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INTERACTION OF TILLAGE WITH SOIL PARAMETERS AND NUTRIENT LEACHING

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Efforts for higher crop yields have led to extensive use of chemical fertilizers that may possibly leach out of crop root zone on applieation of water or rainfall. The leaching results in wastage of fertilizer as well as pollution of subsurface water. As tillage plays a vital role in the leaching process, it was planned to investigate the differential response of tillage-nutrient leac1hing. Traces of nitrates over and above the residual ones were located up to 150 cm after first irrigation. Some tillage practices were found better than others in effective management of fertilizer.

INTRODUCTION

Nitrogen is applied through chemical fertilizers to meet the demands of high yielding crop varieties. Unfortunately, a considerable part of the applied nitrogen (40-50%) is lost through volatilization, dcnitrification and leaching in the form of nitrates (Gill, 1978). Of all the losses, leaching is the most serious as it causes groundwater contamination in addition to loss. of fertilizer which is a costly input.. However, the extent of groundwater pollution through nitrogenous fertilizers has not been fully explored. Viets (1971) stated that subsurface water quality deterioration could be associated with increased nitrogenous fertilizer use but positive evidence is yet awaited.

Various tillage practices alter soil conditions differently and in turn affect the leaching characteristics of a soil. That is why some research workers have attempted to investigate the effects of tillage practices on the NOrN leaching in the soil profile (Devitt *et al.*, 1976 and Kanwar *et al., 1985).* However, the way different tillage practices manage the fertilizer in different soil layers yet needs to be established. Therefore, it was considered useful to investigate the effects of various locally used tractor- powered tillage implements on soil physical properties and nutrient leaching.

MATERIALS AND METHODS

The experiment was conducted at the University of Agriculture, Faisalabad. The textural class of the soil was sandy clay loam. There were 15 plots each measuring 10 m X 56 m. Five tillage implements/treatments namely tine cultivator, sweep cultivator, disk harrow, mould board plow and chisel plow were used at 10, 10, 10, 20 and 30 cm soil depth respectively in a stubble field. There were three replications of each treatment. After seedbed preparation of all the plots with a sweep cultivator twice (10 cm deep), the wheat variety LU 26S was sown with a carefully calibrated graindrill. At sowing time diammonium phosphate at the rate of 125 kg ha^{-1} was applied.

Soil samples for determining moisture content and bulk density were collected from 0-5, 5-10 and 10-15 cm soil depths on the same day. Standard procedures were used for determination of soil moisture and density. These properties were recorded to assess the level of soil tilth obtained from the implements and helped explain leaching characteristics of differently tilled plots. Two weeks after sowing, soil samples were collected with 30 cm increment up to 150 cm from all the plots for determining status of NOrN in the soil profile. Soil samples were taken at three sites in each plot, however, samples from corresponding depths were mixed to prepare composite samples. The samples were air dried, ground, passed through 2 mm sieve and chemical analysis was undertaken to determine NOrN contents in the samples using "Disulphonic Acid Method" (Black, 1965). With first irrigation, urea was applied at the rate of 125 kg ha-!. Soil samples were again taken for NOrN analysis one month after the irrigation in order to determine the movement of NOrN in the soil profile.

Table 1. Nih-ate-nitrogen contents for various tillage treatments (before irrigation)

Tillage treatment	Depths (cm)				
	0-30	30-60	60-90	90-120	120-150
			PP!11		
a. Narrow tine cultivator	10.60	3.54	2.13	1,13	0,53
b. Sweep cultivator	8,13	4.67	1,80	0.73	0.73
c. Disk harrow	7.66	2.26	2.00	0.67	0.46
d. M.B. plough	6.86	z'60	1,20	DAD	0.00
e. Chisel plough	7.80	5.73	0.54	0,34	0.20

RESULTS AND DISCUSSION

Soil moisture content: The analysis of soil moisture data collected from three soil depths 0-5, 5-10 and 10-15 cm showed significant differences for various implements suggesting that the implements managed soil moisture differently in the soil profile. Depth-implement interaction was highly significant. Of particular importance was the effect of disk harrowed plots where moisture was maximum and minimum at 0-10 and 10-15 cm soil layers respectively, compared with other implements. This response of disk harrow is perhaps due to the eompaction underneath the disks. The disk harrow was operated at a depth of 10 cm beyond which soil was compacted and consequently the movement of moisture slowed down.

Dry soil density: Generally dry soil density increased with increasing depth, since movement of smaller soil fractions into the lower soil layers makes them denser. Higher density of lower soil layers could be the result of tractor-implement induced compaction. The effect of disk harrow was interesting in the way that the density decreased in the layer of soil at 5-10 cm depth, whereas the same increased for 10-15 cm soil layer. This differential response can be attributed to the soil compaction caused by the bearing areas of the disks below the depth of ploughing which Was 10 cm in case of disk harrowed plots.

The increase in soil density beyond 10 cm depth in the disk harrowed plots suggests that the Use of this implement is quite suitable for shallow-rooted crops especially in more penneable soils or in the soils where moisture conservation is important. This effect of disk harrow is partly in line with the findings of Sheikh *el al.* (1980) and Sial *et al.* (1981) who considered disk harrow as an appropriate tillage implement for seedbed preparation of wheat crop.

Nitrate-nitrogen leaching before first irrigation: The mean values of NOj-N concentration in various soil layers two weeks after application of diarnmonium phosphate (OAP) are given in Table 1. The main effect of implements tested was non-significant suggesting that the differences in the level of soil tilth, if any, had no effect on NOrN contents at this stage. The main effect of depth was highly significant for the obvious reason that NOrN was concentrated in the upper 0-30 and 30-60 cm soil layers, perhaps due to lack of soil moisture or its movement. That is why nitrates in the layers beyond 90 cm were statistically similar since these contents were residual ones.

the first few weeks. The exact reasons for this response were not clear, however, it was noted that some implements were more beneficial than the others as regards the retention of NOj-N in the upper soil layers.

Nitrate-nitrogen leaching after first irrigation: The mean values of NOJ-N concentration in different soil layers after application of urea alongwith first irrigation are given in Table 2. Again the effect of depth of soil on NOj-N contents tested highly significant. Employment of Duncan's Multiple Range test further revealed that the values for the last two depths were not significantly different (Table 2), whereas it is evident from Table 1 that mean concentrations contained in the last three depths were of the same magnitude. A comparison of the values of NOrN contents before and after irrigation suggests that a noticeable leaching occurred up to 90 cm at the time of second sampling i.e. one month after first irrigation.

Table 2. Nitrate-nitrogen contents for various tillage treatments (after first irrigation)

Tillage treatment	Depths (cm)				
	0-30	30-60	GO-90	90-120	120-150
	ppm				
a. Narrow tine cultivator	8.33	5.40	2.53	1.46	0.67
b. Sweep cultivator	9.73	7.60	2.40	1.60	0.00
c. Disk harrow	5.0()	4.46	3.00	1.34	0.60
d. M.B. plough	4.86	2.86	1.54	1.06	0.34
e. Chisel plough	6.13	4.40	2.00	0.53	0.43

The implement-depth interaction showed maximum NOrN contents in 0-30 cm soil layer in the plots prepared by narrow tine cultivators, whereas the plots tilled with sweep cultivator ranked second in maintaining NOrN in the upper soil layer which is the feeding place of the young plants for

This, downward movement of nitrates would perhaps continue in the irrigations to follow.

CONCLUSIONS

A statistically significant implement-depth interaction suggests that various tillage practices behaved differently in managing nitrates at various soil depths. Sweep-tilled plots were better than narrow tine cultivation in retaining NOrN contents in the upper soil layer of 0-60 cm. It is quite apparent that sweep-tilled plots can be considered appropriate as regards retention of NOJ-N in the top soil layer (0-60 cm) which is the root bed of the plant. The increased nitrate concentration after first irrigation clearly suggests that leaching can be recorded up to 150 cm soil depth just with a normal dose of the fertilizer and a normal irrigation. In case, this trend continues in our agricultural fields year after year, then the day is not too far when we would badly pollute the underground water reservoir. Unfortunately, it would be an irreversible process and the polluted water when used for drinking would present alarming health hazards.

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