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EFFECT OF SOIL TILLAGE AND WEED CONTROL ON WHEAT PRODUCTIVITY

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ABSTRACT

Two field experiments were carried out at El-Gemmeza Agric. Expt. Sta., El-Gharbia Governorate, Middle Delta, during 1997/1998 and 19981/1999 seasons to study the effect of some tillage systems including no-till (as a control), Chisel plowing (16-18 cm), moldboard plowing (18-20 cm), subsoiling + chisel plowing and subsoiling + moldboard plowing and weed control treatments (Arelon, Granstar, Grasp and unweeded check) on the growth and yield of wheat and on the spread of weeds in wheat plots. The results of the combined analysis of both seasons could be summarized as follows:

Bulk density and salinity of the soil were not significantly affected by tillage treatments in both seasons. Whereas, soil porosity % was affected by tillage treatments in the first season. The highest porosity % was recorded by subsoiling + moldboard plowing. Subsoiling + moldboard plowing significantly surpassed the 4 other systems, and Arelon was significantly superior to the other 2 herbicides in depressing weeds at 60, 90 and 120 days from sowing (DFS). The significant interaction indicated superiority of subsoiling + moldboard plowing with Arelon in depressing weed infestation. Plant height and LAI at 60 and at 120 DFS as well as dry matter accumulation at 120 DFS were significantly affected by tillage and weed control treatments as well as their interaction. The best treatment was that including subsoiling + moldboard plowing followed by moldboard plowing (alone). Arelon was the best herbicide affecting those traits. Combining Arelon with subsoiling + moldboard plowing recorded the maximum values for those traits. Subsoiling + moldboard plowing significantly surpassed the other 4 tillage systems in affecting all No. of spikes/m^2, 1000-kernel weight, No. of spikelets/spike, spike length, No. of grains/spike, spike weight, grain weight/spike and yield of straw and grain/fad. Also, Arelon was the best herbicide. Combining subsoiling + moldboard plowing with Arelon recorded the highest values for those traits.

INTRODUCTION

Recently, efforts have been made for maximizing wheat production to face the wide gap between consumption and local production.

Tillage practices and depressing weed competition are among the important factors that have good contribution in increasing wheat yield.

A good tillage system is required for wheat and was found to improve plant growth (Gomaa, 1995; Frederik and Philip, 1996 and Gajri *et al.*, 1997) and soil properties (Gomaa, 1995; Gomaa and El-Naggar, 1995a and 1995b; Eriany, 1996; Gajri *et al.*, 1997; Khadr *et al.*, 1998; Taieb, 1998 and Miller *et al.*, 1999) and consequently grain yield (Gill and Aulakh, 1990; Rizvi *et al.*, 1990; Gomaa, 1995; Frederik and Philip, 1996; Gajri *et al.*, 1997 and Mc Conkey *et al.*, 1997).

Weed competition is a major problem which lowers wheat productivity in Egypt and had also negative effects on plant growth, tillering and grain quality. In addition, costs of weed control reduce the net returns obtained.

Weed control in wheat could be achieved by tillage practices (plowing) (Buhler and Thomas, 1991; Ball, 1992; Frick and Thomas, 1992; Gomaa, 1995 and Tadesse *et al.*, 1996), hand weeding (Al-Marsafy *et al.*, 1992) and chemical control by selective herbicides (El-Mashad *et al.*, 1993; El-Magraby *et al.*, 1993; Kasem *et al.*, 1993; Kholousy, 1993; Salim and Yehia, 1993, El-Maghraby *et al.*, 1994 and Shebl, 1998). Hand weeding is not effective in controlling weeds, particularly perennial weeds, due to the close spacing of plants which prevents hoeing. In addition, hand labour may be scarce or very expensive. Consequently, tillage practices and herbicides are much cheaper and more efficient in controlling weeds, without considerable harmful effects.

The aim of the present investigation is to evaluate: the effect of five tillage systems starting with no-tillage and ending with intensive tillage including subsoiling plus moldboard plowing, in addition to three selective herbicides, namely, Arelon, Grasp and Granstar. The effects of these experimental treatments and their interaction on growth and grain yield of wheat as well as the spread of weeds were studied in two experimental seasons.

MATERIALS AND METHODS

Two field experiments were carried out at El-Gemmeza Agricultural Experimental Station, El-Gharbia Governorate, Egypt; during 1997/1998 and 1998/1999 growing seasons to study the effect of tillage and herbicidal weed control treatments on weed density, grain yield, yield components of bread wheat cultivar, Gemmeza 3 (*Triticum aestivum* L.) as well as soil properties. In both growing seasons wheat was preceded by Maize. Soil was clay with 1.5 and 1.3% organic matter content and had a pH value of 7.8 and 8.0 in 1997/1998 and 1998/1999 seasons, respectively. Each experiment included 20 treatments, which were the combination of 5 tillage systems and 4 weed control treatments as follows:

A. Tillage Systems:

1- No till (control).
2- Chisel-plow (16-18 cm).
3- Moldboard plow (18-20 cm).
4- Subsoiling + chisel plow (16-18 cm).
5- Subsoiling + moldboard plow (18-20 cm).

Disk harrow was applied following each of the above tillage treatments except for the control.

B. Weed control treatments:

1- Unweeded (control).
2- Arelon 50% (Isoproturon) {3-(4-Isopropyl pheng-1, 1 dimethyl urea), (1.25 L/fad.)}.

3- Granstar 75%, 2-{[((N-(4-methyl-6-methl-1, 3, 5-triazin-2-yl) methyl carbonyl) amino) sulfonyl] benzoate, (8 g/fad.)}.
4- Grasp 10%, 2- {[1-(ethoxyiminol propyl) 3-hydrxy-5-(2, 4, 6-trimethyl phenyl] cyclohex-2-enone., (1.25 L/fad.)}.

The herbicides were applied at 35 days after emergence for Ggrasp and 20 days for Arelon and Granstar.

The three herbicides were diluted with 200 liters of water/fad. and sprayed with Knapsack sprayer (20 liters) with the red fan type nozzle.

The design of the experiment was a strip-plot design with four replications. The strip-plots were assigned for the five tillage treatments and the sub-plots for the four weed control treatments. The treatments were distributed at random in the respective plots. The sub-plot size was 7.0x1.5 m = 10.5 m^2. Each sub-plot included 7 rows which were 7.0 m long and 20 cm apart. The recommended seed rate of 50 kg/fad. was used.

Calcium superphosphate (15.5% P_2O_5) was applied during seedbed preparation treatments at the rate of 150 kg/fad. Nitrogen fertilizer was applied in the form of Ammonium nitrate (33.5% N) at the rate of 75 kg N/fad. in 2 split applications before the first and second irrigations.

The two experiments were planted on Nov. 28 in the first season and Nov. 29 in the second season. Other normal cultural practices of growing wheat were followed.

The following characters were estimated:

I- Soil properties:

Soil samples were collected from 0-10, 10-20 and 20-30 cm depths in each main plot from the four replicates, the samples were taken at harvest, the following data were recorded:

1- Soil bulk density: It was determined by dividing the oven dry weight in grams by the volume of the soil in cubic centimeters (ASTM, 1980).
2- Soil porosity: Soil porosity or pore space percent was estimated according to ASTM (1980) using the following formula:

$$\text{Soil porosity} = \frac{P_1 - P_2}{P_1} \times 100$$

Where: P_1 is real density (g/cm^3) or particle density, expressed as grams per cubic centimeters. It is calculated according to the method outlined by Donahue (1958).
3- Soil salinity: Soil salinity was determined as electrical conductivity (EC) mmhos/cm at 25°C by Jackson (1958 and 1967).

II- Weed population:

1- Weed number/m^2: It was counted at 60, 90 and 120 days after sowing.
2- Fresh and dry weight of weeds (g/m^2): Weeds were hand pulled from a random square meter per sub plot at 60, 90 and 120 days after sowing. Fresh weight was estimated and weed samples were dried to a constant weight in a forced air-oven at 70°C to determine dry weed weight.

III- Growth character:

1- Dry matter accumulation: Samples were taken randomly from 0.05 m^2 at 60 and 120 days after sowing. Samples were dried to a constant weight in a forced air-oven at 70°C and dry weight was recorded.
2- Leaf area index (LAI) was measured according to the method proposed by Gomez (1972).
3- Plant height (cm) was determined from 10-plant randomly selected samples at 60, 120 days after sowing and at harvest.

IV- Yield and its components:

At harvest time, number of spikes per square meter; weight of 1000 grains (g), number of spikelets per spike, spike length (cm), number of grains per spike, weight of spike (g), grain weight per spike (g) and grain (in kg/fad.) and straw yield (in tons/fad.) were recorded. Spike characters were recorded as an average of 10 randomly selected spikes, while grain and straw yields were estimated on the whole plot basis.

All the collected data were subjected to statistical analysis as described by Snedecor and Cochran (1967). Mean values were compared by using Duncan's Multiple Range test (1955).

RESULTS AND DISCUSSION

I. Effect of tillage treatments on soil properties at harvest:

1- Bulk density:

Data presented in Table (1) showed that tillage treatments did not significantly affect soil bulk density in both seasons.

Soil depth significantly affected bulk density in both seasons. The increase in soil depth from 0-10 to 10-20 and 20-30 cm significantly increased soil bulk density by 5.30 and 10.61% in the first season, respectively, corresponding to 7.14 and 16.67% in the second season.

The lowest bulk density in the first season, was 1.26 g/cm^3 as recorded with subsoiling + moldboard plowing (18-20 cm) at 0-10 cm depth. In the second season, the lowest value was 1.23 g/cm^3 which was recorded by chisel plowing as well as subsoiling + moldboard plowing at 0-10 cm depth. Similar results were also reported by Khadr *et al.* (1998) and Taieb (1998).

2- Soil porosity:

The results in Table (1) indicated that tillage treatments significantly affected porosity % in the first season where subsoiling + moldboard plowing recorded the highest porosity (49.3%) which surpassed the other 4 tillage systems, but one significant difference when compared with the check treatment (no-till).

In the second season, also the most intensive soil tillage recorded the highest porosity %, being 49.6% but without any significant differences when compared with the 4 other tillage treatments. Porosity % significantly and consistently reduced with the increase in soil depth.

Table (1): Effect of tillage practices for wheat growing on the physical soil properties at different soil depths at harvest.

Tillage treatments	Bulk density (g/m^3)				Soil porosity (%)				EC (mmhos/cm)			
	Soil depth											
	0-10	10-20	20-30	Mean	0-10	10-20	20-30	Mean	0-10	10-20	20-30	Mean
	1997/1998 season											
No-till	1.34^{ce}	1.42^{ad}	1.40^{ad}	1.39	48.3^{a}	46.4^{ab}	43.1^{ab}	45.9^{b}	2.36	2.06	1.99	2.14
Chisel plow (16-18 cm)	1.33^{ce}	1.41^{ad}	1.50^{a}	1.41	49.6^{a}	46.7^{a}	43.4^{ab}	46.6^{ab}	2.00	1.87	1.89	1.92
Moldboard plow (18-20 cm)	1.34^{ce}	1.38^{bd}	1.50^{a}	1.41	49.4^{a}	47.9^{a}	43.4^{ab}	46.9^{ab}	2.25	1.84	1.61	1.90
Subsoiling + chisel plow	1.35^{ce}	1.42^{ad}	1.46^{ab}	1.41	49.0^{a}	46.4^{a}	44.9^{ab}	46.8^{ab}	1.79	1.74	1.70	1.74
Subsoiling + moldborad plow	1.26^{e}	1.32^{de}	1.44^{ac}	1.34	52.3^{a}	50.2^{a}	45.6^{ab}	49.3^{a}	1.69	1.55	1.55	1.60
Mean	1.32^{c}	1.39^{b}	1.46^{a}		49.7^{a}	47.5^{a}	44.1^{c}		2.02	1.81	1.75	
	1998/1999 season											
No-till	1.26^{gh}	1.39^{bf}	1.51^{a}	1.39	52.4^{ab}	49.4^{ad}	43.0^{f}	48.3	1.41	1.40	1.14	1.32
Chisel plow (16-18 cm)	1.23^{h}	1.32^{eh}	1.46^{ac}	1.34	53.5^{a}	50.1^{ac}	44.9^{df}	49.5	1.25	1.40	1.03	1.14
Moldboard plow (18-20 cm)	1.25^{gh}	1.31^{fh}	1.45^{ad}	1.34	52.8^{ab}	50.5^{ac}	45.2^{df}	49.5	1.15	1.40	1.06	1.12
Subsoiling + chisel plow	1.31^{fh}	1.37^{cf}	1.49^{ab}	1.39	50.5^{ac}	48.3^{be}	43.7^{ef}	47.5	1.06	1.20	1.04	1.10
Subsoiling + moldborad plow	1.23^{h}	1.35^{dg}	1.42^{ae}	1.33	53.5^{a}	49.0^{ad}	46.4^{cl}	49.6	1.08	1.05	1.05	1.06
Mean	1.26^{c}	1.35^{b}	1.47^{a}		52.6^{a}	49.5^{b}	44.6^{c}		1.19	1.19	1.06	

The greatest porosity % was observed in the first season with subsoiling + moldboard plowing at 0-10 cm soil depth, being 52.3%. Also, in the second season the same formentioned treatment as well as chisel plowing at 0-10 cm depth recorded the maximum porosity %, being 53.5%.

Similar results were also reported by El-Tohamy (1963), El-Gohary (1978), Gomaa and El-Naggar (1995a) and Miller *et al.* (1999).

3- Soil Salinity:

The results in Table (1) showed that soil salinity (EC) was not significantly affected by either tillage treatments or soil depths in both seasons.

The present results are not in agreement with those reported by Shafshak *et al.* (1996) who found that seedbed preparation treatments, soil depth and their interaction significantly affected soil salinity at harvest.

II- Effect of tillage treatments and methods of weed control on spread of weeds in wheat:

Weed survey at the three sampling dates during the two seasons of experimentation showed that weed species dominating were found in the following descending order: *Polypogon monspeliensis, Ammi majus, Torilis neglecta, Beta vulgaris, Medioago polymorpha, Sphaeranthus suaveolens, Oxalis corniculata, Convolvulus arvensis* and *Chenopoduium album.*

1- Tillage effects:

Results in Table (2) showed that tillage practices significantly affected weed population at 60, 90 and 120 days from sowing (DFS) in the first season and the combined average of both seasons as well as in both surveys (at 60 and 90 DFS) in the second season.

The greatest reduction in weeds number was achieved by subsoiling + moldboard plowing followed by moldboard plowing then subsoiling + chisel plowing.

The results in Table (2) show also that tillage treatments had a significant effect on fresh and dry weights of total weeds in both surveys (at 60, 90 and 120 DFS) except fresh weight of total weeds at 60 days in the first season.

Moldboard plowing, particularly when it was preceded by subsoiling was the best treatment and the worst one was the check treatment (no-till), and the rest three treatments were inbetween. The results showed about the same trend in both seasons and their combined average. It could be concluded that the intensive tillage treatment including subsoiling + moldboard plowing for wheat is a good procedure contributing in the reduction of weed density. Similar results were also reached by Gomaa (1995), Arshad *et al.* (1998) and Spandl *et al.* (1998).

2- Weed control effect:

The effect of weed control treatments on weeds number/m^2 in all surveys (at 60, 90 and 120 DFS) was significant in both seasons as well as in the combined average, Table (2). Nevertheless, Arelon significantly

surpassed the two other herbicides, in depressing weed population. Also, Grasp and Granstar were significantly superior to the check treatment in reducing weed population. The trend of the results is about the same in both seasons, and the combined average.

The results also revealed that weed control treatment significantly affected both fresh and dry weights of weeds in all surveys (at 60, 90 and 120 DFS) in both seasons as well as their combined average. The differences among the four weed control treatments were significant. Arelon was the more effective herbicide followed by Grasp and Granstar. The trend of the results was nearly similar in both seasons and their average. It could be concluded that Arelon was the most effective herbicide in reducing the spread of weeds. Similar results for the effect of herbicides in reducing weed flora in wheat fields were also reported by El-Mashed *et al.* (1993), El-Maghraby *et al.* (1994) and Shebl (1998).

Table (2): Wheat weeds total No. m^2, fresh and dry weight (g/m^2) for different treatments.

Treatments	At 60 days from sowing			At 90 days from sowing			At 120 days from sowing		
	No. m^2	Fresh wt. (g/m^2)	Dry wt. (g/m^2)	No. m^2	Fresh wt. (g/m^2)	Dry wt. (g/m^2)	No. m^2	Fresh wt. (g/m^2)	Dry wt. (g/m^2)
Tillage treatments:	**1997/1998 season**								
No-till	20.75^a	44.72	5.63^a	23.25^a	135.57^a	21.98^a	18.81^a	94.40^a	20.50^a
Chisel plow (16-18 cm)	20.06^a	44.53	5.41^{ab}	22.06^b	127.13^b	20.92^b	14.99^b	89.86^b	17.68^b
Moldboard plow (18-20 cm)	14.38^c	42.53	4.98^b	20.50^c	111.55^d	19.59^c	12.44^c	85.93^c	17.04^b
Subsoiling + chisel plow	16.88^b	43.75	5.03^{ab}	21.00^c	121.69^c	21.03^{ab}	14.06^b	89.27^b	17.24^b
Subsoiling + moldboard plow	12.19^d	41.10	4.80^b	12.63^d	106.29^e	18.56^d	10.25^d	81.53^d	16.48^b
Herbicides treatments:									
Control	27.05^a	59.83^a	6.87^a	26.35^a	147.68^a	25.34^a	18.80^a	102.97^a	22.40^a
Grasp	12.05^c	36.38^c	4.71^c	18.30^c	107.15^c	19.12^c	13.35^c	85.11^c	16.05^c
Granstar	19.55^b	49.38^b	5.54^b	21.00^b	129.74^b	21.78^b	15.35^b	91.95^b	19.78^b
Arelon	8.75^d	27.81^d	3.57^d	13.90^d	97.22^d	15.41^d	8.30^d	72.76^d	12.92^d
Tillage treatments:	**1998/1999 season**								
No-till	14.38^a	19.95^a	2.70^a	7.19^a	66.74^a	7.79^a	5.25	71.40^a	21.39^a
Chisel plow (16-18 cm)	13.00^a	19.34^a	2.31^b	6.88^{ab}	62.33^b	6.23^b	5.00	56.35^b	17.12^b
Moldboard plow (18-20 cm)	10.19^b	15.96^b	2.20^{bc}	6.63^{ab}	64.67^a	4.59^d	4.75	49.06^c	13.99^{bc}
Subsoiling + chisel plow	10.94^b	19.26^a	2.27^b	6.06^b	48.35^c	5.47^c	4.88	54.65^b	15.57^{bc}
Subsoiling + moldboard plow	7.56^c	15.30^b	1.99^c	5.06^c	43.71^d	3.95^e	4.63	42.17^d	12.64^c
Herbicides treatments:									
Control	15.90^a	23.87^a	2.96^a	7.55^a	73.38^a	9.59^a	6.20^a	72.90^a	24.39^a
Grasp	10.30^c	16.03^c	2.08^c	5.80^b	52.89^c	4.48^c	4.50^b	49.39^c	13.38^c
Granstar	12.35^b	19.51^b	2.56^b	6.85^a	61.64^b	5.58^b	5.30^b	55.13^b	16.81^b
Arelon	6.30^d	12.43^d	1.57^d	5.25^b	40.72^c	2.76^d	3.60^c	41.48^d	9.99^d
Tillage treatments:	**Combined**								
No-till	17.57^a	32.33^a	4.16^a	15.22^a	101.16^a	14.88^a	12.03^a	82.90^a	20.94^a
Chisel plow (16-18 cm)	16.53^a	31.94^{ab}	3.76^b	14.47^b	94.73^b	13.58^b	9.97^b	73.10^b	17.40^b
Moldboard plow (18-20 cm)	12.28^c	29.24^{bc}	3.59^b	13.57^c	88.11^c	12.09^c	8.60^c	67.49^c	15.50^{bc}
Subsoiling + chisel plow	13.91^b	30.25^{bc}	3.65^b	13.53^c	85.02^d	13.26^b	9.47^b	71.96^b	16.40^{bc}
Subsoiling + moldboard plow	9.88^d	28.20^c	3.40^b	8.85^d	74.99^e	11.25^d	7.06^d	61.84^d	14.56^c
Herbicides treatments:									
Control	21.48^a	41.85^a	4.91^a	16.95^a	110.53^a	17.47^a	15.63^a	87.93^a	23.40^a
Grasp	11.18^c	26.15^c	3.40^c	12.05^c	80.02^c	11.80^c	8.93^c	67.25^c	14.71^c
Granstar	15.95^b	34.44^b	4.05^b	13.93^b	95.69^b	13.68^b	10.33^b	73.54^b	18.29^b
Arelon	7.53^d	19.12^d	2.57^d	9.58^d	68.97^d	9.08^d	5.95^d	57.11^d	11.44^d

III- Effect of tillage treatments and methods of weed control on growth characters of wheat:

1- Tillage effect:

The results showed that tillage practices significantly affected plant height at 60 and 120 days from sowing (DFS) in both seasons as well as in the combined analysis at previous growth stages, (Table, 3). The tallest plants were obtained by subsoiling plus moldboard plowing which were almost significantly taller than those plants produced by the 4 other tillage treatments. Also, the shortest plants were those of the no-till treatment. The trend of the results is about the same in both seasons, and the combined average. Similar results were also obtained by Marwat *et al.* (1989).

Table (4): Grain yield and its components of wheat for different treatments.

Treatments	No. of spikes/ m^2	Length of spike (cm)	No. of spikelets/ spike	No. of grains/ spike	Weight of 1000 grains (g)	Weight of spike (g)	Grain weight/ spike (g)	Grain yield (kg/fad.)	Straw yield (ton/fad.)
	1997/1998 season								
Tillage treatments:									
No-till	474.56^{c}	9.97^{b}	17.71	37.91^{b}	60.70^{b}	3.16^{b}	2.38	2080^{c}	4.08^{b}
Chisel plow (16-18 cm)	476.75^{c}	10.42^{ab}	18.15	38.86^{ab}	61.57^{ab}	3.19^{b}	2.42	2220^{bc}	4.16^{b}
Moldboard plow (18-20 cm)	520.75^{a}	10.96^{a}	17.94	40.05^{a}	64.20^{a}	3.34^{a}	2.48	2360^{b}	4.41^{ab}
Subsoiling + chisel plow	505.63^{b}	10.73^{ab}	18.13	36.90^{b}	63.57^{ab}	3.31^{ab}	2.43	2230^{bc}	4.25^{b}
Subsoiling + moldboard plow	527.63^{a}	10.98^{a}	18.48	40.48^{a}	64.95^{a}	3.48^{a}	2.53	3040^{a}	4.80^{a}
Herbicides treatments:									
Control	446.80^{d}	9.88^{b}	17.41	33.50^{d}	57.91^{c}	2.66^{c}	1.94^{c}	1920^{c}	4.06^{b}
Grasp	514.45^{b}	10.94^{a}	18.69	40.90^{b}	64.35^{b}	3.38^{b}	2.56^{b}	2640^{a}	4.45^{ab}
Granstar	481.00^{c}	10.39^{ab}	17.53	36.57^{c}	60.75^{bc}	3.23^{bc}	2.38^{b}	2360^{b}	4.14^{b}
Arelon	562.00^{a}	11.23^{a}	18.71	44.38^{a}	68.97^{a}	3.91^{a}	2.91^{a}	2620^{a}	4.71^{a}
	1998/1999 season								
Tillage treatments:									
No-till	441.63^{c}	10.57	20.52^{b}	50.95^{c}	54.69	3.82^{c}	2.64^{b}	2280^{b}	4.28^{c}
Chisel plow (16-18 cm)	460.13^{bc}	10.89	21.18^{ab}	54.37^{b}	56.22	4.11^{b}	2.83^{b}	2250^{b}	4.30^{c}
Moldboard plow (18-20 cm)	472.13^{ab}	11.16	21.57^{ab}	58.51^{ab}	58.75	4.38^{a}	3.10^{a}	2430^{ab}	4.85^{b}
Subsoiling + chisel plow	467.75^{b}	11.03	21.52^{ab}	55.83^{b}	56.67	4.38^{a}	3.08^{a}	2420^{ab}	4.83^{b}
Subsoiling + moldboard plow	585.25^{a}	11.45	22.23^{a}	59.89^{a}	59.33	4.58^{a}	3.23^{a}	2670^{a}	5.93^{a}
Herbicides 'reatments:									
Control	435.90^{c}	10.71	20.70	51.27^{b}	53.81^{b}	4.00^{b}	2.73^{b}	1990^{b}	4.26^{b}
Grasp	502.20^{ab}	11.07	21.69	57.52^{a}	58.29^{a}	4.34^{a}	3.11^{a}	2670^{a}	4.97^{a}
Granstar	479.50^{b}	10.82	21.06	56.35^{a}	56.92^{ab}	4.26^{ab}	2.90^{b}	2420^{a}	4.85^{a}
Arelon	523.90^{a}	11.47	22.14	58.49^{a}	59.50^{a}	4.40^{a}	3.16^{a}	2570^{a}	5.26^{a}
	Combined								
Tillage treatments:									
No-till	458.10^{c}	10.27^{b}	19.11^{b}	44.43^{c}	57.69^{b}	3.49^{d}	2.51^{b}	2180^{c}	4.18^{c}
Chisel plow (16-18 cm)	468.44^{c}	10.65^{ab}	19.66^{ab}	46.62^{b}	58.89^{b}	3.65^{c}	2.62^{b}	2230^{bc}	4.23^{c}
Moldboard plow (18-20 cm)	496.44^{b}	11.06^{a}	19.76^{ab}	49.28^{a}	61.47^{a}	3.86^{b}	2.79^{a}	2390^{b}	4.63^{b}
Subsoiling + chisel plow	486.69^{b}	10.88^{a}	19.83^{ab}	46.37^{bc}	60.11^{ab}	3.84^{b}	2.76^{a}	2330^{bc}	4.54^{cb}
Subsoiling + moldboard plow	556.44^{a}	11.22^{a}	20.35^{a}	50.18^{a}	62.14^{a}	4.03^{a}	2.87^{a}	2860^{a}	5.36^{a}
Herbicides treatments:									
Control	441.55^{d}	10.30^{b}	19.06^{b}	42.39^{d}	55.86^{c}	3.33^{c}	2.34^{d}	1950^{c}	4.16^{c}
Grasp	508.33^{b}	11.01^{ab}	20.19^{a}	49.21^{b}	61.32^{b}	3.86^{b}	2.83^{b}	2650^{a}	4.71^{ab}
Granstar	480.05^{c}	10.61^{ab}	19.29^{b}	46.46^{c}	58.83^{b}	3.74^{b}	2.64^{c}	2390^{b}	4.49^{b}
Arelon	542.95^{a}	11.35^{a}	20.26^{a}	51.44^{a}	64.23^{a}	4.16^{a}	3.03^{a}	2590^{a}	4.99^{a}

It is worth mentioning here that plant height at harvest showed no apparent response to tillage treatment under the conditions of the present investigation.

The results in Table (3) indicated that dry matter accumulation (g/0.05 m^2) was significantly affected by tillage practices at 60 and 120 DFS in the second season only, whereas in the first season as well as in the two seasons average, significant effect was detected only at 120 DFS. The best treatment in enhancing dry matter accumulation was subsoiling + moldboard plowing which significantly surpassed all other treatments except moldboard plowing treatment, also the no-till treatment was inferior to all treatments. The results were identical in both seasons as well as in the combined average.

The present results are in agreement with those reported by Arshad *et al.* (1994), Arshad and Gill (1997) and Gajri *et al.* (1997).

It could be concluded that an intensive tillage system including subsoiling and moldboard plowing was effective in increasing dry matter accumulation of wheat plants, probably due to a deeper penetration of the root system through the soil and more nutrient and water absorption.

The results also revealed that tillage treatments significantly affected LAI at 60 and 120 DFS in the two experimental seasons as well as in the combined analysis, Table (3). The intensive treatment including subsoiling + moldborad plowing was the best treatment and markedly surpassed the 4 other treatments.

The results indicated a similar trend for the effect of tillage treatments on LAI of wheat in both seasons as well as in the combined average.

It could be concluded that LAI of wheat was favourably affected by subsoiling + moldboard plowing as a result of higher dry matter accumulation.

The effect of tillage methods on LAI was also found by Gajri *et al.* (1992) and Arshed and Gill (1997).

2- Weed control effect:

Concerning the effect of herbicides on plant height, the results in Table (3) indicated a significant effect for herbicides at all stages of wheat growth in the first season only, whereas in the second one as well as in the combined average, significant effect was observed at 60 and 120 DFS.

The superiorty of arelon application was evident in both seasons and the combined average on plant height, followed by Grasp then Granstar. However the three herbicides induced significant increases in plant height over the unweeded check. Similar results were also reported by Mady (1996) and Shebl (1998). Also, Shebl (1998) found that Arelon application was more effective on wheat plant height at 60 and 90 DFS compared with hand weeding.

The results in Table (3) show also that weed control treatments had a significant effect on dry matter accumulation (g/0.05 m^2) at 60 and 120DFS in the second season only, whereas significant effect was detected in the first season as well as in the combined analysis of both seasons only at 120 DFS.

Arelon application recorded the highest dry matter accumulation which significantly surpassed that recorded by Grasp, Granstar and the unweeded check. Also, Grasp and Granstar application were significantly

superior to the unweeded check. The results were identical in both seasons as well as in the combined average. Similar results were also reported by Assey *et al.* (1983a and 1983b) and Moyer *et al.* (1992).

The results presented in Table (3) showed also that herbicides application significantly increased LAI at 60 and at 120 DFS in both seasons as well as in the combined average. Arelon application was the best weed control treatment and induced significant increases in LAI at 60 and 120 DFS over the unweeded check as well as the two other herbicides. The two other herbicides, i.e. Grasp and Granstar were effective in increasing LAI over the check treatment in both seasons and the combined average but no significant differences were detected between them, indicating a similar efficiency. Similar results were also reported by Mayer *et al.* (1992); Zaher (1996) and Shebl (1998).

It could be concluded that the three herbicides, in general and Arelon, in particular showed pronounced effect in increasing plant height, LAI and dry matter accumulation in wheat plants as a result of reduction in weed spread and competition for nutrients, water and light.

IV- Yield and its components:

1- Tillage effects:

Data in Table (4) revealed that tillage systems significantly affected all studied traits of wheat in both seasons and their combined average except no. of spikletes and grain weight per spike in the first season and length of spike and weight of 1000 grains in the second season. Subsoiling + moldboard polwing and moldboard plowing (alone) were the best treatments followed by subsoiling + chisel plowing, then chisel plowing (alone) and the worst treatment was the check (no-till). The results showed a similar trend for the effect of tillage treatments in both seasons as well as their combined average.

Data in Table (4) showed also the best treatment that favourably affected grain yield of wheat was subsoiling + moldboard plowing which outyielded significantly no-till, chisel plowing, moldboard plowing and subsoiling + chisel plowing by 46.15, 36.94, 28.81 and 36.32%, respectively in the first season, corresponding to 17.11, 18.67, 9.88 and 10.33%, respectively in the second season, and 31.19, 28.25, 19.67 and 22.75%, respectively in the combined average.

It could be concluded that moldboard plowing, in general, and when it followed subsoiling, in particular, positively affected all growth characters as well as yield components (Tables, 3 & 4). This treatments improved the physical soil properties such as soil bulk density and soil porosity (Table, 1) which in turn improved soil aeration and drainage. The improved soil characters contributed markedly in enhancing growth characters of wheat plants (Table, 3). Also the intensive soil tillage helps in reducing weed density in wheat fields (Table, 2). The present results are in harmony with those obtained by Gomaa (1995), Belliedo *et al.* (1996), Gajri *et al.* (1997) and Bordovsky *et al.* (1998).

2- Weed control effect:

The results in Table (4) indicated a significant effect of the three applied herbicides, in general, and Arelon, in particular on all studied traits of wheat in both seasons as well as their combined average, except length of spike in the second season and no. of spikelets/spike in both seasons.

Table (3): Growth characters of wheat for different treatments.

Treatments	Plant height (cm)			Dry matter accumulation (g/0.05 m^2)		L.A.I.	
	At 60 days	At 120 days	At harvest	At 60 days	At 120 days	At 60 days	At 120 days
	1997/1998 season						
Tillage treatments:							
No-till	25.14^{c}	95.32^{d}	104.27	14.41	74.49^{b}	5.02^{ab}	5.86^{c}
Chisel plow (16-18 cm)	26.82^{b}	96.07^{cd}	104.47	15.53	76.42^{b}	4.78^{b}	6.09^{bc}
Moldboard plow (18-20 cm)	28.78^{a}	98.17^{b}	106.35	16.62	80.36^{a}	5.06^{ab}	6.60^{b}
Subsoiling + chisel plow	26.80^{b}	97.12^{bc}	104.67	16.13	76.34^{b}	4.75^{b}	6.30^{bc}
Subsoiling + moldboard plow	28.96^{a}	100.61^{a}	106.98	16.95	85.13^{a}	5.30^{a}	7.78^{a}
Herbicides treatments:							
Control	23.75^{c}	91.68^{d}	102.23^{b}	11.91	68.28^{c}	4.93^{ab}	5.70^{c}
Grasp	28.30^{b}	99.60^{b}	106.57^{ab}	16.62	75.55^{b}	5.03^{ab}	6.32^{b}
Granstar	27.13^{b}	97.61^{c}	105.16^{b}	15.59	78.73^{b}	4.73^{b}	6.48^{b}
Arelon	30.01^{a}	100.92^{a}	107.43^{a}	19.57	91.62^{a}	5.23^{a}	7.61^{a}
	1998/1999 season						
Tillage treatments:							
No-till	18.34^{b}	80.77^{c}	97.27	16.92^{c}	79.10^{b}	4.11^{b}	4.79^{b}
Chisel plow (16-18 cm)	18.67^{b}	84.20^{b}	98.18	17.01^{bc}	79.83^{b}	3.98^{bc}	6.64^{a}
Moldboard plow (18-20 cm)	18.98^{b}	88.99^{a}	98.71	17.88^{ab}	82.61^{a}	4.19^{b}	6.77^{a}
Subsoiling + chisel plow	18.82^{b}	84.57^{b}	98.64	17.47^{bc}	80.45^{ab}	3.84^{c}	6.71^{a}
Subsoiling + moldboard plow	20.79^{a}	89.57^{a}	98.81	18.75^{a}	84.23^{a}	4.74^{a}	7.05^{a}
Herbicides treatments:							
Control	16.87^{c}	79.71^{c}	96.94	16.18^{c}	73.08^{b}	3.67^{c}	5.55^{c}
Grasp	19.81^{ab}	87.41^{ab}	98.87	17.63^{b}	82.45^{a}	3.93^{bc}	6.40^{b}
Granstar	19.02^{b}	84.79^{b}	98.16	17.22^{b}	82.78^{a}	4.21^{b}	6.36^{b}
Arelon	20.68^{a}	90.56^{a}	99.30	19.41^{a}	86.66^{a}	4.87^{a}	7.25^{a}
	Combined						
Tillage treatments:							
No-till	21.74^{d}	88.04^{d}	100.77	15.67	76.79^{c}	4.56^{b}	5.32^{c}
Chisel plow (16-18 cm)	22.75^{c}	90.14^{c}	101.33	16.27	78.12^{bc}	4.38^{bc}	6.37^{b}
Moldboard plow (18-20 cm)	23.85^{b}	93.58^{b}	102.53	17.25	81.48^{ab}	4.62^{b}	6.68^{b}
Subsoiling + chisel plow	22.81^{c}	90.84^{c}	101.66	16.80	78.39^{bc}	4.29^{c}	6.50^{b}
Subsoiling + moldboard plow	24.88^{a}	95.09^{a}	102.98	17.85	84.68^{a}	5.02^{a}	7.41^{a}
Herbicides treatments:							
Control	20.31^{d}	85.70^{c}	99.59	14.08	70.68^{c}	4.30^{b}	5.62^{c}
Grasp	24.06^{b}	93.51^{a}	102.72	17.13	79.00^{b}	4.48^{b}	6.36^{b}
Granstar	23.07^{c}	91.20^{b}	101.66	16.40	80.76^{b}	4.47^{b}	6.42^{b}
Arelon	25.53^{a}	95.74^{a}	103.37	19.49	89.14^{a}	5.05^{a}	7.43^{a}

Results in Table (4) indicated also a significant effect of the three applied herbicides on grain yield. Grasp and Arelon were of equal efficiency in their effects on grain yield and surpassed the efficiency of Granstar in the first season and the combined average. The results revealed that Grasp, Arelon and Granstar significantly outyielded the unweeded check by 37.50, 36.46 and 22.92%, respectively in the first season, corresponding to 34.17, 29.15 and 21.61%, respectively in the second season. The same trend was also evident in the combined average where Grasp, Arelon and Granstar significantly increased grain yield by 35.90, 32.82 and 24.10%, respectively.

It could be concluded that herbicides, in general and Arelon as well as Grasp in particular, produced marked grain yield increases due to their positive effects on growth and yield component characters. Also, the reduction of weed competion due to the use of herbicides contributes much in the increase in grain yield. Similar results were reported by El-Mashad *et al.* (1993), El-Wekil *et al.* (1993), Soroka *et al.* (1995), Mady (1996), Yenish *et al.* (1997) and Sheble (1998).

V- Interaction effect:

1- Weed growth:

The interaction between tillage and herbicide treatments significantly affected total number, fresh and dry weight of weeds/m^2 in all surveys (at 60, 90 and 120 DFS) in both seasons and their average as shown in Table (5).

The combined analysis of the two seasons indicated that the most efficient weed reduction was achieved by Arelon application when combined with (subsoiling + moldboard plowing), followed by either when combined with (subsoiling + chisel plowing) or chisel plowing (alone). It is worth noting that the results are nearly similar in their trend in both seasons (Table, 5).

2- Yield and its components:

Table (6) shows summary of the interaction effects of the two experimental factors on wheat growth, grain yield and its components. The results showed that this interaction significantly affected all studied traits of wheat in both seasons and their combined average, except dry matter accumulation of wheat at 60 DFS in the first season as well as length of spike and grain weight per spike in the second season.

In general, the best combination that recorded the highest response value was that including Arelon, either when combined with (subsoiling + moldboard plowing), or moldboard plowing (alone) as shown in the two seasons average (Table, 6).

It could be concluded that Arelon was the best effective herbicide with all seedbed preparation treatments, in general and (subsoiling + moldboard plowing), in particular.

Table (5): Summary of significant interaction effects between the two experimental factors (tillage systems and herbicides) on total No. m^2, fresh and dry weight (g/m^2) of weeds in wheat showing the lowest values recorded and involved combinations.

Characters	1997/1998 season		1998/1999 season		Combined	
	Lowest value	Combination of treatments	Lowest value	Combination of treatments	Lowest value	Combination of treatments
At 60 days from sowing:						
No./m^2	3.00	SP + MP x Arelon	4.50	SP + CP x Arelon	4.38	SP + MP x Arelon
Fresh weight (g/m^2)	20.25	CP x Arelon	10.37	SP + MP x Arelon	14.44	SP + CP x Arelon
Dry weight (g/m^2)	2.22	SP + MP x Arelon	0.84	CP x Arelon	2.05	SP + MP x Arelon
At 90 days from sowing:						
No./m^2	9.00	SP + MP x Arelon	4.00	SP + CP x Arelon	7.00	SP + MP x Arelon
Fresh weight (g/m^2)	81.55	SP + MP x Arelon	25.41	CP x Arelon	54.12	SP + MP x Arelon
Dry weight (g/m^2)	12.86	CP x Arelon	1.94	SP + CP x Arelon	8.06	SP + MP x Arelon
At 120 days from sowing:				SP + CP x Arelon		CP x Arelon
No./m^2	5.00	CP x Arelon	3.00	SP + MP x Arelon	4.50	SP + MP x Arelon
Fresh weight (g/m^2)	62.45	No-till	29.40	SP + MP x Arelon	52.06	SP + MP x Arelon
Dry weight (g/m^2)	9.92	SP + MP x Arelon	6.92	MP x Arelon	9.21	SP + MP x Arelon

SP = Subsoil plow CP = Chisel plow (16-18 cm) MP = Moldboard plow (18-20 cm)

Table (6): Summary of significant interaction effects between the two experimental factors (tillage systems and herbicides) on the character studied, showing the highest values recorded and involved combinations.

Characters	1997/1998 season		1998/1999 season		Combined	
	Highest value	Combination of treatments	Highest value	Combination of treatments	Highest value	Combination of treatments
Plant height (cm) at 60 DFS	32.51	SP + MP x Grasp	22.48	SP + MP x Arelon	26.92	SP + MP x Grasp
Plant height (cm) at 120 DFS	104.46	SP + MP x Arelon	94.08	SP + CP x Arelon	98.41	SP + MP x Arelon
DMA ($g/0.05\ m^2$) at 60 DFS	-	----------	21.80	SP + CP x Arelon	21.73	SP + MP x Arelon
DMA ($g/0.05\ m^2$) at 120 DFS	101.36	SP + MP x Arelon	93.33	SP + CP x Arelon	95.78	SP + MP x Arelon
LAI at 60 DFS	6.67	MP x Arelon	6.36	SP + MP x Arelon	5.89	MP x Arelon
LAI at 120 DFS	8.21	MP x Arelon	8.46	SP + CP x Arelon	7.93	MP x Arelon
No. of spikes/m^2	579.25	SP + MP x Arelon	634.00	SP + MP x Arelon	606.63	SP + MP x Arelon
Length of spike (cm)	12.03	SP + MP x Arelon	--	----------	11.84	SP + MP x Arelon
No. of spikelets/spike	19.50	SP + MP x Arelon	22.73	SP + MP x Arelon	21.12	SP + MP x Arelon
No. of grains/spike	46.14	CP x Arelon	61.49	MP x Arelon	53.15	MP x Arelon
Weight of 1000 grains (g)	72.11	SP + MP x Arelon	61.20	MP x Arelon	66.19	SP + MP x Arelon
Weight of spike (g)	4.18	SP + CP x Arelon	4.81	SP + MP x Arelon	4.40	SP + MP x Arelon
Grain weight/spike (g)	2.95	SP + CP x Arelon	--	----------	3.14	MP x Arelon
Grain yield (kg/fad.)	3300	SP + MP x Arelon	3010.00	SP + MP x Arelon	3160.00	SP + MP x Arelon
Straw yield (ton/fad.)	5.18	SP + MP x Arelon	6.72	SP + MP x Arelon	5.95	SP + MP x Arelon

SP = Subsoil plow CP = Chisel plow (16-18 cm) MP = Moldboard plow (18-20 cm)

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تأثير عمليات الخدمة ومقاومة الحشائش على إنتاجية القمح

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**** محطة البحوث الزراعية - الجميزة**

أقيمت تجربتان حقليتان فى محطة البحوث الزراعية "بالجميزة" بمحافظة الغربية (وسط الدلتا) خلال الموسمين الزراعيين ١٩٩٨/٩٧، ١٩٩٩/٩٨م لدراسة تأثير بعض عمليات إعداد الأرض للزراعة والمبيدات العشبية على نمو ومحصول قمح الخبز ودرجة انتشار الحشائش المصاحبة. اشتملت كل تجربة على ٢٠ معاملة عبارة عن التوافق بين خمسة معاملات حرث مختلفة (بدون خدمة - الحرث بالمحراث الحفار (لعمق ١٦-١٨سم) الحرث بالمحراث القلاب (لعمق ١٨-٢٠سم) - حرث تحت التربة + الحرث بالمحراث الحفار - حرث تحت التربة + الحرث بالمحراث القلاب). وأربعة معاملات لمقاومة الحشائش (أريلون ٥٠% بمعدل ١,٢٥ لتر/ف - جرانستار ٧٥% بمعدل ٨ جم/ف - جراسب (١٠%) بمعدل ١,٢٥ لتر/ف - معاملة مقارنة).

وفيما يلى أهم النتائج:

١- لم تكن لمعاملات خدمة التربة تأثير معنوى على الكثافة الظاهرية ومستوى الملوحة للأرض.

٢- تأثرت النسبة المئوية لمسامية التربة بمعاملات الخدمة فى الموسم الأول فقط حيث سجلت معاملة الحرث تحت التربة + الحرث بالمحراث القلاب أعلى قيمة للمسامية.

٣- تفوقت معاملة حرث تحت التربة + الحرث بالمحراث القلاب معنويا على الطرق الأربعة الأخرى كما تفوق مبيد الأريلون معنويا على المبيدين الآخرين فى تأثيره الفعال لمقاومة الحشائش عند أعمار ٦٠، ٩٠، ١٢٠ يوما من الزراعة. وأوضح التفاعل المعنوى بين عاملى التجربة أن استخدام معاملة حرث تحت التربة + الحرث بالقلاب مع مبيد الأريلون أدى إلى تحقيق أفضل النتائج حيث أدت تلك المعاملة إلى خفض انتشار الحشائش.

٤- استجاب كل من طول النبات وصفة دليل مساحة الأوراق عند أعمار ٦٠، ١٢٠، يوما من الزراعة وكذلك تراكم المادة الجافة لنبات القمح عند عمر ١٢٠ يوما من الزراعة معنويا لطرق خدمة التربة ومعاملات مقاومة الحشائش والتفاعل بينها. وكانت أفضل معاملات إعداد الأرض تلك التى تضمنت حرث تحت التربة + الحرث بالمحراث القلاب تليها معاملة الحرث بالقلاب فقط وكان مبيد الأريلون أفضل المبيدات تأثيرا فى حين حققت معاملة الحرث تحت التربة + الحرث بالمحراث القلاب مع استخدام مبيد الأريلون أعلى قيم لصفات النمو السابقة.

٥- أدى استخدام معاملة حرث تحت التربة + الحرث بالقلاب إلى تفوق معنوى مقارنة بالطرق الأربعة الأخرى فى تأثيرها على كل من الصفات التالية: (عدد السنابل بالمتر المربع، وزن ١٠٠٠ حبة، عدد السنيبلات بالسنبلة، طول السنبلة، عدد حبوب السنبلة، وزن السنبلة، وزن حبوب السنبلة، محصول القش والحبوب للفدان) وكان أفضل المبيدات تأثيرا هو الأريلون - كما تحققت أعلى قيم للصفات السابقة من معاملة الحرث تحت التربة + الحرث بالمحراث القلاب مع إضافة الأريلون.