The Libyan Journal of Agriculture: volume 11, 1982

Dryland Wheat Production in the Western Part of Libya
II. Subsoiling and its Residual Effects

SHARAFEDDIN M. SHERIF, MUHAMMAD S. CHAUDHRY AND SHAUKAT KHAN[1]

ABSTRACT

The effects of subsoiling during 1980–81 and its residual effects during 1981–82 on the yield of dryland wheat were studied on the sandy soils of Al-Fateh University Farm, Tripoli.

Significant response to subsoiling (50 cm deep) was exhibited by plant characters like plant height, spikes per plant, grains and weight of grains per spike; total, grain and straw yields, and 1000-grains weight as compared to rotary cultivator with spike-tooth rotor and a crumbler roller (20 cm deep), single-axle 7-disk plow (25 cm deep) and sweep (30 cm deep) during both the seasons. The effect of tillage treatments on weed population was not significant.

Tillage was not repeated during the second year to observe the residual effects of previous year's tillage. The tillage expenses were saved and the results indicated that the yield increase was also maintained. This economized the wheat production. The experiments clearly indicated that subsoiling once every 2 to 3 years is a desirable practice to improve the yields of dryland wheat grown on sandy soils of the western part of Libya.

INTRODUCTION

Wheat is an important grain crop in the Jamahiriya and is grown on about one-fifth of more than one million hectares of cultivated land. Over 80% of the grown wheat is under dryland. The production per hectare varies from 0.2 to 0.8 tons depending upon the time and amount of rainfall (10). The yields can be optimized by soil storage of rainfall, suitable wheat cultivars, proper tillage methods and by adapting approved agronomic practices. Tillage plays a major role in increasing crop production under dryland conditions (1, 2).

Much of the tillage of agricultural soils is primarily carried out to produce a desirable soil physical condition for seed germination and growth of economic plants. Soil moisture is a limiting factor in dryland farming. Tillage practices for dryland farming should also contribute to maximize the soil storage of rainfall. Tripoli area of

[1] *Department of Agricultural Engineering, Faculty of Agriculture, University of Al-Fateh, Tripoli, S.P.L.A.J.*

Libya belongs to semi-arid Mediterranean climate and is characterized by limited water supply through winter rainfall and completely dry summer with high evapotranspiration. Poor tillage here could be very detrimental particularly for dryland farming where high risk exists even under the best of conditions (1). Improper cultivation can badly affect the crop yields by reducing stored soil moisture, increasing evaporation rates and increasing soil erosion by destroying the soil structure.

Many implements and their operational sequences have been successfully tried for improving dryland crop production in different regions of the world. A suitable tillage implement should control weeds, leave crop residue on land surface to retain soil moisture and control soil erosion, maintain a high infiltration rate, develop a firm seedbed in minimum runs and avoid turn up of moist soil to expose it to rapid drying (1, 7). Rotary cultivator with spike-tooth rotor and a crumbler roller prepares a firm seedbed in a single run. Disk plows avoid burial of crop residue due to soil pulverization by the rolling concave disks rather than complete soil inversion. Sweeps loosen and pulverize subsurface soil without inverting it. There is very little disturbance of the surface soil (1, 7, 12). Subsoiling (>40 cm deep) implies breaking through and shattering compacted or otherwise impervious soil layers to improve water infiltration and plant root development. Subsoiliers give the best results in dry soils. A subsoiled land can store 30% more moisture than the unchiselled land (12).

Positive crop growth response to subsoiling has been observed in areas where compacted soil layers existed in the crop root zone and soil moisture was a limiting factor (1, 2, 8, 11). The existence of impervious compact subsoil layers is quite common in Libya. These layers have developed during soil formation process as the laminated layers of Kufra and Sarir (9). These also exist as hard plow-pans in the coastal strip where soils have been continuously plowed to a shallow depth (3, 5).

The effects of various methods of soil cultivation on plant growth have been studied in many countries (2, 8, 11, 13). Many workers in the Jamahiriya have reported the response of irrigated Mexican wheat to various tillage practices. Deep plowing have been found advantageous in Tripoli area. Chaudhry *et al.* (3, 5), Chaudhry and Sherif (4) have found that subsoiling to about 50 cm depth breaks hard plow-pan or hard calcipan subsoil layers to improve soil moisture retention, root growth and nutrient absorption from deeper soil layers. These factors helped to increase yields of wheat. Shaalan *et al.* (14) also showed that tillage by disk plow gave better results than moldboard plow, cultivator, disk harrow and rotavator. El-Sharkawy and Sgaier (9) observed that subsoiling to 50 cm depth increased the root depth by 100% and grain yield by 39% as compared to no-tillage in the Al-Kufra Oasis. The increase in root depth and grain yield was 132% and 54% for 70 cm deep subsoiling.

The work reported so far in the Jamahiriya is mostly related to irrigated wheat. This covers only the one-fifth of the annual cropped area of wheat (10). The rest is planted as dryland or rainfed and have been ignored so far. The yield potential of this enormous area should be explored by the researchers. The present investigations were undertaken to evaluate the effects of subsoiling on dryland wheat production during the first season and its residual effects during the second season.

MATERIALS AND METHODS

Field experiments were conducted at the Faculty of Agriculture Farm, Al-Fateh University, Tripoli, S.P.L.A.J. to study the response of dryland wheat to subsoiling during 1980–81 and its residual effects on the crop of 1981–82. A randomized complete block design with six replications and 3 m × 40 m plot size was used. The plots were assigned to four tillage treatments: rotary cultivator with spike-tooth rotor and a crumbler roller (T_1, 20 cm deep), single-axle 7-disk plow (T_2, 25 cm deep), sweep (T_3, 30 cm deep) and subsoiler (T_4, 50 cm deep). A run of rotary cultivator with spike-tooth rotor and a crumbler roller was superimposed on all tillage treatments to produce a firm seedbed. Prior to seedbed preparation, the plots were broadcasted with 60 kg P_2O_5/ha as superphosphate (18% P_2O_5). Mexican wheat cultivar 'Sidi Mesri 1' was machine-drilled in rows 30 cm apart at 80 kg/hectare on November 15, 1980. Nitrogen at 40 kg N/hectare as ammonium sulphate (21% N) was applied in two equal doses: 6 weeks after seeding and at ear emergence.

The crop of 1980–81 was harvested on April 23, 1981. The stubbled field was kept fallow for next year crop. Tillage treatments were not applied during 1981–82. The lay-out, seedbed preparation, rate and method of seeding, fertilizer rate and procedure of data collection were similar for both the years. Seeding of 1981–82 crop was done on November 11, 1981 and was harvested on April 22, 1982.

Plant height, spikes per plant, grains per spike and weight of grains per spike was recorded from a random sample of ten wheat plants per plot. The weight of weeds/m^2 was determined after air-drying four 0.25 m^2 random samples taken from each plot before harvesting. Total, grain and straw yields were determined by harvesting central 100 m^2 area of each plot. Samples from the threshed crop were taken for 1000-grain weight.

RESULTS AND DISCUSSION

The response of yield and yield components of wheat cultivar 'Sidi Mesri 1' to subsoiling under dryland conditions during 1980–81 and 1981–82 seasons was observed. Subsoiling to 50 cm depth significantly increased the plant height, spikes per plant, grains per spike, weight of grains per spike, total (grain + straw) yield, grain yield, straw field and 1,000-grain weight as compared to rotary cultivator (20 cm deep), single-axle 7-disk plow (25 cm deep) and the sweep (30 cm deep) in 1980–81 (Table 1). All the above plant characters except 1000-grain weight showed similar response to rotary cultivation, disk plowing and sweeping. Grain size after tillage by rotary cultivator was significantly smaller than disk plow and the sweep. The latter two tillage implements resulted in similar grain size or 1000-grain weight. The weight of weeds/m^2 area was not significantly different for all the tillage treatments.

The results for the year 1981–82 are presented in Table 2. Positive residual response to subsoiling (50 cm deep) was shown by different plant characters. Subsoiling significantly affected the plant height, spikes per plant, grains and weight of grains per spike, total yield, grain yield, straw yield and 1000-grain weight as compared to rotary cultivator, 7-disk plow and the sweep. The latter three tillage treatments had similar effects on the above yield components except plant height. Sweeping to 30 cm depth significantly increased the plant height as against rotary cultivation, but was comparable to disk plowing. The differences among all the tillage treatments regarding the weight of weeds/m^2 area were not significant.

The results of both years clearly indicate the utility of subsoiling to about 50 cm depth for improving the dryland wheat production in sandy soils of Tripoli area. The order of efficiency of different tillate systems was: subsoiling >

Table. 1. Response to tillage depths by the yield and yield components of wheat under dryland conditions (1980–81)

Tillage		Plant characters								
Implement	Average depth (cm)	Plant height (cm)	Wt. of weeds/ m^2 (g)	Spikes per plant	Grains per spike	Grain wt. per spike (g)	Total yield (tons/ha)	Grain yield (tons/ha)	Straw yield (tons/ha)	1000-grain wt. (g)
Rotary cultivator	20	48.9	20.4	1.15	25.6	0.81	4.05	1.27	2.78	31.2
7-disk plow	25	50.8	17.7	1.18	25.5	0.80	4.17	1.31	2.86	35.0
Sweep	30	51.4	22.1	1.20	26.1	0.87	4.49	1.42	3.07	35.9
Subsoiler	50	61.0	25.7	1.48	31.7	1.07	5.48	1.87	3.61	38.4
L.S.D.	(0.05)	4.4	N.S.	0.09	2.7	0.10	0.72	0.22	0.53	1.9
	(0.01)	6.1	N.S.	0.12	3.7	0.13	1.00	0.30	N.S.	2.7

Table 2. Response to tillage depths by the yield and yield components of wheat under dryland conditions (1981–82)

Tillage		Plant characters								
Implement	Average depth (cm)	Plant height (cm)	Wt. of weeds/m^2 (g)	Spikes per plant	Grains per spike	Grain wt. per spike (g)	Total yield (tons/ha)	Grain yield (tons/ha)	Straw yield (tons/ha)	1000-grain wt. (g)
Rotary cultivator	20	50.0	31.8	1.28	27.1	0.93	4.66	1.34	3.32	33.5
7-disk plow	25	52.4	32.6	1.28	29.4	0.98	4.75	1.37	3.38	32.6
Sweep	30	54.1	31.6	1.35	30.5	0.94	4.94	1.49	3.45	32.7
Subsoiler	50	60.3	33.1	1.52	35.4	1.10	5.46	1.60	3.86	35.3
L.S.D.	(0.05)	3.8	N.S.	0.10	4.3	0.11	0.50	0.18	0.37	1.9
	(0.01)	5.3	N.S.	0.14	6.0	N.S.	N.S.	N.S.	N.S.	N.S.

sweeping = disking = rotovation. These results have substantiated the earlier finding that deep plowing increased wheat production in the Jamahiriya. Several reasons have been given for this positive response. El-Sharkawy and Sgaier (9) found disking to 15 and 30 cm, and subsoiling to 50 and 70 cm depths at Kufra Production Project to increase irrigated wheat yields by 28, 35, 39 and 54% over no-tillage, respectively. Subsoiling to 50 and 70 cm depth increased root depth by 100 and 132% compared to no-tillage. The increase in root growth due to breakage of impervious laminated subsoil layers found in Kufra Oasis soils resulted in higher yields. They recommended subsoiling of these soils to improve cereal yields. Chaudhry *et al.* (3, 5) and Chaudhry and Sherif (4) observed an obvious improvement in the yield and yield components of irrigated wheat grown after subsoiling (50 cm deep) of sandy soils of Al-Fateh University Farm. This increase in yield was attributed to enhanced root growth and increased absorption of plant nutrients from deeper soil layers, after shattering the calcipans and/or hard plow-pans found in these soils. These results are also in agreement with the results reported by Chaudhry and Sherif (6) regarding the effects of subsoiling on dryland wheat production in sandy soils of Tripoli area.

Comparison of the results of 1980–81 and 1981–82 have been reported in Table 3. It is apparent that although subsoiling significantly increased the yield and yield components of wheat during both the years yet the margin of differences among the tillage treatments has been reduced in 1981–82. The percentage change from rotary cultivator (20 cm deep) calculated for different plant characters due to disk plow (25 cm deep), sweep (30 cm deep) and subsoiler (50 cm deep) during 1980–81 i.e. fresh effects were more than during the 1981–82 season i.e. residual effects. The decrease in yield was small as against substantial reduction in cultivation expenses during the second year. The residual and beneficial effects of subsoiling are expected to show-up for another year or so. The differences then might become insignificant among different tillage depths due to recurrence of soil compaction and reformation of hard plow-pans.

Distribution of rainfall during the cropping season of 1980–81 and 1981–82 is given in Table 4. The total rainfall during the growing period i.e. November to April of 1980–81

Table 3. Percentage change* in plant characters of dryland wheat due to tillage treatments.

Plant characters	Percentage change (1980–81)			Percentage change (1981–82)		
	Disk plow	Sweep	Subsoiler	Disk plow	Sweep	Subsoiler
Plant height	+3.9	+5.1	+24.7	+4.8	+8.2	+20.6
Weight of weeds	−13.2	+8.3	+26.0	+2.5	0.0	+4.1
Spikes per plant	+2.6	+4.3	+28.7	0.0	+5.5	+18.8
Grains per spike	0.0	+2.0	+23.8	+8.5	+12.5	+30.6
Grain wt. per spike	−1.2	+8.6	+32.1	+5.4	+1.1	+18.3
Total yield	+3.0	+10.9	+35.3	+1.9	+6.0	+17.2
Grain yield	+3.1	+11.8	+47.2	+2.2	+11.2	+19.4
Straw yield	+2.9	+10.4	+29.9	+1.8	+3.9	+16.3
1000-grain weight	+12.2	+15.1	+23.1	−2.7	−2.4	+5.4

$$\text{*Percentage change} = \frac{T_i - T_1}{T_1} \times 100$$

Where T_i is respective tillage treatment and $2 \leqslant i 4$

Table 4. Rainfall during 1980–81 and 1981–82 seasons at the Agricultural Research Center, Sidi Mesri, Tripoli.

	Rainfall (mm)	
Month	1980–81	1981–82
June	0.0	0.0
July	0.0	0.0
August	0.0	0.0
September	4.0	0.0
October	66.5	14.0
November	69.0	14.6
December	57.0	25.0
January	129.3	94.7
February	62.3	44.4
March	8.2	58.0
April	2.3	22.2
May	0.0	0.0
Total	398.6	272.9

(328.1 mm) was more than that of 1981–82 (258.9 mm). The pattern of rainfall distribution was also different for both the seasons. The rainfall during vegetative growth period (November to January) in 1980–81 was 255.3 mm and during the seed setting/maturity period (February to April) was 72.8 mm. The figures for the respective periods of 1981–82 season were 134.3 mm and 124.6 mm. The rainfall during the earing/maturity period of 1980–81 crop was low and erratic but it was more and well-distributed during 1981–82 season. This might be the reason for the higher mean values of almost all the plant characters during the second season.

It can be concluded from these experiments that subsoiling once every 2 to 3 years is a beneficial practice for enhancing the yields of dryland wheat grown on sandy soils of the western part of Libya.

LITERATURE CITED

1. Anonymous. 1979. Dryland Agriculture in Winter Precipitation Regions of the World. Dryland Agriculture Technical Committee, Office of International Agriculture, Oregon State Univ., Corvallis, Oregon, U.S.A. 218 p.
2. Burnett, E. and V. L. Hauser. 1967. Deep tillage and soil-plant-water relationships. Proc. Tillage for Greater Crop Production. Publ. 168. Am. Soc. Agr. Engrs. St. Joseph, Michigan, U.S.A. pp. 47–52.
3. Chaudhry, M. S., S. M. Sherif and J. S. Sawhney. 1978. The effect of tillage and nitrogen fertilization on yield and yield components of wheat. Libyan J. Agr. 7:17–23.
4. Chaudhry, M. S. and S. M. Sherif. 1979. Yield response of irrigated wheat grown in sandy soil to deep tillage and phosphorous fertilizer. Libyan J. Agr. 8:9–14.
5. Chaudhry, M. S., S. M. Sherif, F. M. Chaudhry and A. H. Abed. 1979. Micronutrient availability to cereals from calcareous soils. VII. Mechanism of higher wheat production by tillage methods. Pl. and Soil 52:537–545.

6. Chaudhry, M. S. and S. M. Sherif. 1982. Dryland wheat production in the western part of Libya. 1. Response to deep tillage and N-P fertilizers. Libyan J. Agr. II (in press).
7. Culpin, C. 1976. Farm Machinery. Crosby Lockwood Staples, London, U.K.
8. Doty, C. W. and D. C. Reicosky. 1978. Chiseling to minimize the effects of drought. Trans. of ASAE 21:495–499.
9. El-Sharkawy, M. A. and K. Sgaier. 1975. Effect of tillage on root penetration and grain yield of Mexican wheat *Triticum aestivum* L. grown in the Libyan Desert. Libyan J. Agr. 4:25–28.
10. Fuad, J. 1977. Twenty-five years of wheat research in the Socialist People's Libyan Arab Jamahiriya. Proc. First Seminar on Wheat Research in the Libyan Jamahiriya. Agr. Res. Center, Tripoli, S.P.L.A.J. pp. 3–13.
11. Kaddah, M. T. 1976. Subsoil chiseling and slip plowing effects on soil properties and wheat grown on a stratified fine sandy soil. Agron. J. 68:36–39.
12. Kepner, R. A., R. Bainer and E. L. Barger. 1978. Principles of Farm Machinery. AVI Publishing Co., Westport, Connecticut, U.S.A.
13. Rai, R. N. and Yadav, Y. S. 1979. Effect of tillage practices on yield of rainfed wheat in Doon Valley. Ind. J. Agron 24:72–76.
14. Shaalan, M. I., M. S. Chaudhry and F. A. Sorour. 1977. The effect of tillage and planting methods on growth, weed population and yield in semi-dwarf wheat *Triticum aestivum* L. Libyan J. Agr. 6(1):55–67.

إنتاجية القمح تحت نظام الزراعة البعلية في غرب الجماهيرية

II-تأثير الحراثة العميقة

شرف الدين محمد الشريف محمد صديق شودري شوكت خان

مستخلـص

الحراثة العميقة خلال الموسم الزراعي ٨٠ — ٨١ وتأثيرها المتبقي خلال الموسم الزراعي ٨١ — ٨٢ على إنتاجية القمح تحت نظام الزراعة البعلية في محطة أبحاث كلية الزراعة ، جامعة الفاتح بطرابلس .

الحراثة العميقة (50 سم) أبدت إستجابة معنوية لصفات النبات مثل الطول وعدد السنابل ، والحبوب ووزن الحبوب للسنبلة والإنتاج الكلي حبوب وتبن ووزن ألف حبة إذا ما قورنت بمحاريث نشطة ، محراث بمحور دوران أفقي (محراث فرفره) ومحراث شوكي ترددي مزود بعجلة تكسير الطوب بعمق (20 سم) محراث قرصي رأسي ذو سبعة أقراص بعمق (25 سم) ومحراث حفار رجل بطة بعمق (30 سم) خلال الموسمين الزراعيين . ولم يظهر أي تأثير معنوي لمعاملات الحراثة على الأعشاب .

لم تعاد الحراثة خلال الموسم الزراعي الثاني لملاحظة تأثير المتبقي من حراثة الموسم السابق لتوفير تكاليف الحراثة . والنتائج أظهرت زيادة في الانتاجية وكذلك على المحافظة الاقتصادية لانتاج القمح أوضحت التجربة علامة واضحة لحاجة الحراثة العميتة مرة كل سنتين أو ثلاث سنوات كممارسة لخدمة الأرض وتحسين إنتاجية القمح تحت نظام الزراعة البعلية في التربة الرملية في منطقة غرب الجماهيرية .