Effect Of Tillage On Root Penetration and Grain Yield of Mexican Wheat (*Triticum aestivum* L.) Grown In The Libyan Desert

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ABSTRACT

The effect of tillage practice on root penetration, grain yield and grain size of the dwarf Mexican wheat variety 'Super X' was studied in the sandy soil of Al-Kufra desert. Compared to no-tillage, disking to 15 cm deep, disking to 30 cm deep, subsoiling to 50 cm deep and subsoiling to 70 cm deep increased root depth by 24%, 48%, 100% and 132%, respectively. Subsoiling to 70 cm deep increased the grain yield by 54% (4.65 tons/ha), compared to no-tillager treatment (3.026 tons/ha). There was an increase in grain yield of 28.5%, 35% and 39% due to disking to 15 cm deep, disking to 30 cm deep and subsoiling to 50 cm deep, respectively. Grain size, as estimated by weight of 1,000 grains, showed a slight and no-significant decrease due to tillage treatments.

INTRODUCTION

Tillage and seedbed preparation is one of the controversial problems in cultural practices (2,3,4,5). The need and type of tillage and its depth is very variable factor depending on type of crop, soil characteristics, climatic conditions and the agroeconomic factors. In the wheat belt at North Dakota, U.S.A., deep tillage was found unimportant in grain yield and minimum tillage was recommended for wheat production (3). The same observation was reported for wheat production in Kenya (5). Keys *et al.* (4), reported a small difference in yield of wheat due to tillage treatments. Under a rice-wheat crop system in Japan, it was found that an average tillage was better for wheat production than no-tillage or frequent tillage (2).

Worker (6) reported that alfalfa root penetration was hindered by a lamination layer found in the soil of Al-Kufra Oasis. He observed that a thin layer consisting of very fine sand is precipitated at different depths ranging from 9 cm in virgin land to 60 cm for cultivated land. Al-Kufra Oasis is located in the south-eastern part of the Libyan desert at a latitude of 24°N and at a longitude of 23°E. A modern agricultural project was established in that region due to discoveries of large reservoir of ground water. The purpose of Al-Kufra agricultural project is mainly for sheep and grain production. The climatic conditions in the oasis are typical of the arid regions where the maximum and

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the minimum temperatures of July and January are about 37°, 18°C and 19°, 3°C, respectively. The average annual rainfall and relative humidity are 2.5 mm and 50%, respectively. The soil of the project is a sandy soil consisting of more than 90% coarse sand, 2–6% silt and 1–4% clay. It contains less than 0.5% total nitrogen and less than 1% organic matter. The soil pH ranges from 7.4 to 8.3 (1). Due to the existence of a lamination layer in some area of the oasis, the root system of many crops were found to be limited in growth (6). Therefore, it became necessary to determine the type of tillage required for the normal growth and production of wheat.

This paper deals with the effect of depth of ploughing on root growth and on grain yield of Mexican wheat.

MATERIALS AND METHODS

A field experiment was carried out at Al-Kufra Agricultural Project farm to study the response of root system and the grain yield of the Mexican wheat (*Triticum aestivum L.*), variety 'Super X' to depth of ploughing. Five tillage treatments namely: (a) no-tillage other than surface roll and planting, (b) disking to 15 cm deep, (c) disking to 30 cm deep, (d) suboiling to 50 cm deep and (e) subsoiling to 70 cm deep were replicated four times in a randomized block design. The experimental plots were 15 × 500 metres in order to facilitate the mechanized operations. Preplant fertilizer was 450 kg/ha of 18–50–0 in addition to 200 kg/ha of ammonium sulfate top-dressed at the crown root emergence. Wheat was sown at 14 October 1970 at the rate of 100 kg/ha by the seed driller at a depth of 1.5 cm and in rows 30 cm apart. Irrigation was controlled mechanically by the pivot system until the grain reached the hard dough stage. The penetration of the root system was studied by digging soil profiles at the ripening stage of the wheat crop. Grain yield and grain size were determined at harvest time in May.

RESULTS AND DISCUSSION

Tables 1 and 2 show the analysis of variance and the average depth of roots as affected by tillage treatments. There was a highly significant difference among tillage treatments in respect to depth of roots. The average root depth ranged from 17 cm to 39 cm with no-tillage and subsoiling to 70 cm deep having the lowest and highest root depth, respectively. All tillage treatments significantly increased root penetration over the control (no-tillage). Disking to 15 cm deep, disking to 30 cm deep, subsoiling to 50 cm deep and subsoiling to 70 cm deep resulted in 24%, 48%, 100% and 132% increase in root depth over no-tillage, respectively (Table 7). Although the soil of Al-Kufra desert mainly consists of coarse sand, it appears from the present results that root penetration responded highly to tillage treatment. The deeper the depth of tillage the more root penetration. Therefore, one may conclude that ploughing the sand soil at Al-Kufra is a desirable practice in order to secure a well-formed root system. Also, it may be noted that the lamination layer observed in Al-Kufra soil (6) hindered root penetration of wheat, and deep tillage is required for breaking such layer. From the present data it seems that a minimum tillage either by disking or by subsoiling to a depth ranging from 30 to 60 cm deep could be recommended for wheat culture at Al-Kufra oasis.

The analysis of variance and average grain yield as affected by tillage treatments are given in Tables 3 and 4. Although the F test did not show any significant difference in grain yield due to tillage treatments (Table 1), it is obviously noted that a reasonable increase in grain yield was obtained by increasing depth of ploughing (Table 4). The

Table 1 Analysis of variance for root depth as affected by tillage treatments.

Source of variation	d.f.	s.s.	M.S.	F
Replicates	3	12.95	4.32	
Treatments	4	1367.70	341.93	92.67[1]
Error	12	44.30	3.69	
Total	19	1424.95		

[1]Highly significant

Table 2 Root depth (cm) of Mexican wheat as affected by tillage treatment (average of 30 profiles).

Tillage treatments	Root depth (cm)
a) No tillage	17
b) Disking to 15 cm deep	21
c) Disking to 30 cm deep	25
d) Subsoiling to 50 cm deep	34
e) Subsoiling to 70 cm deep	39

L.S.D. 5% = 3 cm

Table 3 Analysis of variance for grain yield of Mexican wheat as affected by tillage treatments.

Source of variation	d.f.	s.s.	M.S.	F
Replicates	3	83,410.15	27,803.38	
Treatments	4	230,283.00	57,570.75	1.791
Error	12	385,742.10	32,145.18	
Total	19	699,435.25		

Table 4 Average grain yield (tons/ha) of Mexican wheat as affected by tillage treatments.

Tillage treatments	Average grain yield (tons/ha)
a) No tillage	3.026
b) Disking to 15 cm deep	3.890
c) Disking to 30 cm deep	4.086
d) Subsoiling to 50 cm deep	4.219
e) Subsoiling to 70 cm deep	4.656

L.S.D. 5% = 1.382 tons/ha

average grain yield ranged from 3.026 to 4.656 tons/ha with no-tillage and subsoiling to 70 cm deep treatments having the lowest and highest grain yield, respectively. The difference of 1.630 tons/ha between these two treatments is significant according to the L.S.D. test (L.S.D. 5% = 1.382 tons/ha). Table 7 shows percentage increase in grain yield of 28.5%, 35%, 39% and 54% due to tillage treatments of disking to 15 cm deep, disking to 30 cm deep, subsoiling to 50 cm deep and subsoiling to 70 cm deep compared to no-tillage, respectively. It appears that such increase in grain yield of wheat (from 28.5 to 54%) due to tillage practice could not be overlooked in wheat production. Taking the agroeconomic factors into considerations, one might recommend, according to present study, a minimum tillage of 50–60 cm deep either by disking or subsoiling the sandy soil at Al-Kufra oasis in order to improve the wheat production.

The analysis of variance and the average weight of 1,000 grains are given in Tables 5 and 6, respectively. The grain size as estimated by the wt. of 1,000 grains for the Mexican wheat variety 'Super' showed no significant effect due to tillage treatments (Table 6). Average wt. of 1,000 grains were 30.0, 27.7, 28.0, 29.6 and 30.0 gm for no-tillage, disking to 15 cm deep, disking to 30 cm deep, subsoiling to 50 cm deep and subsoiling to 70 cm deep, respectively. Table 7 shows slight decrease in grain size of Mexican wheat due to tillage treatments. Compared to no-tillage treatments, disking to 15 cm deep, disking to 30 cm deep and sub-soiling to 50 cm deep and subsoiling to 70 cm deep reduced grain size by 7.6%, 6.6%, 1.3% and 0.0%, respectively. Although the changes in grain size are not significant, it appears from these data, that there is a tendency of reduction in grain size due to tillage treatments.

Table 5 Analysis of variance for grain size (wt. of 1000 grain) of Mexican wheat as affected by tillage treatments.

Source of variation	d.f.	s.s.	M.S.	F
Replicates	3	55.98	18.66	
Treatments	4	21.20	5.30	1.16
Error	12	54.83	4.57	
Total	19	132.01		

Table 6 Average grain size (gm/1,000 grains) of Mexican wheat as affected by tillage treatments.

a) No tillage	30.0
b) Disking to 15 cm deep	27.7
c) Disking to 30 cm deep	28.0
d) Subsoiling to 50 cm deep	29.6
e) Subsoiling to 70 cm deep	30.0

L.S.D. 5% = 3.3 gm

Table 7 Percentage change in root depth, grain yield and grain size of Mexican wheat due to tillage treatments.

Tillage treatments compared	root depth	grain yield	grain size
$\frac{\text{Disking to 15 cm deep} - \text{No tillage}}{\text{No tillage}} \times 100$	+24%	+28.5%	−7.6%
$\frac{\text{Disking to 30 cm deep} - \text{No tillage}}{\text{No tillage}} \times 100$	+48%	+35%	−6.6%
$\frac{\text{Subsoiling to 50 cm deep} - \text{No tillage}}{\text{No tillage}} \times 100$	+100%	+39%	−1.3%
$\frac{\text{Subsoiling to 70 cm deep} - \text{No tillage}}{\text{No tillage}} \times 100$	+132%	+54%	0.0%

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