The Effect of Tillage and Nitrogen Fertilization on Yield and Yield Components of Wheat

M. S. CHAUDHRY[1], S. M. SHERIF[1], AND J. S. SAWHNEY[2]

ABSTRACT

The effect of tillage depth by different implements in seed-bed preparation under four nitrogen fertilization rates on yield and yield components of wheat, cultivar Sidi Mesri 1 (*Triticum aestivum* L.) was studied in a field experiment at Tripoli, Libya. Tillage treatment as compared to no-tillage had higher plant density and late heading, greater root depth, dry root and shoot weight at 4 weeks, plant height, number of spikes per plant, spikes per m^2 and number and weight of grains per spike. The subsoiling (50 cm deep) gave higher values for nearly all the above characters as compared to rotovation (15 cm deep) and disking (25 cm deep). There was no difference between 15 and 25 cm tillage depths for days to heading, plant height, number of spikes per plant, spikes per m^2, number of grains and weight of grains per spike. Nitrogen fertilization had the positive effect over control treatment for observations made after fertilization. The effect of 100 kg N/ha was comparable to 150 kg N/ha. Nitrogen effects for biological yield were noticed in shallow or deep tillage and not on intermediate depth. Except in the no-tillage treatment, increase in nitrogen fertilization increased dry root and shoot weight at 17 weeks, yield of grain and 1000-grains weight. Deep tillage, at least irregularly, seems to be necessary along with nitrogen even in loose sandy soils for proper growth of wheat in the coastal areas of Libya.

INTRODUCTION

No-tillage planting in Agricultural Engineering terminology is a procedure whereby a planting is made directly into an essentially unprepared seed-bed (3). The zero tillage or no-tillage procedure is an agronomic practice of seeding a crop directly into a

[1] *Department of Agricultural Engineering, Faculty of Agriculture, University of Alfateh, Tripoli, S.P.L.A.J.*
[2] *Department of Agronomy, Faculty of Agriculture, University of Alfateh, Tripoli, S.P.L.A.J.*

chemically killed crop residue or weeds without seed-bed preparation. So the difference lies only in preventing the competition from weeds and reducing evaporation and runoff of water from the soil surface. The seed-bed in both cases is not prepared.

The root depth of wheat is increased with increase in depth of tillage from no-tillage to 70 cm (8,11) and the seedling emergence in corn is on the other hand decreased (20). There is no effect of increasing the depth of tillage on grain size of wheat and corn (8,20,22). Increasing the depth of tillage was found to increase the tillering and number of spikes/m^2 in barley (15). Seed-bed preparation by disc plough and rotary cultivator (rotavator) gave higher yields of corn and wheat than no-tillage or spring-tined harrow (16,19,20). The yield of grain was higher with cereals like wheat and barley when seed-bed was prepared by ploughing rather than by rotavator (4,19,23). Deep tillage to 25–55 cm or to 70–90 cm gave higher grain yields of wheat and barley than shallow tillage (5,8,12,14). In some experiments where the range of tillage was small, i.e., 10–40 cm (14) or the soil was low in nitrogen (21) tillage depth had no effect on the grain yield of wheat.

Nitrogen fertilization has been shown to increase plant height (1,21), tillering (1,9,18) and the number of spikes per unit area (1,2,18). The effect of nitrogen on grain weight per spike, grain number per spike and grain size was positive, negative or zero (6,7,9). Nitrogen also increased grain and straw yield (1,2,6,7,10,17,18,21) but the absolute value varies with the location, year and other factors.

The purpose of this experiment was to evaluate the effect of tillage depth (brought about by different implements) and nitrogen fertilization on growth, yield and yield components of wheat.

MATERIALS AND METHODS

A field experiment was laid out on the Farm of the Faculty of Agriculture, Tripoli, S.P.L.A.J. during the season 1976–1977 to study the effect of tillage depths and nitrogen fertilization on the yield, yield components and other growth parameters of wheat, Cv. Sidi Mesri 1. Wheat seeds were planted at the rate of 100 kg/ha on November 14, 1976 by a mechanical seed drill (Massey-Ferguson 34–7) in rows 30 cm apart. The field was fertilized with 300 kg/ha of single superphosphate (16% P_2O_5) before seed-bed preparation. The experiment was laid out as a strip-plot design using tillage as main plots and nitrogen as sub-plots (2.5 × 8 m) with four replications. The main plots were four tillage treatments i.e., no-tillage, 15 cm deep (rotavator with L-blade rotor), 25 cm deep (3-disk plow) and 50 cm deep (Vicon subsoiler). The sub-plots were fertilized with 0, 50, 100 and 150 kg N/ha applied as ammonium sulphate (21% N) in split doses (8 and 13 weeks after seeding). Weekly irrigation was done unless there was a rain. Observations were taken for plant density at 4 weeks, and root length, root weight and shoot weight at 4 weeks and 17 weeks after planting. Wheat crop was harvested in the third week of May, 1977 and the data were taken for weed population, yield of grain and straw, yield components and plant height.

RESULTS AND DISCUSSION

The effect of depth of tillage and nitrogen fertilization was determined for different plant characters. Those characters showing no interaction between depth of tillage and nitrogen fertilizer are shown in Tables 1 and 2.

Tillage increased the plant density, delayed heading, increased root depth, root weight, shoot weight, plant height, number of spikes per plant, spikes per m^2, number of grains per spike and the grain weight per spike. At shallower depths (15 to 25 cm), increasing the tillage depth increased root depth (at 4 and 17 weeks), root weight (at 4 and 17 weeks) and shoot weight at 4 weeks. This effect was obliterated at the end of the experiment when plant height, spikes per plant, spikes per m^2, number of grains per spike and grain weight per spike were not different between 15 cm deep and 25 cm deep tillage for seed-bed preparation. The subsoiling (50 cm deep) showed a significant effect in all characters over the no-tillage treatment indicating the usefulness of deep tillage at least irregularly even in sandy soils (Table 1).

Table 1 The effect of tillage depth on some plant characteristics of wheat, cultivar Sidi Mesri 1.

Tillage depth (cm)	1	2	3	4	5	6	7	8	9	10	11
0	69.0	103.0	71.2	11.2	18.3	0.11	0.20	1.4	77.0	22.1	0.89
15	128.0	104.0	78.0	15.0	22.4	0.27	0.35	2.0	201.0	42.2	1.76
25	138.0	104.0	80.8	16.5	22.8	0.46	0.49	2.1	215.0	45.5	1.78
50	151.0	106.0	82.8	18.3	35.4	0.65	0.62	2.3	227.0	52.9	2.23
LSD (0.05)	20.0	2.0	4.3	1.4	2.6	0.08	0.13	0.2	31.0	6.9	0.36

1. Seedling/m^2, 2. Days to heading, 3. Plant height (cm), 4. Root depth at 4 weeks (cm), 5. Root depth at 17 weeks (cm), 6. Dry root weight at 4 weeks (g), 7. Dry shoot weight at 4 weeks (g), 8. Spike number per plant, 9. Spikes per m^2, 10. Grain number per spike and 11. Grain weight per spike (g).

Table 2 The effect of nitrogen fertilization on some plant characteristics of wheat, cultivar Sidi Mesri 1.

Nitrogen kg/ha.	1	2	3	4	5	6	7
0	102.3	76.6	23.6	1.8	148.0	33.2	1.45
50	103.2	78.0	25.2	1.9	170.0	39.3	1.57
100	104.4	80.1	26.2	2.0	202.0	44.0	1.80
150	106.8	80.1	27.0	2.0	200.0	46.1	1.84
LSD (0.05)	1.2	1.8	1.6	0.1	24.0	7.0	0.30

1. Days to heading, 2. Plant height (cm), 3. Root depth at 17 weeks (cm), 4. Spike number per plant, 5. Spikes per m^2, 6. Grain number per spike and 7. Grain weight per spike (g).

The effect of nitrogen fertilization on days to heading, root length (at 17 weeks), plant height, number of spikes per plant, spikes per m^2, number of grains per spike and the grain weight per spike is presented in Table 2. Nitrogen fertilization had a positive effect on all these characters. It delayed maturity, increased root length at 17 weeks, plant height, number of spikes per plant, spikes per m^2 and number and weight of grains per spike. The effect of nitrogen was gradual from zero nitrogen to 50 kg N/ha and onwards. The effect of 50 kg N/ha was not different from zero nitrogen. The 100 kg N/ha resulted in significantly late heading, more plant height, spikes per plant and spikes per m^2 than 50 kg N/ha. The 150 kg N/ha was comparable to 100 kg N/ha.

All the characters that responded to tillage (Table 1) also responded to nitrogen treatment (Table 2) except plant density, root depth and shoot weight at 4 weeks after

planting. It may be interpreted that the beneficial effect of tillage was observed on the same characters which responded to nitrogen except in early seedling growth though there was no interaction between the tillage and nitrogen treatments for their effect on these characters. Tillage did improve the emergence rate and the absence of response to nitrogen for emergence was expected as the food material in grain is responsible for emergence of the seedling. Nitrogen fertilization was done on 8 and 13 weeks after seeding so there was no effect of the added nitrogen on root and shoot growth at 4 weeks. A positive effect of nitrogen at 17 weeks shows that root growth is encouraged by nitrogen fertilization. The main components of yield i.e., spikes per plant and grain number and weight per spike were both affected by tillage and fertilization independently. It indicates the importance of proper seed-bed preparation and fertilization for potential grain yield even in loose sandy soils.

Significant interactions were found between the depth of tillage and nitrogen fertilization for dry weight of roots and shoots of wheat at 17 weeks as well as for biological yield (grain + straw), grain yield and grain size. These data and some other useful information obtained from this experiment (but not statistically analysed) are presented in Table 3.

Table 3 The effect of tillage depth and nitrogen fertilization on different plant characters in wheat, cultivar Sidi Mesri 1.

Tillage depth (cm)	Nitrogen kg/ha.	1	2	3	4	5	6	7	8
0	0	1.13	13.24	1.02	1.86	0.43	1.43	23.20	29.53
	50	1.08	13.89	1.08	1.89	0.53	1.36	26.63	30.29
	100	1.38	14.09	0.93	2.63	0.73	1.90	27.60	32.29
	150	1.37	14.15	1.32	3.19	0.92	2.27	28.83	31.68
15	0	2.00	19.29	0.12	7.69	1.98	5.71	25.90	33.95
	50	2.36	19.32	0.12	12.30	4.18	8.12	33.85	36.12
	100	2.41	20.31	0.13	13.24	4.72	8.52	36.28	40.87
	150	2.88	20.48	0.14	12.61	4.86	7.75	38.63	41.50
25	0	2.57	22.30	0.09	11.95	3.45	8.50	28.78	32.78
	50	2.71	22.23	0.10	12.58	4.11	8.47	32.60	33.77
	100	3.49	23.42	0.10	11.49	4.76	6.73	41.58	42.57
	150	3.34	23.81	0.14	12.25	4.89	7.36	39.95	41.05
50	0	2.65	23.42	0.15	13.54	3.93	9.61	28.93	33.92
	50	3.51	24.07	0.15	13.06	4.61	8.45	35.25	35.22
	100	3.67	24.61	0.17	12.03	4.77	7.26	39.80	42.52
	150	3.62	25.01	0.19	13.66	5.62	8.04	41.73	42.72

1. Dry root weight at 17 weeks (g), 2. Dry shoot weight at 17 weeks (g), 3. Weight of weeds at harvest (kg/m^2), 4. Biological yield (tons/ha), 5. Grain yield (tons/ha), 6. Straw yield (tons/ha), 7. Harvest index and 8. 1000 grains weight (g).

The lowest dry weight of roots at 17 weeks was found in no-tillage treatment under all fertilizer rates, and zero fertilizer rate in all tillage treatments. The opposite was true at deepest tillage and highest fertilizer treatments. Highest root weights were obtained from 100 kg N/ha in all tillage treatments expect 15 cm deep rotavation.

The dry weight of shoot at 17 weeks was highest in 150 kg N/ha and lowest in zero fertilizer treatment. The shoot weights increased with the increased depth of

tillage. The differences, were widening with increase in fertilizer as the tillage depth increased.

The biological yield (grain + straw) per hectare was the lowest in the no-tillage treatment amounting to about 14% of the maximum yield indicating the importance of proper seed-bed preparation for wheat even in sandy soils. The differences were smaller with increase in tillage depth from 15 to 50 cm. The effect of nitrogen was noticed only in 15 cm and 50 cm depths of tillage. This was perhaps due to better utilization in rotavation and leaching in subsoiling. Nitrogen increased biological yield in 15 cm deep rotovation, while at 50 cm deep subsoiling, 100 kg/ha was the poorest one. There was no difference among the other nitrogen treatments and the control.

The grain yield was increased by fertilizer in each tillage treatment except no-tillage (perhaps the water penetration was not enough to make it available to plants). The yield was higher in 100 kg N/ha (and equal to 150 kg N/ha) than 50 kg N/ha except in the 50 cm depth where 150 kg N/ha gave higher yield than 50 and 100 kg N/ha.

The weight of 1000-grains was increased by nitrogen fertilization except in the no-tillage treatment. The 100 kg N/ha treatment gave higher grain weight than 50 kg N/ha in 15 and 50 cm depths. It gave higher grain weight than even 150 kg N/ha in 25 cm deep disking.

The weight of weeds at harvest was about tenfolds more with no-tillage than after tillage treatments. It showed an increasing trend with increase in fertilization and tillage depth. Straw yield and harvest index (grain/biological yield $\times$ 100) also increased by nitrogen and tillage. These are given for information only and have been derived from the other parts of the table.

It is apparent from the results that no-tillage without weed control even on sandy soils is a poor seed-bed and also nitrogen is necessary for the increased growth and yield of wheat. All the important components of yield and the yield apparently improved with nitrogen and depth of tillage. Deep cultivation (to 50 cm) at least on an irregular basis, seems to be desirable for wheat growth in the coastal areas of the Libyan Jamahiriya.

LITERATURE CITED

1. Abdeljawad, A. and A. Arafa. 1974. Morphological and yield of wheat response to cycocel spray. J. Agr. Res. (S.P.L.A.J.) 2:209–221.
2. ———. 1975. Study on the effect of nitrogen source and level on yield of wheat and wheat components. Agr. Res. 3:111–118.
3. A. S. A. E. 1977. Terminology and definitions for soil tillage and soil tool relationships. Agr. Engrs. Yearbook 341–342.
4. Anonymous. 1967. Barley growing without plowing. 59th Ann. Report Norfolk Agric. Sta. pp. 10–11.
5. Bretan, I; I. Simionescu; G. Paven, V. Goia and P. Sebok. 1972. The effect of increasing the plowing depth for principal crops on yield, weeds and soil moisture. Agricultura 27:123–132 (Romania).
6. El-Sharkawy, M. A., K. Sgaier and M. M. Ramadan. 1973. Response of wheat to cycocel (CCC) application. II-Effects of nitrogen level and CCC concentration on yield components of dwarf and tall wheat (Triticum aestivum L.) Libyan J. Agr. 2:21–26.
7. El-Sharkawy, M. A. and K. Sgaier. 1974. Effect of preplanting fertilizer, source and rate of postemergence nitrogen on the yield and growth of dwarf wheat in the Kufra Oasis, The Libyan Jamahiriya, Libyan J. Agr. 3:53–68.
8. ———. 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.
9. El-Sharkawy, M. A., F. A. Sorour and M. Abaza. 1976. Response of a newly developed variety of dwarf wheat to nitrogen level and supplementary irrigation. Libyan J. Agr. 5:17–26.
10. El-Tabbakh, A. E., A. Salam, A. Haddad; A. A. Kareem and S. Gomoa. 1975. A study of response of irrigated wheat in sandy soil to application of nitrogen and phosphorus. Agr. Res. (S.P.L.A.J.). 3:29–36.
11. Finney, J. R. 1973. Root growth in relation to tillage. Chemistry and Industry 14:676–678.
12. Hepp, F. 1974. Yield response to shallow and deep tillage of sandy soil. Novenytermeles 23:357–366 (Hungary).
13. Jones, J. N., J. E. Moody, G. M. Shear; W. W. Moschler and J. H. Lilland. 1968. The no-tillage system for corn. Agron. J. 6:17–20.
14. Kaddah, M. T. 1976. Subsoil chiseling and slip plowing effects on soil properties and wheat grown on a stratified sandy soil. Agron. J. 68:36–39.
15. Kopecky, M. 1970. The effect of subsoiling on the yield and quality of malting barley. Rostl. Vyroba 16:1095–1104 (Czechoslovakia).
16. Reddy, D. S. and C. Dakshinamurti. 1971. Root growth and soil structure under different tillage operations and uniform application of fertilizer. Ind. J. Agr. Sci. 41:413–422.
17. Salam A., S. Ismael; B. Muzwagi; H. Faraj and S. Gomoa. 1975. Application of increased rates of fertilizer nitrogen to a sandy soil in Jafara Plain (Tajoura) and a clay soil in El-marj Plain (El-Marj) under wheat. Agr. Res. (S.P.L.A.J.) 3(1):131–138.
18. Sawhney, J. S. 1971. The effect of nitrogen fertilization on tillering and components of yield in wheat. Libyan J. Agr. 1:19–24.
19. 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.
20. Sorour, F. A., M. A. El-Sharkawy; and M. S. Osman. 1975. Influence of tillage method on growth of yield of corn (Zea mays L.). Libyan J. Agr. 4:47–50.
21. Sorour, F. A. and M. A. El-Sharkawy. 1976. The effect of cycocel and nitrogen level on the growth and yield of Sidi Misri 1 dwarf wheat (Triticum aestivum L.). Libyan J. Agr. 5:33–38.
22. Stibbe E., and U. Kafkafi. 1973. Influence of tillage depths and P-fertilizer application rates on the yields of annual cropped winter grown wheat. Agron. J. 65:617–620.
23. Wellings, L. W. 1968. Minimum cultivations for cereals on the experimental husbandry farms. Proc. 9th British Weed Control Conf. 9:842–848.

تأثير الحراثة والسماد النيتروجيني على الانتاج الكلي والجزئي على القمـــح

محمد صديق شودري شرف الدين محمد الشريف جاقديف سوهني

مستخلص البحث

يتلخص فى تأثير عمق احرث باستعمال معدات مختلفة لتهيئة مهد البذور وأربع معاملات تسميد نيتوجينية مختلفة على الانتاج الكلي والجزئي على قمح سيدى المصـــرى وتمت الدراسة فى حقل تجارب بطرابلس الجماهيرية العربية الليبيـــة الشعبيـــة الاشتراكيـــة ٠

قورنت نتائج عمق الحرث مع حقل آخر كان به عمق الحرث صغرى (البذر بواسطة البذارة بدون حراثة الحقل مسبقا) وظهر من نتائج المقارنة ان نسبة النباتات أعـــلى واستخراج السنابل متأخرة وعمق الجذور أكبر وتمت مقارنة المجموع الخضرى والجذور الجافة فى كلتا الحالتين بوزنهما مرة كل أربعة أسابيع وكذلك طول النبات وعـــدد السنابل للنبات الواحد وعددها فى المتر المربع وعدد ووزن الحبوب فى السنبلة الواحـدة وظهر كذلك أن الحرث العميق باستعمال محراث حفار بعمق ٥٠ سم يعطى نتائج عالية فى كل المتغيرات السابقة اذا ما قورنت بعمق الحرث ١٥ سم بواسطة العزاقة والمحراث الاسطوانى بعمق ٢٥ سم واتضح ان لا يوجد أى اختلاف فى نتائج الحرث لعمق ١٥ الى ٢٥ سم فى خلال أيام استخراج السنابل وطول النبات وعدد السنابل للنبات الواحـد وعددها فى المتر المربع ووزن وعدد الحبوب للسنبلة الواحدة ٠

أما بالنسبة للسماد النيتروجينى فقد أعطى نتائج ايجابية على جميع القطـــع المعاملـــة ٠

أما بالنسبة لتأثير كمية التسميد بمعدلات قنطار ونصف على انتاج القمح للحرث السطحى والعميق وليس على متوسط العمق وظهر انه بالنسبة للحرث الصغـــــرى يزداد وزن الجذور الجافة والمجموع الخضرى بعد سبعة عشر اسبوعا وكذلك محصول الحبوب ووزن ألف حبة واتضح ان الحرث العميق يبدو ذو أهمية مع السماد النيتروجينى حتى فى التربة الرملية لزراعة القمح فى الشريط الساحلى فى الجماهيرية ٠