Dryland Wheat Production in the Western Part of Libya
I. Response to Deep Tillage and N–P Fertilizers

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ABSTRACT

A field experiment was conducted at the Faculty of Agriculture Farm, University of Al-Fateh, Tripoli, S.P.L.A.J., during 1979–80. The effect of four tillage practices and nine N–P fertilizer combinations on the yield and yield components of wheat, cultivar Sidi Mesri 1 (*Triticum aestivum* L.) was studied under sandy soil and rainfed conditions.

Subsoiling (50 cm deep) significantly increased the total (grain + straw) yield, grain and straw yield, spikes per m^2, grains per spike, weight of grains per spike and 1000-grain weight compared to rotary cultivator (20 cm deep), 7-disk single-axle plow (25 cm deep) and sweep (30 cm deep). The order of their effectiveness was: rotary cultivator = 7-disk plow = sweep < subsoiler.

The fertilizer rates per hectare were: zero fertilizer, 20 kg N, 40 kg N, 30 kg P_2O_5, 60 kg P_2O_5, 20 kg N + 30 kg P_2O_5, 40 kg N + 30 kg P_2O_5, 20 kg N + 60 kg P_2O_5, and 40 kg N + 60 kg P_2O_5. The fertilizer combinations of 20 kg N and 40 kg N with 60 kg P_2O_5 per hectare significantly improved the wheat yield and its components compared to the other combinations. The increase in tillage depth and fertilizer rate increased the plant height and the number of spikes per plant.

The positive response of different plant characters to deep tillage and N–P fertilization clearly suggests the use of proper cultivation implements and fertilizer rates to increase the dryland wheat production.

INTRODUCTION

Tillage is a fundamental crop production practice to create a seedbed favorable for seed germination and subsequent plant growth. Its method, amount and depth depend upon soil type, crop and climatic conditions. Moisture conservation is an important tillage objective for dryland farming where limited moisture affects crop production. Generally, dryland crop yields will be improved by the tillage practices such as: controlling weeds; leaving crop residues on the land surface for moisture retention and erosion control; maintaining a high infiltration rate potential; developing a firm seedbed; and by avoiding tillage practices that turn up moist soil to expose it to rapid drying (1, 4, 12).

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Rotary cultivator with spike-tooth rotor and a crumbler roller gives a firm seedbed in a single run. The depth is about 20 cm and is controlled with a depth wheel and/or skids. The tilth is affected by forward speed to PTO speed ratio and by the adjustment of the rear shield. Lower the gear chosen and lower the rear shield, the finer will be the tilth (1, 3, 8).

Disk plows are widely used in the dryland farming regions of the world. Minimal crop residue burial occurs due to soil pulverization by the rolling concave disks rather than complete soil inversion. The plows can easily operate in hard, dry, sticky and rocky soils. The local single-axle 7-disk plow is a mounted vertical disk plow. These are mostly used for relatively shallow tillage depth of about 25 cm (1, 3, 12, 14).

Sweeps are subsurface implements used to loosen and pulverize the soil without inverting it. Sweeps have V-shaped blades in standards attached to a frame. Except in the space immediately adjacent to the standard, there is relatively little disturbance of the surface soil. These require high under-frame clearance to operate in heavy residue conditions. The tillage depth is about 30 cm (3, 8).

Subsoiling generally implies breaking through and shattering compacted or otherwise impervious layers to improve soil infiltration characteristics. Subsoilers give the best results when soil is dry and a subsoiled land can store 30% more moisture than the unchiselled land (14).

Wheat is a very important crop in the Jamahiriya. About one-fifth of more than one million hectares of cultivated land is used for wheat growing. Four-fifth of the grown wheat is under dryland which produces 0.2 to 0.8 tons/hectare depending upon the time and amount of rainfall (11). The yields can be increased by using improved wheat cultivars, proper tillage and by approved agronomic practices. Tillage contributes a major share in increasing crop production under dryland conditions (1, 4, 12).

Several studies have compared various methods of soil cultivation and their affects on plant growth in many countries. Tillage methods have also been fairly scrutinized for Libya by Chaudhry *et al.* (5, 7), Chaudhry and Sherif (6), El-Sharkawy and Sgaier (10), Shaalan *et al.* (15) and Sorour *et al.* (20). Spring-tined cultivator, rotary cultivator, disk harrow, mold-board plow and disk plow were mainly used. Disk plow produced higher yields than other implements under irrigated conditions.

Subsoiling from 40 cm to 90 cm depth has been found necessary for increased crop yields in areas of the world containing a compact soil layer within crop root zones (4, 9, 13). This is also a common soil feature in several regions of Libya where layers have developed during the process of soil formation such as the laminated layers of Kufra and Sarir (10). These also exist as hard plow-pans in the coastal areas where soils were continuously plowed to a certain depth (5, 6, 7, 20).

Studies in Libya have shown strong potential advantages of subsoiling for irrigated wheat. Chaudhry *et al.* (5, 7) and Chaudhry and Sherif (6) have observed in Tripoli area that subsoiling upto 50 cm broke the hard plow-pans, increased root development and improved the yield. El-Sharkawy and Sgaier (10) found 50 cm and 70 cm subsoiling in Kufra Oasis to increase the root depth by 100 and 132 percent respectively. Grain yield also increased by 39 to 54 percent compared with a no-tillage treatment.

Fertilizers are mainly applied to increase field crop production. Local workers like Chaudhry *et al.* (5), Chaudhry and Sherif (6) and Yousef *et al.* (23) found 100 to 120 kg N and 70 to 80 kg P_2O_5 per hectare to significantly enhance the growth and yield of irrigated wheat grown on calcareous sandy soils of Tripoli area.

Significant effects of nitrogen and phosphorus use in dryland wheat production have been reported by many workers. Basibekov and Mukashev (2), Sharma and Upadhyaya (16), Shekhawat and Mathur (17), Singh *et al.* (18), Thakur *et al.* (21) and Yadahalli and Patil (22) found that application of 30 to 60 kg N/hectare produced 20 to 100 percent more grain yields compared to no fertilization under different soil and rainfall conditions. Dryland wheat yields were also improved from 20 to 35 percent by applying 30 to 60 kg P_2O_5/hectare according to Basibekov and Mukashev (2), Singh *et al.* (19) and Yadahalli and Patil (22).

The studies carried out in the Libyan Jamahiriya are mostly confined to irrigated wheat grown on 20 percent of the annual cropped area of wheat. The remaining 80 percent is under dryland wheat producing only 0.2 to 0.8 tons/hectare (11). This enormous dryland wheat area urgently deserves the attention of the researchers to explore its yield potential. The objective of these preliminary investigations was to evaluate the effect of tillage methods and fertilizer rates on the growth and yield of dryland wheat.

MATERIALS AND METHODS

A field experiment was conducted at the Faculty of Agriculture Farm, Tripoli, S.P.L.A.J., during 1979–80 to study the effect of various tillage depths, nitrogen and phosphorus levels on the yield and yield components of dryland wheat grown on a calcareous sandy soil. Mexican semi-dwarf wheat (*Triticum aestivum* L.) Cv. Sidi Mesri 1 was planted on November 7, 1979 by a mechanical seed drill. The seeding rate was 80 kg/ha., and the rows were 30 cm apart.

The experiment was laid out as a strip plot design with three replications and subplot size was 3 m × 8 m. The main plots were assigned to four tillage treatments Viz: rotary cultivator with spike-tooth rotor and a crumbler roller (20 cm deep), single-axle 7-disk plow (25 cm deep), sweep (30 cm deep) and subsoiler (50 cm deep). The subplots were assigned to nine fertilizer treatment combinations of ammonium sulphate (21% N) at the rate of 0, 20 and 40 kg N/ha and single superphosphate (18% P_2O_5) at the rate of 0, 30 and 60 kg P_2O_5/ha. Superphosphate was applied as full dose before the seedbed preparation. Nitrogen was applied in two equal doses: 6 weeks after seeding and at the boot stage. The crop was harvested during the first week of May, 1980.

A random sample of ten wheat plants was taken from each sub-plot to record the number of spikes per plant, number of grains per spike, weight of grains per spike and plant height. The spikes per m^2 were counted from four randomly selected areas of 0.25 m^2 from each sub-plot. Central 15 m^2 area of each sub-plot was harvested to find the total (grain + straw) yield, grain yield and the straw yield. The samples for 1000-grain weight were taken from the threshed crop.

RESULTS AND DISCUSSION

The effect of tillage depths and N–P fertilization rates was determined for different plant characters of dryland wheat. The characters showing independent response to tillage depths and N–P fertilizer combinations are presented in Tables 1 and 2. The plant characters exhibiting interaction between the tillage depths and N–P fertilizer combinations are reported in Table 3.

Table 1 Effect of tillage depths on different plant characters in wheat, cultivar Sidi Mesri 1 under dryland conditions.

Tillage		Plant Characters						
Imple-ment	Average Tillage depth (cm)	Total yield (tons/ha)	Grain yield (tons/ha)	Straw yield (tons/ha)	Spikes/m^2	Grains per spike	Grain wt. per spike (g)	1000-grains wt. (g)
Rotary culti-vator	20	4.74	1.32	3.42	99.6	23.9	0.82	33.3
7-disk plow	25	4.74	1.33	3.41	97.5	25.4	0.98	33.4
Sweep	30	4.77	1.34	3.43	100.9	24.3	0.90	34.5
Sub-**Soiler**	50	6.28	1.74	4.54	118.3	29.7	1.10	38.8
L.S.D.	(0.05)	0.75	0.22	0.54	8.5	2.8	0.09	2.2
	(0.01)	1.13	0.33	0.81	12.8	4.2	0.13	3.4

Subsoiling to 50 cm depth significantly increased the total (grain + straw) yield, grain and straw yield, spikes per m^2, grains per spike, weight of grains per spike and 1000-grain weight (Table 1), as compared to rotary cultivator (20 cm deep), 7-disk plow (25 cm deep) and sweep (30 cm deep). The differences among the seedbed preparation by rotary cultivator with spike-tooth rotor and a crumbler roller (20 cm deep), single-axle 7-disk plow (25 cm deep) and the sweep (30 cm deep) were not significant for the above plant characters. The order of their efficiency was: rotary cultivator = 7-disk plow = sweep < subsoiler. These results, thus, substantiated the earlier findings indicating that subsoiling increased the yield of wheat grown on sandy soils of the Libyan Jamahiriya. Several reasons have been given for the beneficial effects of subsoiling. El-Sharkawy and Sgaier (10) reported that subsoiling (50–70 cm deep) of hard impervious laminated layers of Al-Kufra Oasis soils provided a better environment for root growth and enhanced the grain yield of irrigated wheat. Chaudhry *et al.* (5, 7) and Chaudhry and Sherif (6) found a positive improvement in the yield of irrigated wheat grown after 50 cm deep subsoiling of Tripoli soils. The increase in the yield was attributed to better root development and increased absorption of plant nutrients from deeper soil layers, after the breakage of the subsoil calcipans and/or hard plow-pans by subsoiling to 50 cm depth.

Some of the nitrogen and phosphorus fertilizer combinations showed significant differences in the yield and yield components of dryland wheat (Table 2). Zero fertilizer, 20 kg N + zero P_2O_5, 40 kg N + zero P_2O_5, zero nitrogen + 30 kg P_2O_5, 20 kg N + 30 kg P_2O_5 and zero N + 60 kg P_2O_5/hectare showed similar effects on different plant characters. The application of 40 kg N + 30 kg P_2O_5/hectare gave significantly higher straw yield, number of spikes per m^2 and 1000-grain weight than the above-mentioned fertilizer rates. The effect of 40 kg N + 30 kg P_2O_5/hectare was similar to the fertilizer combination of 20 kg N + 60 kg P_2O_5/hectare regarding the total yield, grain yield, straw yield, spikes per m^2 and 1000-grain weight. The fertilizer rate of 20 kg N + 60 kg P_2O_5 resulted in significantly higher weight and number of grains per spike than all the fertilizer treatments except the treatment of 40 kg N +

Table 2. Effect of fertilizer rates on different plant characters in wheat, cultivar Sidi Mesri 1 under dryland conditions.

Fertilizer rates $N+P_2O_5$ kg/ha	Plant characters: Total yield (tons/ha)	Grain yield (tons/ha)	Straw yield (tons/ha)	Spikes per m^2	Grains per spike	Grain wt. per spike (g)	1000-grain w. (g)
0+ 0	4.83	1.34	3.49	93.3	22.7	0.88	31.6
20+ 0	4.96	1.38	3.58	95.3	23.1	0.83	33.6
40+ 0	4.91	1.37	3.54	103.2	20.7	0.78	32.8
0+30	5.01	1.39	3.62	99.0	26.2	0.98	34.3
20+30	4.94	1.37	3.57	88.0	21.0	0.77	33.5
40+30	5.32	1.48	3.84	116.2	23.8	0.86	37.5
0+60	4.88	1.38	3.50	94.2	25.1	0.93	32.7
20+60	5.65	1.57	4.08	118.6	32.5	1.22	37.4
40+60	5.92	1.62	4.30	128.9	37.4	1.31	39.4
L.S.D. (0.05)	0.47	0.14	0.34	13.9	7.4	0.36	2.4
L.S.D. (0.01)	0.65	0.19	0.47	19.1	10.2	N.S.	3.3

60 kg P_2O_5/hectare. The differences between the effects of 20 kg N + 60 kg P_2O_5/hectare and 40 kg N + 60 kg P_2O_5/hectare on the yield and yield components of wheat were not significant. The later fertilizer treatment significantly improved all the plant characters compared to the remaining 7 fertilizer treatments. The current studies have shown that application of 20 to 40 kg N with 60 kg P_2O_5 per hectare could enhance the yield of dryland wheat grown on sandy soils.

The interactions were found significant between the tillage methods and fertilizer rates for plant height and the number of spikes per plant (Table 3). The lowest plant height was found in rotary cultivation (20 cm deep) and zero fertilizer rate. The plant height was improved with the increase in tillage depth and fertilizer rate. A similar interaction was observed for the number of spikes per plant. The spike number increased with the increase in tillage depth and fertilizer rate.

Table 3. Effect of tillage depths and fertilizer rates on different plant characters in wheat, cultivar Sidi Mesri 1 under dryland conditions.

Plant characters	Average tillage depth (cm)	Fertilizer rates $N+P_2O_5$ kg/hectare: 0+0	20+0	40+0	0+30	20+30	40+30	0+60	20+60	40+60
Plant height (cm)	20	36.3	37.0	36.7	38.0	39.7	43.7	38.7	44.7	49.0
	25	37.7	36.4	36.4	39.0	40.4	46.7	42.4	48.4	52.0
	30	41.0	39.7	38.7	40.7	41.0	46.7	42.7	48.0	52.0
	50	48.0	48.4	47.4	51.4	49.0	54.4	46.7	61.4	67.7
Spikes per plant	20	1.0	1.1	1.0	1.1	1.0	1.1	1.0	1.2	1.3
	25	1.0	1.1	1.0	1.0	1.0	1.2	1.1	1.2	1.3
	30	1.0	1.1	1.0	1.0	1.2	1.2	1.1	1.2	1.3
	50	1.2	1.2	1.3	1.1	1.3	1.5	1.2	1.5	1.7

Interaction: L.S.D. for plant height (0.05) = 4.58 and (0.01) = 6.01 cm.
L.S.D. for spikes per plant (0.05) = 0.16 and (0.01) = 0.21 spikes per plant.

The current results clearly indicate that the yield and yield components of dryland wheat grown on sandy soils can be significantly improved by deep tillage and N–P fertilizers.

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إنتاجيــة القمح تحت نظام الزراعة البعلية في منطقة غرب الجماهيريــة

I - الإستجابة لعمق الحرث ومعــاملات التسميد (نتروجين — بوتاسيوم)

محمد صديق شودري شرف الدين محمد الشريف

المستخلــص

أجريت التجربة في محطة تجارب كلية الزراعة — جامعة الفاتح خلال الموسم الزراعي ١٩٧٩ — ١٩٨٠ لدراسة تأثير أربعة أنواع من الحراثة وتسع معاملات تسميد (نتروجين — بوتاسيوم) على الإنتاج الكلي والجزئي لمحصول قمح سيدي المصري I في تربة رملية وتحت نظام الزراعة البعلية .

أعطت الحراثة بمحراث تحت التربة بعمق (٥٠) سم دلالة معنوية في زيادة الأنتاج الكلي (حبوب+تبن) وزيادة في عدد السنابل في المتر المربع ، وعدد الحبوب في السنبلة ، وزن الحبوب للسنبلة ووزن ألف حبة مقارنة لحراثة بمحراث دوراني (عزاقة بسلاح صرف I) ولعمق ٣٠ سم — ومحراث قرصي ذو سبعة أقراص رأسية وبعمق ٣٥ سم ومحراث حفار مزود بسلاح رجل بطة (١٧,٥ سم) بعمق ٣٠ سم . وترتيب المحاريث حسب فعاليتها ، محراث دوراني ، والمحراث القرصى الرأسي يماثل المحراث الحفار وجميعها أقل من محراث تحت التربة .

أما بالنسبة لمعدلات التسميد للهكتار فكانت على النحو الآتي ، صفر تسميد ٣٠ كيلو غرام (ن) ٤٠ كيلوغرام (ن)، ٣٠ كيلوغرام (بو$_٢$أ$_٥$)، ٦٠ كيلوغرام (بو$_٢$أ$_٥$)، (٣٠ كخ ن+٣٠ كغ بو$_٢$أ$_٥$)، (٤٠ كغ خ+٣٠ كغ بو$_٢$أ$_٥$)، (٣٠ كغ ن+٦٠ كغ بو$_٢$أ$_٥$)، (٤٠ كغ ن+٦٠ كغ بو$_٢$أ$_٥$) . ولقد أعطت معدلات التسميد. ٣٠ كغ ن + ٤٠ كغ ن مع ٦٠ كيلوغرام (بو$_٢$أ$_٥$) للهكتار دلالة معنوية في تحسين زيادة الإنتاج الكلي والجزئي مقارنة مع المعدلات الأخرى وإن زيادة عمق الحراثة ومعدل التسميد أعطى زيادة في طول النبات وعدد السنابل للنبات . والإستجابة لمختلف خواصى النبات تتأثر بعمق الحراثة ومعدلات التسميد أصبحت ظاهرة واضحة لاختيار معدل الحراثة ومعدلات التسميد لزيادة إنتاجية القمح تحت نظام الزراعة البعلية .