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EFFECT OF DIFFERENT FERTILIZERS ON SOIL STRENGTH

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Prediction equations were developed for predicting the strength of soil when different fertilizers at different levels were applied. The soil strength was found to increase linearly with the application of high doses of fertilizers. Maximum strength was recorded when phosphorus fertilizer was used. The order of merit of the fertilizers in increasing the strength of soil was established in this study as phosphorus mixed fertilizer, nitrogen and potassium fertilizers. Further, the strength of soil was found higher when fertilizer mixed with soil was placed below pure soil as compared to its placement above the pure soil.

INTRODUCTION

It is a recognised fact that certain sails seal the soil, make it harder to penetrate and retard the movement of water. The enerb'Y expended in breaking such a crust like layer of soil is consequently very high. Such a fact has developed a warning that the chemical fertilizers which arc so useful for the growth of crops, may leach down with water and render the lower layers of soil hard to penetrate.

The chemical and nutritional effects of fertilizers which are beneficial for the growth of crops have been studied quite comprehensively by the soil scientists. Nevertheless, their effects on the physical and engineering properties of soil have been rarely studied. It is quite possible, as indicated above, that fertilizers which are being applied so abundantly may result in the accumulation of impermeable layers of sails at certain depths of soil and thus may result in the formation of a dangerous hard pan, which may be ruptured only with the use of a very high powered tractor and thus causing the wastage of the fuel and energy. Keeping the above in view, the present study was undertaken to measure the strength of soil with the application of different fertilizers at various levels.

MATERIALS AND METHODS

i. Mixed and individual fertilizers were used in this study to determine their effects on the strength of soil as determined by a penetrator having a diameter equal to about 0.25 cm and moving at a speed of 20 cm/minute. An Offner Dynograph was used to amplify and record the strength.

ii. The mixed fertilizer (5-20-20), consisting of 5% total nitrogen, 20% available phosphoric acid, 20% potassium and 55% inert material (calcium, sulphur, manganese and hydrogen) was used. Three levels of such a fertilizer equivalent to 0.66%, 1.98% and 3.30% of the weight of soil were used with a requisite amount of soil in small plastic boxes (20 cm long, 10 cm wide and 10 cm deep).

The experiment was subdivided into 2 phases. In the first phase of the

experiment, a mixture of soil and fertilizer was placed in the bottom of the box to a depth of 3.8 cm (1.5 inch) and pure soil was placed over it giving a total depth of 7.62 cm (3 inches). In the second phase of the experiment, the mixture of soil and fertilizer was placed above the pure soil. Water was sprayed on the soil with an electrical sprayer and fertilizer placed in boxes so as to achieve a moisture content of 16%. The boxes were then compacted to 0.7 N/cm^2 (1 psi) by means of a hydraulic press and then placed in a constant temperature chamber at 20° C. The strength of soil was determined after 8 days with a penetrometer having a diameter of 0.25 cm.

Four levels of the above fertilizers equivalent to 0.44%, 0.88%, 1.32% and 1.76% of the weight of soil were used. The soil with the necessary amount of individual fertilizers was placed at the bottom of the box up to a depth of 5.08 cm (2 inches) and pure soil was placed over it giving a total depth of 7.62 cm (3 inches). Again, compaction pressure of 0.7 N/cm^2, moisture content 16% and temperature 20° C were used and the strength was determined after 8 days with the penetrometer of 0.25 cm in diameter, as before.

It may be noted that after several years of application fertilizer may accumulate to form a dangerous hard layer below the surface of soil. Therefore, very high levels of fertilizers (ranging from 4,000 to 20,000 kg ha^{-1}) have been considered in this study.

Table 1. Strength of soil with the mixed fertilizer

Fertilizer level		Strength of soil in N/cm^2*	
% of weight of soil (Ft)	kg ha^{-1}	Fertilizer mixed with soil placed above pure soil (SI)	Fertilizer mixed with soil placed below pure soil (52)
0.66	4,000	179	199
1.98	12,000	218	268
3.30	20,000	268	328

*Each entry for strength in this table is a mean of six observations.

In order to determine the contribution of the three primary nutrients (nitrogen, phosphorus and potassium) of the mixed fertilizer towards soil strength, the following individual fertilizers were used:

33-0-0 (Ammonium nitrate)
0-20-0 (Superphosphate)
0-0-60 (Potassium sulphate)

RESULTS AND DISCUSSION

The results of soil strength in case of the mixed fertilizer have been given in Table 1.

Soil strength determined in case of individual fertilizers, has been recorded in Table 2.

Table 2. Strength of soil with the individual fertilizers

Fertilizer level		Strength of soil in N/cm^2*		
% of weight of soil (F_2)	kg ha^{-1}	Nitrogen fertilizer (33-0-0) *(S3)*	Phosphorus fertilizer (0-20-0) *(S4)*	Potassium fertilizer (0-0-60) *(Ss)*
0.44	2600	169	213	163
0.88	5200	172	238	164
1.32	7800	180	263	179
1.76	10400	189	283	184

"Each entry for strength in this table is a mean of six observations.

The following equations were developed for predicting the strength of soil:

$S_1 = 135 + 34.0\ F_1$ (r = 0.995) 1
$S_2 = 168 + 49.0\ F_1$ (r = 0.995) 2
$S_3 = 160 + 15.4\ F_2$ (r = 0.974) 3
$S_4 = 190 + 53.4\ F_2$ (r = 0.995) 4
$S_5 = 153 + 18.0\ F_2$ (r = 0.948) 5

where

SI = Strength of soil in N/cm^2, when a mixture of mixed fertilizer and soil was placed above pure soil;

S2 = Strength of soil in N/cm^2, when a mixture of mixed fertilizer and soil was placed below pure soil;

S3 = Strength of soil in N/cm^2, when nitrogen fertilizer (33-0-0) was mixed with soil;

S4 = Strength of soil in N/cm^2, when phosphorus fertilizer (0-20-0) was mixed with soil;

S_5 = Strength of soil in N/cm^2, when potassium fertilizer (0-0-60) was mixed with soil;

F_1 = Mixed fertilizer as % of weight of soil;

F2 = Individual fertilizer as % of weight of soil, and

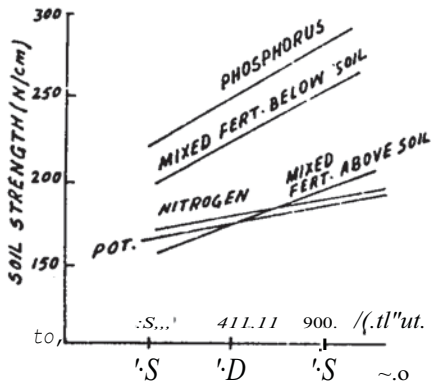
r = Correlation coefficient

Figure 1 depicts the effect of fertilizers on the strength of soil.

The following conclusions may be drawn from the above:

CONCLUSIONS

i, The effect of different fertilizers in soil strength is linear as indicated by the above equations. In other



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words, the soil strength increases uniformly with the addition of different fertilizers.

ii. Figure 1 indicates that strength of soil is maximum with phosphorus fertilizer.

iii. Strength of soil is minimum with potassium fertilizer.

iv. Strength of soil achieved with the mixed fertilizer lies between the phosphorus and nitrogen fertilizers.

v. Strength of soil is higher when fertilizer mixed with soil is placed below pure soil as compared to its placement above the pure soil.

vi. The order of merit of different fertilizers in increasing the strength of soil is as under:

a. Phosphorus fertilizer
b. Mixed fertilizer
c. Nitrogen fertilizer
d. Potassium fertilizer

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