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Yield Response of Irrigated Wheat Grown on Sandy Soil to Deep Tillage and Phosphorus Fertilizer

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ABSTRACT

The response of the semi-dwarf wheat, cultivar Sidi Mesri 1 (Triticum aestivum L.), to deep tillage and phosphorus fertilizer was studied on the sandy soil of Tripoli, the Libyan Jamahiriya. Subsoiling (50 cm deep) as compared to disk plowing (25 cm deep) and rotary cultivation (15 and 20 cm deep) gave significantly higher grain yield, spikes per plant, spikes per m^2, number and weight of grains per spike, and 1000-grain weight. The response to disk plowing and rotary cultivators was not different. The addition of 80 kg P_2O_5/ha significantly enhanced the yield and its components. Higher dose showed no further effect. There was no interaction between the tillage depth and phosphorus for wheat yield and yield components. Occasional deep tillage and regular phosphorous fertilization seems necessary to increase wheat production in sandy soils of the coastal belt of the Libyan Jamahiriya.

INTRODUCTION

Tillage of agricultural soils is done to produce a desirable soil physical condition for seed germination and growth of economic plants. Its method, amount and depth is a local decision which depends upon soil, crop and climatic factors.

The positive effects of tillage on wheat production in the Libyan Jamahiriya have been reported by Chaudhry *et al.* (6, 7), El-Sharkawy and Sgaier (9) and Shaalan *et al.* (14). The tillage implements used were spring-tined cultivator, disk harrow, rotavator (rotary cultivator with L-blade rotor), disk plow, moldboard plow and subsoiler. Seed-bed prepared by disk plow and rotavator usually gave better growth and higher yields than by spring-tined cultivator and disk harrow in Tripoli area. The disk plowing to 15–30 cm depth also increased the root growth and grain yield as compared to no-tillage of sandy soils of the Libyan Desert or Al-Kufra Oasis, the Libyan Jamahiriya (9). El-Sharkawy and Sgaier (9) reported that 50 to 70 cm deep subsoiling of Al-Kufra Oasis soils increased the root depth and grain yield of Mexican dwarf wheat, cultivar Super X. Chaudhry *et al.* (6, 7) observed significant increase in root depth, root development, yield and yield components of semi-dwarf wheat, cultivar Sidi Mesri 1, from 50 cm deep subsoiling of sandy soils of Tripoli, the Libyan Jamahiriya. The

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enhanced grain yield was indicated to be the result of the breakage of hard plow-pan, more root growth and increased absorption of micronutrients from deeper soil layers after subsoiling.

Deep tillage and subsoiling has been reported to increase the crop yields in areas where compact layers existed in the soil profiles restricting the root growth (1, 4, 16). Such layers also exist in some regions of the Libyan Jamahiriya. Laminated layers of Al-Kufra Oasis and calcipans or hard plow-pans in the coastal belt are some examples. Subsoiling of these sandy soils to 50–70 cm depth increased growth and yield of wheat as compared to conventional 15–30 cm deep tillage by rotary cultivators and disk plows (6, 7, 9). Several studies conducted in other countries under similar conditions have also shown the utility of subsoiling. This is a usual practice in some areas of Romania (4), Imperial Valley of California (11), Yugoslavia (12), India (13) and United Kingdom (16), where a significant growth response and increase in wheat yield has been reported with tillage of 40–90 cm depth.

Phosphorus fertilization has been found to increase the growth and yield of wheat grown on loamy soils of Montana, U.S.A. (2), Yugoslavia (12) and India (15). A few earlier studies conducted in the Libyan Jamahiriya (5, 8, 17) showed that phosphorus fertilization usually has the positive effect on yield and yield components of wheat. Conflicting results have, however, been reported. El-Sharkawy (8), for example observed that application of phosphorous fertilizer at 100 kg of P_2O_5 ha–enhanced plant growth and grain yield of semi-dwarf Mexican wheat, cultivar Sidi Mesri 1, on the sandy soils of Al-Kufra Oasis, the Libyan Jamahiriya. Yousef *et al.* (17) similarly found significant increase in plant growth, grain yield and yield components of wheat from the addition of phosphorus at 72 kg of P_2O_5/ha on sandy soils of Tripoli, the Libyan Jamahiriya. Chaudhry *et al.* (5) indicated that about 80 kg of P_2O_5/ha may be enough for most of the soils of Jafara Plain, Libya. El-Tabbakh *et al.* (10) observed no effect of phosphorus fertilizer on the yield of irrigated wheat on some Jafara soils.

The objective of this experiment was to investigate the response of wheat yield and its components to deep tillage and phosphorus fertilization.

MATERIALS AND METHODS

The experiment was conducted at the Faculty of Agriculture Farm, Alfateh University, Tripoli, S.P.L.A.J., during the year 1977–1978, to study the yield response of wheat, cultivar Sidi Mesri 1 (Triticum aestivum L.) to deep tillage and phosphorus fertilizer. The experiment was laid out as a strip-plot design with four replications and 3×8 m plot size. The main plots were assigned to four tillage treatments i.e., 15 cm deep (rotavator or rotary cultivator with L-blade rotor), 20 cm deep (rotary cultivator with spike-tooth rotor and a crumbling roller), 25 cm deep (7-disk plow) and 50 cm deep (Vicon subsoiler). The sub-plots were broadcasted with 0, 40, 80, and 120 kg of P_2O_5/ha as single superphosphate (18% P_2O_5) before seed-bed preparation. Seeding was done on November 12, 1977 at the rate of 100 kg/ha by a mechanical seed drill (Massey–Ferguson 34–7) in 30 cm apart rows. Each plot was fertilized with 100 kg N/ha as ammonium sulphate (21% N), applied in two equal doses, 7 and 13 weeks after seeding. The field was sprinkler irrigated at 5–10 days interval according to the growth stage of the crop and the amount of rainfall. The crop was harvested in the second week of May, 1978.

The spikes per plant, grains per spike and weight of grains per spike was recorded from five wheat plants chosen at random from each plot. The spikes per m^2 were

counted from a random area of one square meter. The total (grain plus straw) and the grain and straw yields were determined by harvesting a 10 m^2 area from the center of each plot. The 1000-grain weight was taken by sampling from the threshed crop. The harvest index (grain/total yield $\times$ 100) was also calculated.

RESULTS AND DISCUSSION

The response of yield and yield components of wheat, cultivar Sidi Mesri 1, to different tillage depths and phosphorus fertilizer doses was determined. The plant characters showing independent response to tillage depths and phosphorus rates are presented in Tables 1 and 2.

Tillage or subsoiling to 50 cm depth significantly increased the grain yield, spike number per plant, grain number and weight per spike, and 1000-grain weight (Table 1) as compared to disk plowing (25 cm deep) and the two rotary cultivators (15 and 20 cm deep). Subsoiling (50 cm deep) and disk plowing equally affected the total yield (grain plus straw), straw yield and spikes per m^2. The harvest index (grain/total yield $\times$ 100) was slightly improved by tillage to 50 cm depth. The response of plant characters like total yield, grain and straw yield, spike numbers per plant, spike number per m^2 and 1000-grain weight to shallower tillage depths (15, 20 and 25 cm) was not significantly different. The disk plowing gave significantly more grain number and weight of grains per spike than 15 cm deep rotovation. The differences between the seed-bed preparation by rotary cultivator with spike-tooth rotor plus a crumbling roller (20 cm deep) and rotary cultivator with L-blade rotor (15 cm deep) were not significant for wheat yield and yield components. This indicates the utility of deep tillage to more than 40 cm depth (subsoiling) at suitable intervals even in sandy soils (Table 1). The mechanism of its beneficial effects is not clearly known. Several reasons have been given. El-Sharkawy and Sgaier (9) have indicated that the breakage of hard laminated layers of Al-Kufra Oasis soils by 70 cm deep subsoiling significantly increased the root depth and improved the grain yield of irrigated wheat. Chaudhry *et al.* (6, 7) observed a positive improvement in yield and yield components of irrigated wheat grown after 50 cm deep subsoiling of sandy soils of Tripoli, the Libyan Jamahiriya. This increase in yield was attributed to enhanced root growth and increased absorption of plant nutrients from deeper soil layers, after the breakage of calcipans or hard plow-pans by subsoiling to 50 cm depth.

Phosphorus fertilizer had a positive effect on total (grain plus straw), grain and straw

Table 1 The response to tillage depths by the yield and yield components of wheat.

Plant characters	Tillage depths (cm)				LSD	
	15	20	25	50	0.05	0.01
Total yield (tons/ha)	8.01	7.69	8.52	9.36	0.96	N.S.
Grain yield (tons/ha)	3.00	2.88	3.17	3.59	0.34	0.49
Straw yield (tons/ha)	5.01	4.81	5.35	5.77	0.63	N.S.
Harvest index (%)	37.26	37.25	37.01	38.11	N.S.	N.S.
Number of spikes per plant	1.80	1.90	1.87	2.24	0.11	0.16
Number of spikes per m^2	133.06	133.81	150.81	168.44	19.60	28.16
Number of grains per spike	48.12	49.93	52.78	57.04	3.05	3.77
Weight of grains per spike (g)	1.95	2.07	2.29	2.52	0.21	0.31
1000-grain weight (g)	34.81	35.54	36.18	37.91	1.67	N.S.

Table 2 The response to phosphorus fertilizer rates by the yield and yield components of wheat.

Plant characters	Fertilizer kg P_2O_5/ha				LSD	
	0	40	80	120	0.05	0.01
Total yield (tons/ha)	7.25	7.50	9.22	9.60	0.87	1.25
Grain yield (tons/ha)	2.57	2.87	3.55	3.64	0.33	0.47
Straw yield (tons/ha)	4.68	4.63	5.67	5.96	0.57	0.82
Harvest index (%)	35.34	37.89	38.48	38.02	1.07	1.53
Number of spikes per plant	1.90	1.91	2.01	1.98	N.S.	N.S.
Number of spikes per m^2	128.06	148.13	153.69	156.25	18.78	N.S.
Number of grains per spike	47.31	50.58	53.70	56.08	5.44	N.S.
Weight of grains per spike (g)	1.91	2.11	2.31	2.50	0.28	0.40
1000-grain weight (g)	32.45	35.36	36.87	39.60	1.25	1.79

yield, harvest index. spikes per m^2, grain number per spike, weight of grains per spike and 1000-grain weight (Table 2). The response to 120 kg P_2O_5/ha was not significantly different from 80 kg P_2O_5/ha. The latter dose showed significantly higher values than 40 kg P_2O_5/ha and the control for nearly all the above plant characters. The number of spikes per plant was slightly affected by phosphorus. The current beneficial effects of phosphorus fertilization support the earlier studies indicating phosphorus fertilizer to be necessary for wheat production in the Jafara Plain. The soils of even other regions require phosphorus fertilization for the successful crop production. Its dose, however, varies from region to region and even within the Jafara Plain. The phosphorus rates, in fact, are never consistent in an area and strongly depend upon the types of crops, their yield levels to be obtained, the nature of management, irrigation system and the previous fertilization history of a productive site. The current studies have, thus, shown 80 kg of P_2O_5/ha to be enough for optimum wheat production in Tripoli or Jafara Plain, the Libyan Jamahiriya. The present observations are similar to the earlier findings by Chaudhry *et al.* (5) and Yousef *et al.* (17). They observed that about 80 kg of P_2O_5/ha may be enough for most of the soils of Jafara Plain. Both the studies represent irrigated crop production with wheat grain yield usually varying from 3 to 5 tons/ha.

There was no interaction between the tillage depths and phosphorus fertilizer rates for all of the plant characters observed in this study (Tables not shown).

The yield and yield components of wheat were improved by deep tillage and phosphorus. The practice of deep tillage and phosphorus fertilization seems desirable to enhance wheat production in the coastal belt of Socialist People's Libyan Arab Jamahiriya.

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تأثير الحراثة العميقة والتسميد الفسفورى على إنتاج القمح المروى النامى في التربة الرملية

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المستخلص

استجابة القمح المتوسط من نوعية سيدى المصرى — للحرث العميق والتسميد الفسفورى قد درس بالنسبة للتربة الرملية بمنطقة طرابلس بالجماهيرية العربية الليبية الشعبية الاشتراكية . الحرث العميق (عمق ٥٠٠ مم) قورن بالمحاريث القرصية (عمق ٢٥٠ مم) والمحراث الدوراني (عمق من ١٥٠ إلى ٢٠٠ مم) أعطت تأثيرًا معنويا بزيادة إنتاج الحبوب وعدد السنابل بالنسبة للنبات ، عدد السنابل بالنسبة للمتر المربع ، وعدد ووزن الحبوب بالنسبة للسنبلة ووزن ألف حبة . . .

وتأثير المحرات القرصي والمحراث الدوراني لا يعطى أية فروق . زيادة ثمانين كيلوجرام من السماد بوأه للهكتار أعطت نتائج قيمة على الإنتاج وباقي عناصر الإنتاج الأساسية الجرعات الزيادة لم تؤد إلى أية نتائج ذات أهمية . ولا توجد أية علاقة بين عمق الحراثة والتسميد الفسفورى إنتاج القمح وباقي عناصر الإنتاج الأساسية الحراثة العميقة بين الفنينة والأخرى والتسميد الفسفورى العادى يعتبر في حكم الضرورى لزيادة إنتاج القمح في التربة الرملية في الشريط الساحلى بالجماهيرية العربية الليبية الشعبية الاشتراكية .