Pak. J. Agri. Sci.
27 (1) 34, 1990

INVESTIGATION OF TILLAGE REQUIREMENT FOR WHEAT SEEDLING EMERGENCE

M.S. SABIR, MANZOOR AHMAD & M.ASLAM
Departments of Farm Machinery & Power & Soil Science,
University of Agriculture, Faisalabad

A laboratory study was conducted to investigate the effects of sowing depth, moisture content, soil bulk density and organic matter on wheat seedling emergence. For this purpose wheat cultivar LU 26S was sown in pots filled with sandy clay loam soil. A total number of 162 pots were used for all the treatments. It was found that the combination of 2.5 cm sowing depth, 1.2 g/cm3 soil bulk density and 16 % moisture content registered the highest seedling emergence rate which was 82%. In another combination, the lowest seedling emergence of 17% was recorded at 1.4 g/cm3 soil density, 12% moisture content and 5cm seed placement depth. Thus it was concluded that the tillage implements used for seedbed preparation should create soil bulk density of 1.2 g/cm3 and conserve 16% soil moisture in the vicinity of seed placement maintaining 1.45% organic matter in the soil for better emergence.

INTRODUCTION

Advances in tillage technology have contributed a lot in improving yields of various crops. The physical properties of soil which influence the behaviour of plant growth are relatively a few, but their interactions are much complicated. Thus it is impossible to determine the quantitative significance of an individual factor. The soil particles are displaced when plant root grows, the magnitude of which mainly depends on the diameter of root. Nevertheless, soil resistance to this deformation depends upon several factors, including soil bulk density, moisture content, penetration resistance , pore size and texture. It has been observed that where soil strength is high such as in plow pan, the force exerted by plant root is not sufficient to overcome such resistance, ultimately root development is affected and is limited to the surface soil above this compacted zone.

Tillage operations are generally conducted to achieve fine soil tilth by reducing soil strength and compaction. These operations also facilitate the free movement of air and water, essential for plant growth. It tends to alter soil bulk density and soil strength (Bolten et al., 1981) in the tilled zone. The soil properties ultimately affect soil aeration (Arkin and Taylor, 1981), soil water movement, soil resistance to root growth and nutrient distribution (Hallmark and Barber, 1981). Plant growth is thus indirectly affected by tillage operation, improved soil environment like soil moisture content, soil aeration, nutrients or fertilizer movement, soil temperature and soil strength.

Our soil has tremendous potential which is not being properly exploited. In order to achieve this production potential, mechanization in the country is essential in addition to increased cropping intensity, employment of improved soil and water management techniques. Therefore, seedbed should be prepared with suitable implements in order to create good environment essential for raising bumper crops. The use of improper tillage implements is merely the wastage of time, energy and resources, thus affecting the soil structure and ultimately the yields of crops adversely.

Keeping in view the significance of

tillage operations on plant growth as well as the adverse effects of excessive tillage on soil structure, this study was designed to investigate the effect of different levels of organic matter, moisture content, soil bulk density, and sowing depth on seed/seedling performance of LU 26S wheat variety.

MATERIALS AND METHODS

The research work reported in this paper was carried out during 1986-87 in the net house of Soil Science Department, University of Agriculture, Faisalabad, in order to investigate tillage requirements for wheat crop. For this purpose wheat cultivar LU 26S was sown in pots. Sandy clay loam soil collected from top 15cm cultivated area was used for this research. The soil was air dried, grounded to pass through 2mm sieve. The soil was divided into three parts to mix 0.47, 1.45 and 2.95% of organic matter one month prior to the sowing of crop. Various factors under study were organic matter, moisture content, soil bulk density and sowing depth, whereas fertilizer level and atmospheric conditions were uniform. All the 162 treatments were repeated thrice. Physico-chemical analysis of soil was performed by Bouyoucas hydrometer method using 1% sodium hexametaphosphate as defloculent. Soil textural class was determined using the international textural triangle.

For each organic matter level, three moisture levels, (12,16 and 20%), were maintained. The wet soil was then transferred to plastic bags to attain moisture equilibrium in the soil. At the time of sowing three levels of bulk density for each moisture level were created by compacting the soil by slow loading rate method with the help of a manual press. These being equivalent to 1.2, 1.3 and 1.4 g/cm . Hadas (1987) claimed that when loading was done at slow rate, uniform stress distribution was assumed to exist throughout the compacted soil, however, for fast loading this assumption did not hold true.

Polythene bags were kept inside the pots to avoid any toxicity. Twenty kilogram soil of known organic matter and moisture content was placed in the pot and compacted to known volume to achieve desired soil bulk density (1.2, 1.3, 1.4 g/cm3) with the help of a mechanical manual press. Sixteen seeds of wheat cultivar LU 26S were placed in two rows, 10cm apart on this compacted soil. In order to maintain sowing depth, again known weight of soil (with the same organic matter and moisture level) was placed over the seed and recompacted to achieve the same soil bulk density. Germination was recorded upto 21 days after sowing. A seed was considered germinated when it was 1 cm above the soil surface, and the daily germination was noted by counting the germinated seeds.

RESULTS AND DISCUSSION

Data regarding the effect of sowing depth, soil bulk density, moisture content and organic matter levels on the average germination rate of seed are presented in Table 1. It is evident that the rate of germination was slightly decreased with the increase of seed placement depth from 2.5 to 5.0 cm. It was also observed that shallow sowing depth gave more uniform germination when moisture level in the soil was close to field capacity, whereas at lower moisture levels deeper planting depth was superior. The effect of soil bulk density on seed germination was observed negative i.e. germination decreased as the soil bulk density increased. The highest germination rate (59.1%) was at the lowest soil bulk density of 1.2 g/cm whereas it was 21.6% in the case of the most dense soil having 1.4 g/cm3 soil bulk density. Sheikh (1976) found a linear decrease in the seed germination with the increasing soil bulk density. The results reported here also agree with the finding of Colenso (1986) who concluded that mechanical impedence was the crucial factor for poor germination.

Table 1 shows that the maximum germination upto 60% was observed at 16% moisture level and resulted in decreased germination at 20% and 12% moisture contents. Soil moisture affected the plant growth and germination probably by affecting the physical and chemical properties of soil. At low moisture level high osmotic pressure was responsible for poor germination, whereas, at high moisture, poor aeration of the soil and injury from too rapid imbibition reduced the germination.

Table 1 . Means of seed germination

Factor	Level	Percent germination
Depth (cm)	2.5	47.6
	5.0	45.3
Soil bulk density (g/cm^3)	1.2	59.1
	1.3	57.1
	1.4	21.6
Moisture content (%)	12	25.0
	16	60.0
	20	53.0
Organic matter (%)	0.47	46.0
	1.45	48.2
	2.95	43.8

The organic matter in the soil exhibited positive response with regard to the rate of seed germination. Maximum emergence(48.2%) was observed when organic matter was applied at a rate of 1.45% which was not very high as compared to the germination rate in case of 0.47% and 2.95% organic matter. The improvement in the germination may be due to creation of conducive conditions for water intake, improvement in soil aeration and reduced adverse effect of high soil bulk density. The analysis of variance showed that all the treatments (sowing depth, soil bulk density, moisture content and organic matter) significantly affected the rate of emergence at 5% level of probability. Various interactions including sowing depth and soil bulk density, soil bulk density and moisture level,organic matter and moisture level, and sowing depth, soil bulk density and moisture level were also found significant. The rate of germination as affected by these interactions is presented in Tables 2 and 3.

It is clear from Table 2 that there was little increase in seed germination with increasing organic matter, being maximum at 1.45% with a moisture content of 16%. Further addition of organic matter did not improve the germination rate. The best rate of germination was observed at 16% moisture and 1.45% organic matter level. The lowest rate of germination was at 12% moisture and 2.95% organic matter.

Table 2. Effect of moisture content and organic matter on seed germination(%) (average of 2 and 3 levels of sowing depth and moisture content respectively)

Organic matter (%)	Moisture content			O–mean
	12%	16%	20%	
0.47	27%d	61% a	51% c	46%
1.45	68% d	63% a	56% c	49%
2.95	19% d	56% a	54% c	43%
M–mean	2.5	6.0	5.4	13.8

Unlike letters denote significant difference (P–o.05).
Least significant difference (LSD) = 3.45.

Table 3. Effect of sowing depth, soil bulk density and moisture content on seed germination rate(%)

Moisture content (%)	Soil bulk density (g/cm^3)			M- mean
	1.2	1.3	1.4	
		Sowing depth 2.5 cm		
12	28 de	33 d	19 g	26 a
16	82 a	74 b	26 ef	61 a
20	70 bc	66 bc	27 df	54 a
		Sowing depth 5 cm		
12	21 fg	33 d	17 g	24 a
16	81 a	72 bc	21 fg	59 a
20	71 bc	68 bc	21 fg	53 a
B-mean	59 a	57 a	22 b	138

The interaction among sowing depth-soil bulk density and moisture level (Table 3) showed that the highest seed gemination rate(82%) was at the sowing depth of 2.5 cm, soil bulk density of 1.2 g/cm^3 and 16% moisture content, which was not significantly higher than 5 cm sowing depth, 1.2 g/cm^3 soil bulk density and 16% moisture level. In this interaction the lowest germination (17%) was found at the highest soil bulk density (1.4 g/cm^3) with 12% moisture content and 5 cm seed placement depth.

CONCLUSIONS

The germination at shallow depth was better during early days but was almost equal after 21 days. Maximum germination was observed at 1.2 g/cm³ and the minimum at 1.4 g/cm³ soil bulk density. Maximum germination was observed at moisture level of 16% and 1.45% organic matter, while further addition of organic matter did not improve the germination.

At various interactions maximum germination was recorded at 1.45% organic matter and 16% moisture content which was almost the same with 0.47% organic matter and 16% moisture content. The interaction among sowing depth, soil bulk density and moisture gave maximum germination at 2.5 cm sowing depth, 1.2 g/cm³ soil bulk density and 16% moisture content. The highest soil bulk density alongwith other combinations gave poor results. In depth analysis of the data suggests that the tillage implements be selected to produce a soil density of 1.2 g/cm³, maintaining soil moisture and organic matter at 16% and 1.45% levels respectively at the sowing depth of 2.5 cm in order to improve wheat seedling emergence.

REFERENCES

Arkin, G.F. and F.M. Taylor. 1981. Modifying the root environment to reduce crop stress. ASAE Pub1. 14-81. St. Joseph, MI., USA.

Bolten, E. F., A. Driks and M. McDonnel. 1981. Effect of fall and spring plowing at three depths on soil bulk density, porosity and moisture in Brookstom clay tillage operations. Canad. Agri. Engg. 23 (2): 71-76.

Colenso, J. M. 1986. Soil, physical environment and seedling emergence. M.Sc. Thesis, Silso College, Cran Field Institute of Technology, UK.

Flocker, W.J. and R. C. Menary. 1960. Some physical responses in two tomato varieties associated with different levels of soil bulk density. Hilgardia, 30(3): 101-121.

Gupta, S. C. and W. E. Larson. 1979. Estimating soil water retention characteristics from particle size distributions, organic matter and bulk density. Water Resources Research, 15(6): 1633-1639.

Hadas, A. 1987. Soil compaction under quasistatic and impact stress loading. Soil and Tillage Research, 9: 181-186.

Hallmark, W. B. and S. A. Barber. 1981. Root growth and morphology, nutrient up take and nutrient status of soybean as affected by soil permeability and bulk density. Agronomy Journal, 73:779-782.

Sheikh, G. S. 1976. Soil resistance and emergence of seedling. Pak.J. Agri. Sci. 13 (1): 41-48.