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Salient Characteristics of Cultivated Soil Influenced by Legume and Cereal Cropping System

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Abstract

Soil Nitrogen and Organic Matter were determined before sowing and after the harvest of crops to assess the effect of wheat and chickpea growth on soil fertility. Chickpea crop utilized less soil N and NO_3-N as compared to other crops even when nitrogen was applied but it caused a significant increase of nitrogen and organic matter in soil whereas wheat exhausted the nutrients. The total N and NO_3-N level in the soil fell down much more in case of wheat cultivated without N application. The control treatment showed a slight fluctuation in measured parameters. Organic matter of the soil was ameliorated by crops grown over the season comparatively better by chickpea crop.

Introduction

Cultivation of soil on crop lands tends to deform soil and so alters the structure changing in various soil physical properties. An evaluation of productivity of crop lands is currently very timely for several reasons. Net productivity has an influence on carbon balance, it is interrelated with carbon dioxide dynamics in the atmosphere as well as it has an influence on the soil organic matter and nitrogen fixed by legumes (Herridge *et al.,* 1995; Aslam *et al.,* 1997). Residues store nutrient elements that are gradually released when mineralized by soil micro-organisms and are important as available energy for soil biota, to drive the nutrient cycles (Low, 1972; Coleman *et al.,* 1983; Buyanovsky and Wagner, 1986). From this stand point post harvest residues deserve much more attention than they have received. Consideration of quantity and character of post harvest residues as factors in soil management should be equal to that given to fertilizer application, moisture and tillage practices in maintaining soil productivity.

Economic yield of cultivated crops has always been the major focus of any detailed study to neglecting of collection of data on overall productivity. Even though estimates of the amount of carbon and nitrogen in the form of the above ground plant residues are sometimes available for agricultural ecosystems, those related to the roots are generally not known. This is to be expected because of the difficulties connected with the sampling of the below ground system and it occurs despite the fact that the necessity of collecting data on root accumulation is widely recognized (Loomis and Gerakis, 1975). Conceding the need to get information regarding change in soil fertility level influenced by legume and cereal cropping, the study was planned on marginal land of arid zone.

Materials and Methods

Field experiment was conducted for six months to study the salient characteristics of the soil influenced by cereal and legume crop growth in field area of National Agricultural Research Centre, Islamabad during the wheat growing season, 1996-97. The experiment was planned with the following treatments.

T1 = Control (un-cropped)
T2 = Wheat Crop without N application
T3 = Wheat Crop with N at 100 kg ha^{-1}
T4 = Chickpea Crop

There were four replications of each treatment (4x10 m plot size) in randomized complete block design. The control treatment was kept uncropped after ploughing. The soil was sandy loam (well drained) with saturation percentage = 16.6 percent, pH = 7.8, ECe = 0.14 dS m^{-1}. Four soil samples were collected randomly from each treatment (0-90 cm deep) before sowing and after the harvest of crop. Analysis for total Nitrogen, soil NO_3-N and Organic Matter was done according to the methods described by Richards (1954) and Soltanpour and Workman (1979). All the weeds from control as well as cropped treatments were removed regularly to make the results more accurate. Formal crop data regarding plant density, straw and grain yields of the cropped treatments were collected. The data obtained from each treatment were analysed statistically to see the level of significance (Steel and Torrie, 1980).

Results and Discussion

Soil nitrogen: The cropped treatments significantly influenced soil fertility (Table 2). The uncultivated treatment maintained approximately the same level of total nitrogen and soil NO_3-N contents while a significant reduction in

Table 1: Plant density and yield of wheat and chickpea obtained from cultivated treatments

	Average of four repeats		
Treatments	Plant Density (Per m^2)	Straw Yield (G/m^2)	Grain Yield (g/m^2)
T1	-	-	-
T2	64.28	326.38	156.67
T3	76.17	464.21	223.44
T4	37.02	224.33	112.29

Table 2: Total Nitrogen, NO_3-N and Organic Matter status of Soil (0-90 cm deep) as effected by wheat and chickpea

	Total N (%)			NO_3-N (μg^{-1})			Organic Matter (%)		
Treatment	Before sowing	After harvest	% decrease	Before sowing	After harvest	% decrease	Before sowing	After harvest	% decrease
T1	0.028b	0.027b	0.001bc	6.460a	6.456a	0.004d	0.443c	0.440c	0.003a
T2	0.027b	0.016d	0.011a	6.456a	4.571d	1.885a	0.447c	0,421d	-0.026b
T3	0.029b	0.024bc	0.005b	6.461a	5.096c	1.365b	0.445c	0.503b	-0.058c
T4	0.028b	0.038a	-0.010d	6.457a	5.483b	0.974c	0.448c	0.557a	-0.109d

Values followed by same letter(s) are statistically non-significant

these nutrients was observed where wheat was grown without nitrogen application. It is generally believed that wheat is an exhaustive crop which utilized the available nutrients for its necessary growth. The yield components are given in Table 1.

The wheat sown with nitrogen application sparingly impressed the level of soil nitrogen determined after the harvest. It is presumably because of nitrogen top dressed that provided the nutrient requirements for its growth under poor conditions. On the other hand, chickpea crop responded better to maintain fertility level of soil and showed less diminution in NO_3-N level followed by wheat crop fertilized with nitrogen as compared to rest of the treatments. Besides this, a superficial addition of total N in soil was observed by chickpea crop. It is therefore, assumed that unlike cereals, legume crops can improve the soil fertility especially by nitrogen fixation in nitrogen deficient soils. Similar findings have been discussed by Low (1972), Coleman *et al.* (1983), Buyanovsky and Wagner (1986), Rupela (1992), Herridge *et al.* (1995) and Aslam *et al.* (1997).

Organic Matter: A significant improvement in soil organic matter was observed by cropping system (Table 2). Among the cultivated treatments, maximum increase in percent organic matter was found with cultivation by chickpea crop followed by wheat fertilized with nitrogen at 100 kg ha^{-1}. It is quite reasonable to assume that legume plants growing in similar ecological conditions supply organic rhizodeposition in the field resulting an increase in organic matter due to biomass production that is an important part of the carbon flow through the soil compartment of agro-ecosystems (Jenkinson, 1971). Further nitrogen concentration fixed by chickpea in root system had frequently stimulated rapid decomposition as compared to wheat (receiving no nitrogen) cultivated treatment. The increase in organic matter in case of wheat cultivation receiving nitrogen might be due to the effect of nitrogen applied in soil as discussed by Gregorich *et al.* (1996). Subsequently slow decomposition due to depressed activity of microflora in case of uncultivated treatment, caused a slight fall in organic matter. A small decrease in organic matter in case of uncropped treatment over the growth period may be due to some problems of carbon turnover that concerned with maintenance of a desirable level of soil organic matter under cultivation by crops. Resembling interpretations had been reported by Brown and Dickey (1970), Smith and Douglas (1971), Sauerbeck and Johnen (1977), Barber (1979), Whipps (1984) and Buyanovsky *at al.* (1985).

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