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Comparative Study of Conventional and Conservation Tillage on Soil Crop Environment

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ABSTRACT

Tillage is the process of creating a suitable environment such as seedbed/rootbed for the germination of seeds, the establishment of a crop and its satisfactory development up to harvest. The study was conducted on a sandy clay loam soil continuously for two years. The results of one pass of mouldboard plough followed by two passes of diskharrow and two passes of tine cultivator (conventional tillage) and one pass of dyna drive followed by one pass of diskharrow and one pass of tine cultivator (conservation tillage) with respect to soil crop parameters were compared. During second year, early sowing by one week delayed germination of seeds by one week under existing environmental conditions. The maximum germination took place within 25 days in both the years. Greater crop yield was obtained for those treatments in which tine cultivator was used as secondary tillage implement. Mouldboard plough followed by two passes of tine cultivator was found to be more appropriate and profitable tillage implement in obtaining greater crop yield.

Key Words: Conventional tillage; Conservation tillage; Seed germination; Crop yield

INTRODUCTION

Tillage is the process of creating a suitable environment such as seedbed/rootbed for the germination of seeds, the establishment of a crop and its satisfactory development up to harvest. Selection of the right combination of tillage implements is necessary to create a soil environment conducive for optimum germination and maximum yield.

It is always considered that a seedbed is that layer of soil which has been tilled to promote seed germination, seedling emergence and plant growth. For best germination and growth, the tillage must ensure sufficient moisture, oxygen, nutrients, and heat. In addition, the tillage should facilitate root penetration and seedling emergence through the soil profile. Generally, the success of any tillage practice is reflected by the health of plants and crop yield. Loveday (1980) stated that the consideration of pore space, its distribution and continuity provides more water retention, gas exchange and root rannification. These parameters are important for understanding the effect of different tillage practices on soil crop environment. In this study, the performance of conventional and conservation tillage practices have been evaluated from two crop parameters namely, seed emergence and crop yield.

MATERIALS AND METHODS

The study was conducted continuously for two years on a sandy clay loam soil. The study area was devided into 16 plots of 24 x 6 m. each. In this study, four tillage treatments were compared using mouldboard plough and dyna drive as primary tillage implements; whereas, diskharrow and tine cultivator as secondary tillage implements. The mouldboard plough followed by two passes of diskharrow and two passes of tine cultivator (T1 & T2) was regarded as conventional tillage whereas dyna drive followed one pass of diskharrow and one pass of tine cultivator (T3 & T4) was regarded as conservation tillage. Each treatment in the field was replicated four times. Mouldboard plough was used at a depth of 25 cm; whereas, diskharrow, tine cultivator and dyna drive was used at a depth of 10 cm.

Pastoral, a variety of winter barley was sown at the rate of 169 kg ha-1 during first year and at the rate of 172 kg ha-1 in the second year one week earlier than first year. The plots were sprayed to kill weeds and insects. Other necessary operations such as fertilisation and interculture were carried out to facilitate the investigation. Seedling emergence were recorded during both the experimental years. A line of one meter length was replicated five times in each plot at random positions and germination was counted on both sides of the line on different days till the germination stopped. From germination data, plant population density was calculated. After harvesting the crop, yield was measured for both the experiments. The crop samples were taken from all the 16 plots with three random replications in each plot from an area of one m^2. The crop samples were harvested and carefully thrashed. The samples were then sieved to remove material other

than grain before final weighing to calculate the crop yield (grain + straw). Then grain yield was calculated at 15% moisture content. Minitab statistical package was used for analysis of data.

RESULTS AND DISCUSSION

Seed germination. A significantly greater seed germination and plant population density were recorded for treatment 4 as compared to treatments 1, 2 and 3 during experiment 1 (Table I). This may be associated with per cent seed germinated of the total (348 seeds m^{-2}) seed sown. The per cent emergence observed was 69, 65, 62 and 85% for treatments 1, 2, 3 and 4, respectively (Table I). The increased number of seed germinated on each date can be attributed to greater seed moisture uptake under treatment 4 than all other treatments. The plant population density was increasing at each date; whereas, seed germination was decreasing (Table III). The plant population density was maximum when seed germination completed which was expected, and germination was maximum after 25 days of sowing (Table III). The fluctuation of seed germination at each date under different tillage treatments (Table IV) is associated with seed soil contact characteristics.

Table I. Seed emergence m^{-2}, plant population density m^{-2} averaged over all days and per cent emergence (Experiment 1)

Trts.	Avgd. SGR m^{-2}	Avgd. PPD m^{-2}	Per cent emergence
T1	18	242	69
T2	17	228	65
T3	14	219	62
T4	22	307	85

Trts.= Treatments; Avgd.= Averaged over all days; SGRM m^{-2}=Seed germination rate per meter square; PPD m^{-2}=Plant population density per meter square

Table II. Seed emergence m^{-2}, plant population density m^{-2} averaged over all days and per cent emergence (Experiment 2)

Trts.	Avgd. SGRm^{-2}	Avgd. PPD m^{-2}	Per cent emergence
T1	21	333	92
T2	23	315	86
T3	19	318	88
T4	22	309	86

Trts.= Treatments; Avgd.= Averaged over all days; SGRM m^{-2}=Seed germination rate per meter square; PPD m^{-2}=Plant population density per meter square

During experiment 2 greater plant population density under treatment 1 than under treatments 2, 3 and 4 is associated with per cent seed emergence of the total (360 seeds m^{-2}) seeds sown (Table II). The per cent emergence observed was 92, 86, 88 and 86 per cent for treatments 1, 2, 3 and 4, respectively (Table II). The greater seed emergence at each date under treatments 2 and 4 than under treatments 1 and 3 (Table II) can be attributed to greater seed moisture uptake inspite of the fact that plant population density was greater for treatment 1.

Table III. Seed germination rate and plant population density m^{-2} per day averaged over all treatments (Experiment 1 & 2)

Experiment 1			Experiment 2		
DAS	Avgd. $SGRd^{-1}$	Avgd. $PPDd^{-1}$	DAS	Avgd. $SGRd^{-1}$	Avgd. $PPDd^{-1}$
8	89	177	15	116	231
9	43	220	16	17	265
12	7	240	19	16	297
15	4	252	22	5	327
19	3	264	26	3	350
23	2	270	30	2	365
33	1	276	40	1	372
47	0	279	54	0	372

DAS= Days after sowing; Avgd.$SGRd^{-1}$ = Averaged overall seed germination rate per day per meter square; Avgd. $PPDd^{-1}$ = Averaged overall plant population density per day per meter square;

Table IV. Effect of different tillage treatments and days after sowing on seed germination rate

Trts.	Days after sowing							
	8	9	12	15	19	23	33	47
T1	115	23	18	5	3	2	1	0
T2	117	15	16	5	3	2	1	0
T3	115	15	15	5	4	2	1	0
T4	116	14	15	6	4	2	1	0

During experiment 2 one week early sowing delayed seedling emergence by one week but germination was maximum after 25 days (Table III). This partly confirms the results forwarded by (Edward 1957a, b; 1958) who found that sowing time did not have much effect on time of emergence and percentage of emergence. But it partly contradicts the results presented by (Braunack & Dexter, 1988) that early sowing date resulted less time to emerge and higher percentage of emergence.

Crop yield. The crop yield was greater under treatment 2 than under treatments 1, 3 and 4. This difference was not statistically significant (Table V). This is in line with the results reported by Chaney *et al.* (1985) on sandy clay loam that mean grain yields of spring barley were marginally low after direct drilling than after shallow conventional ploughing. In another study, Carter and Rannie (1985) pointed out that the areas in which soil moisture is a constraint for plant zero tillage has produced crop yield similar to conventional tillage. Greater crop yield for treatment 2 than treatment 1 and similarly for treatment 4 than treatment 3 can be associated with the tine cultivator used as secondary tillage implement which might have increased continuity of pore spaces which can be affected by compaction caused by bearing area of the disk harrow. Therefore, greater yield of treatments in which tine cultivator is used as secondary tillage implement can be associated with appropriate seedbed/rootbed formation.

Table V. Crop yield (grain + straw) ton ha^{-1} during (Experiment 1 & 2)

Trts.	Experiment 1 Crop yield (ton ha^{-1})		Experiment 2 Crop yield (ton ha^{-1})	
	Grains	Straw	Grains	Straw
T1	7.83	11.37	7.16	9.20
T2	8.04	12.42	7.49	9.51
T3	7.83	12.79	6.46	7.29
T4	7.95	12.90	6.67	8.22

Trts.= Treatments; ha= Hectare

During experiment 2 a significantly greater crop yield under treatments 1 and 2 than under treatments 3 and 4 (Table V) can be associated with greater soil moisture content and nutrient availability after winter through late spring and lower dry bulk density of soil after winter through crop establishment period before harvesting. Greater crop yield for treatment 2 as compared to treatment 1 and 4 as compared to treatment 3 can be associated with the effect of tine cultivator used as a secondary tillage implement that might have affected soil pores continuity. The greater crop yield of treatments in which tine cultivator is used as secondary tillage implement can be associated with appropriate seedbed/rootbed formation.

CONCLUSIONS

1. Early sowing date delayed time of seedling emergence but increased percent emergence during second year of experimentation.
2. There was a consistency in crop yield under conventional tillage while there was no consistent relationship between crop yield under conservation tillage in both the years.
3. Mouldboard plough followed by two passes of tin cultivator (treatment 2) was found more appropriate and profitable tillage implement in obtaining greater crop yield.

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