determining factors for both the years are given in Table 2. The soil edaphic factors such as soil impedence, aeration and temperature are modified by tillage operations, which ultimately influence the soil environment for seed germination and crop growth. In the first year the maximum yield was obtained for treatment T_6 (4,210 kg/ha), followed in decreasing order by T_5 (4,195 kg/ha), T_1 (4,185 kg/ha), T_4 (4,138 kg/ha), T_3 (4,096 kg/ha) and T_2 (3,615 kg/ha). The maximum yield in T_6 may be due to better pulverisation of soil, resulting in proper seed and soil contact, which caused good germination (265 plants/m^2). The lowest yield was observed in treatment T_2 because of poor seed and soil contact, as the clod size was big and did not create good tilth for proper germination of crop (170 plants/m^2). However, statistically there was no significant difference in treatments for crop yield and other crop parameters. The yield of zero-tillage plot was on a par with that of tillage treatments.

During the second year of the experiment the maximum yield was obtained in treatment T_5 (4,150 kg/ha), followed in decreasing order by T_6 (4,114 kg/ha), T_4 (4,110 kg/ha), T_3 (4,062 kg/ha), T_1 (3,726 kg/ha) and T_2 (3,463 kg/ha). It is clear that yield increased with increase in number of passes of harrow from two to four. This

Table 2. Effect of tillage treatments on crop yield and yield contributing factors

Treatment	Yield (kg/ha)		Germination count, (no. of plants/m^2)		Tiller count (no. of plants/m^2)		Plant height (cm)	
	1995-96	1996-97	1995-96	1996-97	1995-96	1996-97	1995-96	1996-97
T_1	4,185	3,736	198	176	286	232	82	81
T_2	3,615	3,463	170	165	240	210	81.4	80
T_3	4,096	4,062	210	195	274	266	81.6	81.5
T_4	4,138	4,110	226	210	294	282	81.5	81.5
T_5	4,195	4,150	260	222	305	290	83.5	83.5
T_6	4,200	4,114	265	230	310	284	84.2	84.4
CD ($P = 0.05$)	NS	164.73	NS	NS	NS	23.64	NS	NS

trend could be possibly due to good tilth of seed-bed and better seed-to-soil contact, providing favourable environment for germination of seed that ultimately resulted in increased yields. However, the decrease in yield was non-significant from treatment T_5 to T_6, perhaps because the four harrowings in T_5 created a desired tilth of seed-bed and further tillage operation did not cause much change in quality of seed-bed, as seen in Table 2.

The yield in treatment T_2 was significantly lower than in all the other treatments, indicating that one harrowing followed by two cultivator and one planking does not create a favourable seed-bed for crop production. Also, the zero-tillage treatment (T_1) had significantly lower yield compared with that in treatments T_3, T_4, T_5 and T_6. The percentage increase in yield over zero-tillage T_1 in treatments T_3, T_4, T_5 and T_6 was 8.72, 10, 11 and 10.11% respectively. However, there was no significant difference between treatments T_3, T_4, T_5 and T_6. The maximum yield increase of 11% was observed in treatment T_5 compared with that in zero-tillage treatment. The additional cost of tillage over zero-tillage was Rs 700 in T_2, Rs 950 in T_3, Rs 1,200 in T_4, Rs 1,450 in T_5 and Rs 1,950/ha in T_6. These are based on prevailing rate of custom hiring of tractor-drawn implements like harrow, cultivator and planking at Rs 250/ha, Rs 200/ha and Rs 50/ha respectively. Thus the cost of tillage increased linearly with increase in number of tillage operations. In the first year of trial, since there was no significant difference in yield between the treatments, there was a saving of Rs 950 to 1,200 in zero-tillage system. However, in the second year, there was significantly lower yield in zero-tillage (T_1) compared with that in T_3, T_4, T_5 and T_6, and the yields in T_3, T_4, T_5 and T_6 were at par. Therefore the treatment T_3 gave economic returns in addition to saving in time.

Thus on the basis of 2 years of experiment, it can be concluded that there was no consistency in the zero-tillage treatment giving yield at par with that in tilled plots. In general, minimum tillage (two passes of harrow followed by two passes of cultivator and one planking) may be recommended for seed-bed preparation for saving in time and economic returns. Also, with excessive tillage operations the yield either stagnated or reduced.

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