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Roles of Planting Methods, Irrigation Techniques and Weed Control Treatments in Wheat Crop Performance, Associated Weeds and Water Productivity

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ABSTRACT

A field trial was executed at Gemmeiza during 2014/2015 and 2015/2016 winter seasons. The experiment aiming at finding the response of wheat crop and the associated weeds to planting methods *vis* Raised Bed Broadcasting (RBB), Flat in Rows (FR) and Flat Broadcasting (FB), irrigation techniques (irrigating as 40, 60 and 80% of available soil moisture were depleted) and weeding treatments (Pallas, Atlantis, Brominal w + Topik, Hand weeding and Un-weeded (Control) as well as their interactions. The crop-water relationships e.g. water use and water productivity were considered. The adopted treatments were assessed in split–split plot experimental design with 3 replicates, where planting methods, irrigation techniques and weed control treatments were represented in main, split and split-split plots, respectively. The main findings were as follows:1- Raised Bed Broadcasting (RBB), comparable with FR or FB ones, resulted in reduced fresh weight values of grassy, broad-leaved and total annual weeds, and on the other side, enhanced tillers No. plant^{-1}, plant height, 1000-grain weight, straw and grain yields. In addition, lower Water consumptive use values were detected with RBB, and averaged 14.71 and 18.22% over the two seasons, respectively, lesser than those with FR and FB. Water Productivity under RBB were increased, and averaged 42.73 and 31.95% over the two seasons, respectively, comparable with FR and FB techniques. 2- Irrigating at 80% ASMD regime exhibited lower values of grassy, broad-leaved and total annual weeds fresh weight, comparing with 40 and 60% ASMD regimes. Higher tillers No. plant^{-1} values were recorded for 40%ASMD, whereas plant height, 1000-grain weight, straw and grain yields exhibited higher values under 60% ASMD. Cu under 80% ASMD, as two season averages, were10.38 and 5.42%, respectively, lower than those with 40 and 60% ASMD, and higher WP was attained, and averaged 22.46 and 23.60% over the two seasons, respectively, more than those with 40 and 60% ASMD techniques.3- Brominal w+ Topik application, comparable with the other tested weeding treatments, exhibited desired trends for the parameters under study, where fresh weight of grassy, broad–leaved and annual total weeds and Cu were reduced. Additionally, higher values of plant height, 1000-grain weight, grain and straw yields as well as WP were recorded with Brominal w +Topik application. The bilateral interaction of planting method (RBB) and irrigation regime (80% ASMD) resulted in the lowest fresh weight values of grassy and Broad- leaved weeds and total. Furthermore, significant higher values of plant height, 1000-grain weight in the two seasons and grain yield in 1st season were recorded. The interaction between 80 % ASMD irrigation technique and Brominal w + Topik application resulted in, on two seasons mean basis, lower values of fresh weight for grassy and broad-leaved and total weeds. In addition, except tillers No. plant^{-1} trait, higher values of plant height, 1000-grain weight, straw and grain yields (19.86 ardab fed^{-1}) were obtained. The interaction between RBB and Brominal w + Topik application exhibited lower values of fresh weight for grassy, broad-leaved weeds and total. Furthermore, except tillers No. plant^{-1} trait, higher values of plant height, 1000-grain weight, straw and grain yields were recorded. In the present investigation, the tertiary interaction of RBB, 80% ASMD and Brominal w + Topik application exhibited desired figures of Cu and WP for wheat crop. Due to the attained results, it could be advisable to plant wheat on raised beds and irrigating as 80% of available soil moisture was depleted besides Brominal w + Topik application in order to annual associated weeds control and to obtain acceptable water use and water productivity figures.

Keywords: Wheat crop performance, planting methods, irrigation techniques, water consumptive use, water productivity, weed control.

INTRODUCTION

Wheat (*Triticum aestivum L.*) is the most important cereal crop of the world. In Egypt, local wheat production does not match the consumption, so it is important to use the available natural resources of water and land efficiently in order to mitigate production–consumption gap. Agronomic practices have been successfully adopted and proved to be effective to increase the crop production in many countries. Among different agricultural inputs, crop variety, planting method, water management and weed control are important in improving the quality and productivity of wheat (Bhat *et al*. 2006). The proper of the essential practices in improving the crop production. Some common annual weeds growing with cultivated crops use up to three times as much water to produce a pound of dry matter as do the crops (Parker, 2003). The weeds caused and extra competition of crop plants with biotic factors of environment, the large population of weed plant caused drought effects to the crop plants as much of moisture is taken by weed plants which ultimately caused damage of crop plants, (Ali *et al*., 2012). Therefore, controlling weeds in fields is necessary to rise up yield quantity and quality, as well as minimize great losses in crop production resulting from weed-crop competition. In addition, losses caused by weeds exceeded the losses from any category of agricultural pests. Shaban *et al*. (2009) reported that wheat grain yield losses due to weed interference accounted for 27.5%. Moreover, during harvest and dockage, a reduction on quantity and/or quality could be happened, consequently, leading to the reduction on the economic return. In connection, Marwat *et al.* (2013) reported that weeds having strong competition with the wheat crop for light, nutrients and moisture adversely affect the wheat production. Under water-stress condition, weeds can reduce crop yields more than 50% through moisture competition alone (Abouziena and Haggag 2016). Mekky *et al.* (2010) found that Clodinafop–propargyl (Topik 15%WP) application was effective to control grassy weeds in wheat. The authors added that agronomic practices such as choice of competitive varieties and seedbed planting had a significant impact on weeds. In addition, Gibson (2000) stated that water requirement for the growth of weeds is mainly of interest from the stand-point of competition with the crop plant for the available soil moisture. Dalley *et al.* (2006) reported that weed density is important in depletion of soil moisture and has significant negative effects on the WUE of crops. Raising weed density decreases soil water

and crop yields, however, the competitive ability of different weed species at similar densities may not have the same influence on water use. EL-Metwally *et al.* (2015) found that application of 100% water requirement recorded the highest values compared to 50 and 75% treatments in term of plant height, number of spike m^{-2}, spike weight, grains number $spike^{-1}$, weight of 1000 grains, yield and yield attributes of wheat. Furthermore, Hobbs *et al.* (2000) reported that bed planting improved water distribution and efficiency, fertilizer use efficiency, reduced weed infestation, crop lodging and reduced seed rate without sacrificing yield. Choudhury *et al.* (2007) reported that under furrow bed sowing method water can be conserved almost 25-35% for rice-wheat as compared to the basin with an increase in yield of 6-52%. Ahmad *et al.* (2010) reported that bed furrow method consumed about 35.6% less water and increased wheat grain yield by 13.4% higher than that in flat border method. Furthermore, Majeed *et al.* (2015) stated that the three years of pooled data indicated that increasing N application to 120 kg ha^{-1} in bed planting increased wheat yield up to 5.12 t ha^{-1}, statistically higher than the yield (4.45 t ha^{-1}) in flat planting at the same N rate.

The present investigation aiming at determining the extent to which some agronomic practices *vis* planting methods, irrigation techniques, weeding regimes and their interactions on associated weeds, wheat crop performance and water productivity in Middle Nile Delta district.

MATERIALS AND METHODS

In order to accomplish the present research objective, a field trial was executed at Gemmeiza (Middle Nile Delta, Lat. 30.47 Long. 31.00) during the winter seasons of 2014/2015 and 2015/2016.the soil was classified as (Clayey, Smectitic, Superactive, Mesic, Typic Haploxererts) Bulk density, some of soil hydrodynamic constants, and weather factors of the experimental sites are shown in Table 1 and 2, respectively.

The experiments aiming at finding the response of wheat and the associated weeds to planting methods, irrigation techniques and weeding control treatments as well as their interactions. Crop water use and water productivity as crop–water relationships were considered. The adopted treatments were assessed in a split–split experimental plot design with three replicates, where the main plots were allocated to planting methods and irrigation techniques were represented in the split plots and split-split plots were occupied by the weed control treatments.

Table 1. Bulk density and some hydrodynamic constants of the experimental soil.

Soil depth (cm)	Bulk density (gcm^{-3})	Field capacity (%, wt./wt.)	Wilting Point (%, wt./wt.)	Available water, mm
0 – 15	1.10	45.60	24.30	35.15
15 – 30	1.20	42.30	22.10	36.36
30 – 45	1.31	39.50	21.00	36.35
45 – 60	1.38	36.90	18.60	37.88
Mean	1.18	41.10	21.50	∑ 145.74

Table 2. Some climatic elements of the experimental site (1997 – 2006 averages*).

Month	Temperature (max.°C)	Temperature (min.°C)	Wind speed (ms^{-1})	Relative humidity (%)	Rainfall ($mm\ month^{-1}$)	Pan evaporation ($mmday^{-1}$)
October	29.8	18.6	0.8	61.7	0.0	4.1
November	25.3	15.2	0.7	63.5	4.9	2.6
December	21.1	11.6	0.8	66.0	10.5	1.9
January	19.3	9.7	0.8	67.2	20.4	1.6
February	19.7	9.6	1.2	63.5	21.8	2.1
March	22.0	10.6	0.9	62.9	19.5	3.2
April	26.6	13.6	0.9	60.3	2.4	4.6
May	32.4	17.3	4.3	57.8	0.0	6.1

***Source: Water Requirements and field Irrigation Research Department, SWERI.**

The adopted treatments were as follows:

A– Main plots (Planting methods)

P_1- Flat planting in rows, 20 cm apart, using a planting machine, (FR)

P_2- Flat Broadcasting, (FB)

P_3- Raised beds broadcasting, (RBB)

B– Split–plot (Irrigation techniques) where irrigation was applied according to Available Soil Moisture Depletion (ASMD) percentage within the effective root zone (60 cm depth) based on Class A pan records as follows: I1- 40% ASMD I2- 60% ASMD I3- 80% ASMD

On determining water consumptive use, soil samples were collected using a regular auger just before and 48 hours after each irrigation and at harvest time in 15 cm increment system from soil surface down to 60 cm of soil profile. Water consumptive use was calculated according to Israelsen and Hansen (1962) as follows:

$$CU\ (cm) = \frac{\theta 2 - \theta 1}{100}\ X\ Bd\ X\ ERZ$$

Where:

CU = water consumptive use (cm).

θ2 = Soil moisture percentage by weight, determined 48 hours after irrigation.

θ1 = Soil moisture percentage by weight, determined before the following irrigation.

Bd = Bulk density ($kg\ m^{-3}$)

ERZ= Effective root - zone (60 cm)

Water consumptive use as ($m^3\ fed^{-1}$) was obtained by multiplying the value of CU (cm) by 42.

It is worthy to mention that No. of irrigation events under the adopted irrigation techniques *vis* 40, 60 and 80% ASMD were 5, 4 and 3 irrigation events, respectively.

C– Split – split plot (Weed control treatments):

W_1- Pallas 4.5% OD at 160 $cm^3\ fad^{-1}$ rate (Pyroxsulam,), applied at 3 - 5 leaf growth stage.

W_2- Atlantis 1.2% OD at 400 $cm^3\ fad^{-1}$ rate (Iodosulfuron-methyl-sodium + mesosulfuron-methyl-sodium,), applied at 2 - 4 leaf growth stage.

W_3- Brominal w 24 % EC + Topik 15% WP (Bromoxynil octanoate, + Clodinafop -propargyl,). Brominal at 1000 $cm^3\ fad^{-1}$ rate was applied at 3 - 5

leaf growth stage, while Topik at 140 g fad^{-1} rate was applied within a month after the life irrigation.

W_4- Hand weeding was carried out twice, just before life irrigation, and 15 days later.

W_5- Un-weeded (Control).

All the assessed herbicides were foliar sprayed by Cp3 knapsack sprayer with 200 litters of water fad^{-1}. Seed bed was prepared as usual for high wheat production in the area, and the N, P and K fertilizers were applied as recommended. The wheat seeds (Seds12 variety) were sown on 24th and 25th November in 1st and 2nd seasons, respectively. Seeding rate was used as recommended for each planting methods. The split–split - plot area was 10.8 m^2 containing 3 beds, 120 cm width and 3 m length in bed planting cause.

Data recorded: The following data were recorded:

1. Weeds survey

Weeds were hand pulled from one square meter randomly twice of each plot at 60 and 90 days after planting, then classified into two groups e.g. Annual grassy and Annual broad-leaved and total annual weeds as well.

2. Growth, Yield and yield components

At harvest, the following characters were recorded: Number of tillers plant^{-1}and plant height (cm) as growth traits, and 1000 - grain weight (g), as yield component, straw yield (ton fed^{-1}) and grain yield (ardab fed^{-1}, one ardab equals 150 kg). Data were subjected to the proper statistical analyses according to Snedecor and Cochran (1980). The means of treatments were compared using Least Significant Difference (LSD) at 5% probability level according to Waller and Duncan (1969).

RESULTS AND DISCUSSION

1. Wheat crop performance: -

Effect of planting methods:

Data concerning wheat crop performance reveal that all the studied parameters were significantly affected by the adopted planting methods, and RBB planting was superior than both FR and FB ones, in 1st and 2nd seasons, Table 3. Growth traits e.g. tillers No. plant^{-1} and plant height were increased under RBB planting by 9.42 and 65.41% and by 21.25 and 70.88%, respectively, higher than FR and FB ones, in 1st and 2nd seasons. The corresponding increase values in plant height comprised 3.82 and 4.79% and by 3.22 and 6.96%, respectively, in the same order of planting methods and seasons.

The increases in the reproductive trait, 1000-grain weight, with RBB planting reached to 4.79 and 8.37% and to 4.70 and 8.19%, respectively, more than those with FR and FB planting, in 1st and 2nd seasons. Additionally, straw and grain yields exhibited similar trend as influenced by the adopted planting methods, and RBB resulted in higher straw yield figures, which amounted to 7.06 and 11.66% in 1st season and to 7.11 and 11.72% in 2nd season, respectively, more than FR and FB planting methods. The corresponding grain yield increases were 9.17 and 16.03% in 1st season and 9.06 and 15.81%, respectively, in the same order of treatments. The obtained results are in accordance with those of Mollah *et al.* (2009) who found in 2-season experiment that wheat yield was increased with bed planting using 70 cm wide beds with two and three plant rows bed^{-1} over conventional method, and ranged 19 - 21% and 17 - 20%, respectively. In addition, Ahmad *et al.* (2010) found that wheat grain yield was 13.4% higher in bed and furrow method than that in flat border method. Mahmood *et al.* (2013) with three planting method *viz.* triple-row bed planting, double-row bed planting with bed planter and control (single row sowing on flat with Rabi drill), and found that grain yield was 3953, 3728 and 3364 kgha^{-1}, and 1000-grain weight amounted to 40.3, 37.7 and 35.3 g, respectively. Noorka and Tabasum (2013) reported that, except 1000-grain weight, tillers No. plant^{-1}, plant height, grains and biological yields were significantly increased with raised bed planting method, comparable with conventional flat planting. Furthermore, Majeed *et al.* (2015) stated that the three years of pooled data indicated that increasing N application to 120 kg ha^{-1} in bed planting increased wheat yield up to 5.12 t ha^{-1}, statistically higher than the yield (4.45 t ha^{-1}) in flat planting at the same N rate.

Table 3. Effect of planting methods, irrigation techniques and weed control on tillers No. plant^{-1}, plant height and 1000-grain weight, straw and grain yield in 2014/2015 and 2015/2016 seasons.

Treatments	2014/2015					2015/2016				
	Tillers No. plant^{-1}	Plant height (cm)	1000-grain weight, (g)	Straw yield (tonfed^{-1})	Grain yield (ard.fed^{-1})	Tillers No. plant^{-1}	Plant height (cm)	1000-grain weight, (g)	Straw yield (tonfed^{-1})	Grain yield (ard.fed^{-1*})
Planting Methods										
P_1	5.20	94.35	52.37	6.80	16.24	5.13	95.51	53.63	7.03	16.66
P_2	3.44	93.47	50.64	6.52	15.28	3.64	92.17	51.90	6.74	15.69
P_3	5.69	97.95	54.88	7.28	17.73	6.22	98.59	56.15	7.53	18.17
LSD,05	0.33	0.99	0.59	0.11	0.10	0.46	0.46	0.54	0.11	0.10
Irrigation Techniques										
I_1	5.44	94.60	52.04	6.78	16.18	5.62	94.70	53.30	7.01	16.58
I_2	4.84	97.76	54.15	7.10	17.14	5.02	97.16	55.41	7.33	17.57
I_3	4.04	93.41	51.70	6.73	15.94	4.36	94.41	52.97	6.96	16.36
LSD,05	0.37	0.49	0.30	0.07	0.09	0.34	0.36	0.33	0.07	0.11
Weed control Treatments										
W_1	6.48	99.93	56.40	7.44	18.19	6.49	99.75	57.66	7.69	18.61
W_2	5.70	99.16	56.32	7.39	18.05	6.07	99.10	57.59	7.64	18.47
W_3	5.33	101.44	57.03	7.63	18.77	5.89	102.10	58.30	7.88	19.19
W_4	3.63	90.08	48.91	6.32	14.61	3.70	89.15	50.17	6.53	15.01
W_5	2.74	85.67	44.49	5.57	12.47	2.85	87.03	45.75	5.76	12.92
LSD,05	0.44	0.75	0.27	0.80	0.07	0.30	0.34	0.25	0.08	0.08

P_1=Flat planting in rows, P_2=Flat Broadcasting, P_3=Raised beds broadcasting, I_1=40% ASMD, I_2=60% ASMD, I_3=80% ASMD W_1=Pallas, W_2=Atlantis, W_3=Brominal w + Topik, W_4=Hand weeding, W_5=Un-weeded.

Effect of irrigation techniques:

Data in Table 3 clear out that tillers No. plant^{-1} and plant height, as growth traits, were significantly affected due to the adopted irrigation techniques in 1st and 2nd seasons. Higher tillers No. plant^{-1} values were recorded for 40% ASMD irrigation technique, and comprised 12.40 and 34.62% and 11.96 and 28.90% in 2nd season, respectively, higher than those with 60 and 80% ASMD irrigation techniques. Plant height exhibited different trend, where the higher figure was obtained with 60% ASMD irrigation technique, and amounted to 3.34 and 4.66% in 1st season and to 2.60 and 2.91%, respectively, higher than those under 40 and 80% ASMD irrigation techniques. Likely, 1000-seed weight trait, straw and grain yields, in 1st and 2nd seasons, exhibited the same trend of plant height, where higher values were attained with 60% ASMD irrigation technique. Mahamed *et al. (*2011) stated that increasing the SMD level significantly reduced the yield and yield components of the "Hawi" bread wheat, and grain yield reduction was 26.6 and 30.8% for 60 and 75% SMD, respectively, compared with 50% SMD.

Effect of weed control treatments

Data in Table 3 reveal that tillers No. plant^{-1} and plant height, as growth traits, were significantly altered due to the assessed weed control treatments in 1st and 2nd seasons. Higher tillers No. plant^{-1} values 6.48 and 6.49 were recorded with Pallas, which were higher by 13.68, 21.58, 78.51 and 136.50% than those with Atlantis, Brominal w + Topik, hand–weeding and un-weeded treatments, respectively, in 1st season. The corresponding increases in 2nd season were 6.92, 10.19, 75.40 and 127.72%, respectively, in the same order of weed control treatments. The highest plant height values were 101.44 and 102.10 cm were recorded with Brominal w + Topik treatment, respectively, in 1st and 2nd seasons. The plant height increases with Brominal w + Topik treatment comprised 1.51, 2.30, 12.61 and 18.41% higher than those recorded with Pallas, Atlantis, Hand–weeding and un-weeded treatments, respectively. The corresponding increases in 2nd season were 2.36, 3.03, 4.10 and 17.32%, respectively, in the same order of weed control treatments. The 1000-grain weight trait exhibited similar trend, and the highest values e.g. 57.03 and 58.30 g, were recorded with Brominal w + Topik treatment, respectively, in 1st and 2nd seasons. The increases 1000-grain weight with Brominal w + Topik treatment amounted to 1.11, 1.26, 16.60 and 28.19% higher than those recorded with Pallas, Atlantis, Hand – weeding and un-weeded treatments, respectively. The corresponding increases in 2nd season were 1.11, 1.23, 16.20 and 27.43%, respectively, in the same order of weed control treatments. Brominal w + Topik still exhibiting higher values of grain and straw yields in 1st and 2nd seasons. Straw yield was 7.63 ton fed^{-1} under Brominal w + Topik, which surpassed those with Pallas, Atlantis, Hand – weeding and un-weeded treatments in 1st season by 2.55, 3.25, 20.73 and 36.98%, respectively. The corresponding increases in 2nd season reached to 2.47, 3.14, 20.67 and 36.81%, respectively, in the same order of weed control treatments. Likely, grain yield reveals similar trend, where the increases with Brominal w + Topik treatment comprised 18.77 drdab fed^{-1} in 1st season, that increased by3.19, 3.99, 28.47 and 50.52%m respectively, higher than those recorded with Pallas, Atlantis, Hand – weeding and un-weeded treatments. The corresponding increases in 2nd season amounted to 3.12, 3.90, 27.85 and 48.53%, respectively, in the same order of weed control treatments. In this sense, EL-Bawab and Kholousy (2003) reported that controlling weeds by herbicidal treatments increased wheat grain yield by about 40.3 and 13.6%, compared to un-weeded and hand-weeding treatments, respectively. In addition, Shaban *et al*. (2009) reported that wheat grain yield losses due to weed interference accounted for 27.5%.

2. Water Consumptive Use (Cu): -

Effect of planting methods:

Data in Table 4 indicate that the lower Cu values were detected with RBB planting method, and amounted to 14.69 and 18.83% in 1st season and to 14.72 and 17.60% in 2nd season, respectively, lesser than those with FR and FB planting methods. In this sense, Mollah *et al*. (2009) reported that bed planting with 70, 80 or 90 cm width savings of irrigation water were 41- 46%, 42- 48% and 44- 48 %, respectively over conventional method. Aggarwal and Goswami (2003) found that average of 3-year data showed that total water use by the crop was reduced nearly by 5 cm, under treatment with 3 rows of wheat per bed compared to conventional planting. In addition, Hassan *et al*. (2005) reported that there was 36 % saving of water for wheat in raised bed technology as compare to the flat basin.

Table 4. Effect of planting methods, irrigation techniques and weed control treatments on Water Consumptive Use (m^3 fed^{-1}) of wheat crop in 2014/2015 and 2015/2016 seasons.

Planting methods	Irrigation techniques	Weed control treatments W_1	W_2	W_3	W_4	W_5	Mean
		2014/2015					
	I_1	1987.4	2044.4	1935.0	2266.3	2416.8	2130.0
P_1	I_2	1974.1	2147.4	1857.0	2164.0	2306.2	2089.7
	I_3	1965.1	1957.5	1768.4	2051.4	2102.8	1969.1
Mean		1975.6	2049.8	1853.4	2160.6	2275.3	2062.9
	I_1	2188.4	2223.2	2291.1	2402.0	2579.6	2336.9
P_2	I_2	1929.1	2183.2	2013.1	2219.4	2457.6	2160.5
	I_3	1851.9	1908.4	1835.5	2108.8	2329.6	2006.9
Mean		1989.8	2104.9	2046.6	2243.4	2455.6	2168.1
	I_1	1779.6	1750.3	1713.7	1966.0	2179.5	1877.8
P_3	I_2	1656.0	1609.4	1648.5	1884.1	1994.7	1758.5
	I_3	1513.1	1546.3	1567.6	1745.4	1843.7	1643.2
Mean		1649.6	1635.3	1643.3	1865.2	2005.9	1759.9
Weed control mean		1871.6	1930.0	1847.8	2089.7	2245.6	1996.9
		2015/2016					
	I_1	2681.2	2551.9	2711.8	2740.5	2780.1	2693.1
P_1	I_2	2483.1	2487.6	2520.1	2523.7	2676.1	2538.1
	I_3	2262.3	2316.8	2260.7	2452.7	2519.6	2362.4
Mean		2475.5	2452.1	2497.5	2572.3	2658.6	2531.2
	I_1	2762.3	2737.7	2619.1	2784.8	2948.5	2770.5
P_2	I_2	2503.0	2553.1	2506.4	2678.1	2824.6	2613.1
	I_3	2388.6	2385.1	2374.3	2546.4	2684.3	2475.7
Mean		2551.3	2558.6	2500.0	2669.8	2819.1	2619.8
	I_1	2122.5	2116.5	2178.7	2346.1	2497.2	2252.2
P_3	I_2	2078.9	2169.1	2002.5	2256.5	2312.7	2163.9
	I_3	1947.8	1983.1	1985.0	2198.7	2182.8	2059.5
Mean		2049.7	2089.5	2055.4	2267.1	2330.9	2158.5
Weed control mean		2358.9	2366.8	2351.0	2503.1	2603.1	2436.5

P_1=Flat planting in rows, P_2=Flat Broadcasting, P_3=Raised beds broadcasting, I_1=40% ASMD, I_2= 60% ASMD, I_3=80% ASMD, W_1=Pallas, W_2=Atlantis, W_3=Brominal w + Topik, W_4=Hand weeding, W_5=Un-weeded.

Effect of irrigation techniques:

Data in Fig, 1 reveal that Cu under 80% ASMD were 11.43 and 6.48% in 1st season, and 9.32 and 4.35% in 2nd season, respectively, lower than those with 40 and 60% ASMD. The reduced Cu value under 80% ASMD are mainly attributed to lesser applied water, which resulted in lower crop canopy transpiration and lower soil surface evaporation as well, compared with 40 and 60% ASMD. In this respect, Rizk and Sherif (2014) found that under sprinkler irrigation, water consumptive use of wheat was increased with increasing available soil moisture.

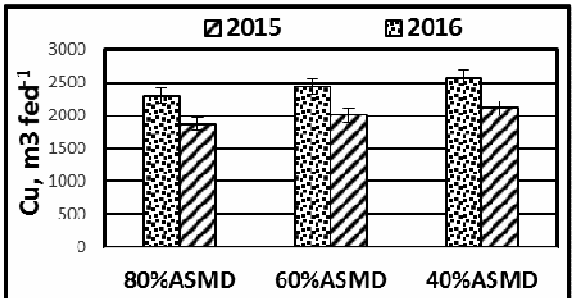

Fig.1: Effect of irrigation techniques on Cu for wheat in 2014/15 and 2015/16 seasons

Effect of weed control treatments:

Data in Table 4 clear out that among the assessed weeding regimes affecting Cu, Brominal w + Topik was superior, and resulted in the lowest Cu figures comprised 1847.81 and 2351.00 m^3 fed^{-1}, respectively, in 1st and 2nd seasons. Values of Cu with Brominal w + Topik application were 0.13, 4.26,11.58 and 17.72% lower than those recorded with Pallas, Atlantis, Hand – weeding and control applications, respectively, in 1st season. Similar trend was observed in 2nd season with corresponding Cu reduction values reached to 0.33, 0.67,6.08 and 9.69% with Brominal w + Topik application in the same order of the abovementioned weeding regimes. It is obvious that weed control is an important practice in wheat production for conserving the already limited water resources. In connection, Shoup and Holman (2012) stated that proper weed control raises available soil water for crop production.

3. Water Productivity (WP): -

Effect of planting methods:

The term water productivity is used exclusively to denote the amount or value of product over volume or value of water depleted or diverted. The value of the product might be expressed in different terms e.g. biomass, grain, money (FAO, 2003). Data in Table 5 reveal that WP values under RBB irrigation technique were increased by 26.89 and 33.82 in 1st season and by 25.25 and 26.53% in 2nd season, respectively, comparable with FR and FB techniques. Higher WP with bed planting could be due to efficient use of irrigation water under that irrigation method. Hameed and Solangi (1993) reported that wheat planted on beds and furrow irrigation showed higher yield and water use efficiency than flat-planted wheat. Hobbs *et al.* (2000) stated that bed planting has shown improved water distribution and efficiency. In addition, Aggarwal and Goswami (2003) reported that water-use efficiency was increased by 0.03-ton ha^{-1} cm^{-1} under 3 rows of wheat per bed compared to conventional planting. Moreover, Fischer *et al.* (2005) reported that irrigation water management was more efficient with the use of furrows than with conventional flood irrigation. Hassan *et al.* (2005) reported that there was 50% increase in water productivity for wheat in raised bed technology as compare to the flat basin.

Table 5. Effect of planting methods, irrigation techniques and weed control treatments on WP (kgm^{-3}) of wheat crop in 2014/2015 and 2015/2016 seasons.

Planting methods	Irrigation techniques	Weed control treatments W_1	W_2	W_3	W_4	W_5	Mean
		2014/2015					
P_1	I_1	1.33	1.29	1.40 1.388	0.94	0.78	1.15
	I_2	1.25	1.14	1.39	0.93	0.76	1.09
	I_3	1.51	1.50	1.70	1.16	0.90	1.35
Mean		1.36	1.31	1.50	1.01	0.81	1.19
P_2	I_1	1.19	1.17	1.17	0.87	0.72	1.02
	I_2	1.26	1.11	1.28	0.88	0.69	1.04
	I_3	1.59	1.50	1.62	1.12	0.80	1.33
Mean		1.35	1.26	1.36	0.97	0.74	1.12
P_3	I_1	1.58	1.59	1.69	1.13	0.93	1.39
	I_2	1.61	1.64	1.69	1.12	0.95	1.40
	I_3	2.02	1.97	2.02	1.41	1.08	1.70
Mean		1.83	1.73	1.80	1.22	0.99	1.51
Weed control mean		1.51	1.43	1.55	1.06	0.84	1.27
		2015/2016					
P_1	I_1	1.01	1.06	1.00	0.79	0.70	0.91
	I_2	1.02	1.01 1.298	1.05	0.82	0.68	0.92
	I_3	1.34	1.30	1.35	0.99	0.77	1.15
Mean		1.12	1.12	1.13	0.87	0.72	0.99
P_2	I_1	0.96	0.97	1.05	0.77	0.65	0.88
	I_2	0.99	0.97 1.225	1.05	0.76	0.62	0.88
	I_3	1.26	1.23	1.28	0.95	0.72	1.09
Mean		1.07	1.05	1.13	0.83	0.66	0.98
P_3	I_1	1.36	1.35	1.36	0.98	0.84	1.18
	I_2	1.31	1.24	1.42	0.96	0.85	1.16
	I_3	1.60	1.57	1.62	1.15	0.96	1.38
Mean		1.42	1.38	1.47	1.03	0.88	1.24
Weed control mean		1.20	1.18	1.24	0.91	0.75	1.06

P_1=Flat planting in rows, P_2=Flat Broadcasting, P_3=Raised beds broadcasting, I_1=40%ASMD, I_2=60%, ASMD, I_3=80%ASMD, W_1=Pallas, W_2=Atlantis, W_3=Brominal w + Topik, W_4=Hand weeding, W_5=Un-weeded.

Effect of irrigation techniques:

Figure 2 illustrate that 80% ASMD irrigation technique exhibited higher WP reached to 22.69 and 23.73% in 1st season and to 22.22 and 23.47% in 2nd season, respectively, higher than those with 40 and 60% ASMD. The present results are parallel with Al-Kaisi and Yin (2003) who stated that irrigation effectively increases crop yield although water-use efficiency (WUE) decreases as the irrigation rate increases. In addition, Mahmood and Ahmad (2005) reported that water use efficiency was greater when irrigation was applied at 50% SMD and was reduced at 70% SMD. Rizk and Sherif (2014) found that the highest value of Water Use Efficiency (WUE) when irrigation water was applied at 60% available soil moisture for straw and 40% available soil moisture for grain.

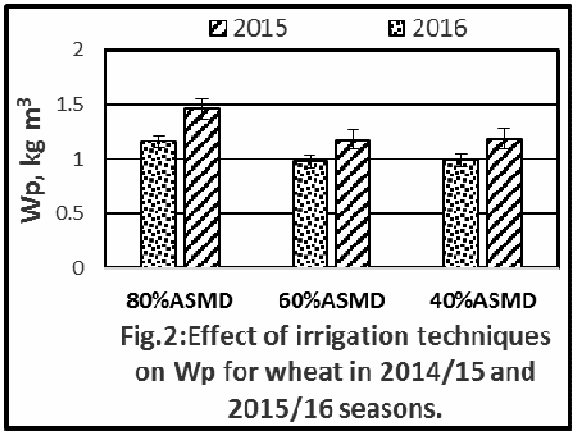

Fig.2:Effect of irrigation techniques on Wp for wheat in 2014/15 and 2015/16 seasons.

Effect of weed control treatments:

Data in Table 6 show that Brominal w + Topik treatment resulted in the higher WP values e.g. 1.55 and 1.24 kgm^{-3} in 1st and 2nd seasons. The increases in WP with Brominal w+ Topik treatment were 2.65, 8.39, 46.23 and 84.52% in 1st season, and 3.33, 5.08, 36.26 and 65.33% in 2nd season higher than those under Pallas, Atlantis, Hand – weeding and control weeding regimes, respectively. Dalley *et al.* (2006) stated that weed density is important in depletion of soil moisture and has significant negative effects on the WUE of crops.

4. Fresh weight of grassy, broad-leaved and total annual weeds

The dominant weed species in the present study were identified and their fresh weight percentages as proportioned to un-weeded (control) were recorded during 2014/2015 and 2015/2016 seasons as follows:

1-Grassy weeds (canary grass) *Phalaris sp.* 24.2 to 33.0 %

2-Broad- leaved weeds

- Wild beet, sea beet *(Beta vulgaris)*18.8 to 14.2 %,
- Curly dock *(Rumex dentatus)*16.5 to 12.3 %,
- Lamb squarters *(Chenopodium sp.)* 12.6 to 8.7 %),
- Watercress (*Coronopus squamatus*) 20.4 to 16.3 %,
- Mallow (*Malva parviflora*) 7.5 to 8.5 % and
- Common bishop *(Ammi majus)* 0.0 to 7.0 %.

Effect of planting methods:

Data in Table 6 indicate that the adopted planting methods significantly influenced the fresh weight of grasses, broad- leaved weeds and total weeds, and such trend was true in the two survey events and two growing seasons. RBB method resulted in reduced values of total annual weeds at 1st and 2nd surveys in 1st season, and reached (32.76 and 48.53%) and (28.10 and 44.06%) lower than that with FR or FB, respectively. The corresponding reduction values at 1st and 2nd surveys in the second season comprised (30.11 and 41.08%) and (23.82 and 35.81%) in the same order of the treatments. Additionally, fresh weight of grasses and broad- leaved weeds exhibited similar trends, where reduction values, in fresh weight of grass in 1st and 2nd surveys, amounted to (39.42 and 49.24%) and (26.91 and 41.26%) in 1st season and (36.25 and 45.19%) and (30.48 and 38.88%) in 2nd season, under FR or FB, respectively, comparable with RBB.

The corresponding reduction in broad- leaved weeds were, in 1st and 2nd surveys, (30.31 and 48.23%) and (28.56 and 45.23%) in 1st season and (27.13 and 39.14%) and (20.61 and 34.42%) in 2nd season, in the same order of surveys times, growing seasons and treatments. Total fresh weight of annual weeds (sum of 2 field surveys) in 1st season under RBB planting method were reduced by 30.18 and 46.07%, respectively, compared with FR and FB ones. In 2nd season similar trend was noticed, where the reduction values under RBB planting amounted to 26.89 and 38.38%, comparing with FR and FB, respectively. In this sense, Hobbs *et al.* (2000) found that bed planting has shown reduced weed infestation. In addition, Abouziena and Haggag (2016) stated that seedbed planting is among the agronomic practices had a significant impact on weeds.

Table 6. Effect of planting methods, irrigation techniques and weed control treatments on fresh weight of the grassy, broad–leaved and total annual weeds associated with wheat crop at 60 and 90 days after Planting in 2014/2015 and 2015/2016 seasons.

Treatments	2014/2015						2015/2016					
	Grassy Weeds (gm^{-2})		Broad-leaved weeds (gm^{-2})		Total Weeds (gm^{-2})		Grassy Weeds (gm^{-2})		Broad-leaved weeds (gm^{-2})		Total Weeds (gm^{-2})	
	Days After Planting											
	60	90	60	90	60	90	60	90	60	90	60	90
Planting Methods												
P_1	66.2	92.9	184.4	218.8	250.6	311.7	230.6	240.8	475.1	501.1	705.7	741.9
P_2	79.0	115.6	248.3	285.0	327.4	400.6	268.2	273.9	568.8	606.6	837.0	880.5
P_3	40.1	67.9	128.5	156.1	168.5	224.1	147.0	167.4	346.2	397.8	493.2	565.2
LSD,05	8.9	17.5	19.5	15.4	24.8	11.0	26.6	39.9	24.9	63.0	40.9	35.6
Irrigation techniques												
I_1	78.5	119.3	223.9	264.8	302.4	384.1	259.0	278.7	537.4	600.9	796.4	879.6
I_2	62.0	89.7	184.3	218.2	246.3	307.8	219.5	225.2	455.1	505.6	674.6	730.8
I_3	44.9	67.4	153.0	177.0	197.9	244.4	167.2	178.2	397.6	399.0	564.8	577.2
LSD,05	7.81	13.0	12.2	22.9	12.9	22.0	15.0	31.3	17.8	87.1	16.0	96.0
Weed control treatments												
W_1	22.4	35.9	63.2	83.4	85.6	119.3	64.7	69.6	175.5	205.7	240.2	275.3
W_2	23.9	38.8	71.7	97.5	95.6	136.3	73.5	78.8	185.4	239.8	258.9	318.6
W_3	17.0	30.8	47.6	58.3	64.6	89.2	53.6	58.4	151.1	146.1	204.7	204.5
W_4	47.9	75.2	131.2	164.0	179.1	239.3	145.5	152.0	325.7	375.1	471.2	527.1
W_5	197.8	279.9	621.6	696.7	819.4	976.6	738.9	778.0	1479.2	1542.5	2218.1	2320.5
LSD,05	5.5	9.7	14.4	23.8	16.5	24.5	22.7	35.4	22.9	78.9	30.3	90.4

P_1=Flat planting in rows, P_2=Flat Broadcasting, P_3=Raised beds broadcasting, I_1=40% ASMD, I_2=60% ASMD, I_3=80% ASMD, W_1=Pallas, W_2=Atlantis, W_3=Brominal w + Topik, W_4=Hand weeding, W_5=Un- weeded.

Effect of irrigation techniques

Data in Table 6 reveal that the adopted irrigation techniques significantly influenced the fresh weight of grasses, broad-leaved weeds and total, which tended to reduction as soil moisture stress increased, and such trend was recorded with surveys events in the two seasons of study. Irrigating at 80% ASMD reduced Fresh weight of grasses values, and reached to (42.80 and 27.58%) and (35.44 and 23.83%) at 1st and 2nd surveys during 1st season, respectively, comparable with 40 an 60% one. Similar trend was noticed in 2nd season with corresponding reduction values amounted to (45.50 and 24.86%) and (36.06 and 20.87%), respectively, in the same order of survey times and irrigation treatments. Values of broad- leaved weeds exhibited the same trend in 1st season, where reductions under 80% ASMD were (31.67 and 16.98%) and (26.01 and 12.63%), respectively, at 1st and 2nd surveys compared with 40 and 60% ASMD. The reduction values in 2nd season comprised (33.16 and 18.88%) and (33.60 and 21.08%), respectively, in the same order of survey times and irrigation treatments.

Effect of weed control treatments:

Data in Table 6 reveal that the assessed weeding regimes significantly influenced the fresh weight of grasses, broad- leaved weeds and total, comparable with the control (un-weeded), and such trend was recorded with surveys events in the two seasons of study. Brominal w + Topik application proved to be superior in reducing fresh weight of grass, broad – leaved and annual total weeds, and such finding was true in 1st and 2nd surveys in the two seasons of study. Brominal w + Topik resulted in reductions in fresh weight of grasses reached to 24.11, 28.87, 64.51 and 91.41% lower than Pallas, Atlantis, Hand–weeding and control regimes, respectively, in 1st survey in 1st season. EL-Metwally *et al.* (2015) found that Bromoxynil and tribenuron-methyl came in the first order for controlling total broad-leaved weeds.

The corresponding reduction values in 2nd survey amounted to 14.21, 20.62, 59.04 and 89.00% in the same order of weeding regimes, respectively. In 2nd season, reductions in fresh weight of grasses were (17.16, 27.07 and 63.16 and 92.75%) and (16.09, 25.89 ,61.58 and 92.49 %) respectively, in 1st and 2nd surveys lower than those with Pallas, Atlantis, Hand – weeding and control regimes. Likely, the corresponding reduction values in broad – leaved weeds in 1st season were (24.68, 33.61, 63.72 and 92.34 %) and (30.10, 40.21, 64.45 and 91.63%), respectively, lower than those with Pallas, Atlantis and Hand – weeding and control regimes in1st and 2nd surveys. In 2nd season, the corresponding reduction figures amounted to (13.90, 18.50, 63.61 and 89.79%) and (28.97, 39.07, 61.05 and 90.53%), respectively, in the same order of 1st and 2nd surveys and weeding regimes. Values of fresh weight of total annual weeds in 1st season were (24.53, 32.43, 63.93 and 92.11%) and (25.23, 34.56, 62.72 and 90.87%), respectively, lower than those of in1st and 2nd surveys. The corresponding reduction values in 2nd season amounted to (14.78 20.93, 56.56 and 90.77 %) and (25.72, 35.81, 60.20 and 91.87%), respectively in the same order of growing seasons and weed control treatments. In connection, Mekky *et al.* (2007) reported that application of bromoxynil + clodinafop–propargyl and hand–weeding twice decreased the fresh weight of total weeds by 99 and 84%, respectively, comparable with un – weeded control.

5. Effect of interactions:

It worthy to mention that the tertiary interactions of the adopted treatments insignificantly affected most of the studied parameters, so, such interactions will be not discussed, and bilateral interactions were considered.

Effect of planting methods and irrigation techniques interaction on fresh weight of grassy, broad- leaved and total weeds at 60 and 90 DAP:

Data in Table 7 reveal that fresh weight (gm^{-2}) of grassy, broad- leaved and total weeds at 60 and 90 DAP, were insignificantly affected by planting methods and irrigation techniques interaction in 2nd season, however, the lowest values were recorded with RBB and 80% ASMD interaction. In 1st season, the fresh weight of Grassy Weeds at 90 DAP and Broad- leaved weeds at 60 DAP were significantly influenced due to the abovementioned interaction, the lowest values reached to 130.9 and 21.15 gm^{-2}, respectively. In addition, Total weeds values were significantly affected, and exhibited lowest figures amounted to 134.6 and 423.1 gm^{-2} at 60 and 90 DAP, respectively.

Table 7. Effect of planting methods and irrigation techniques interaction on fresh weight of grassy, broad-leaved and total weeds at 60 and 90 days after planting in 2014/2015 and 2015/2016 seasons.

Treatment		2014/2015						2015/2016					
		Grassy weeds (gm^{-2})		Broad- leaved weeds (gm^{-2})		Total weeds (gm^{-2})		Grassy weeds (gm^{-2})		Broad- leaved weeds(gm^{-2})		Total weeds (gm^{-2})	
Planting methods	Irrigation Technique	Days After Planting (DAP)											
		60	90	60	90	60	90	60	90	60	90	60	90
P_1	I_1	84.9	291.7	216.5	553.8	301.4	845.5	122.8	305.9	256.6	613.9	379.4	919.8
	I_2	67.5	241.4	183.0	466.7	250.4	708.1	92.4	240.2	215.7	496.9	308.1	737.1
	I_3	46.3	158.6	153.7	404.8	200.0	563.3	63.5	176.4	184.2	392.4	247.7	568.8
P_2	I_1	102.5	326.3	300.7	655.3	403.2	981.5	151.4	342.2	347.5	719.9	498.9	1062.1
	I_2	76.5	266.0	243.3	555.5	319.8	821.5	110.5	266.7	280.1	612.1	390.6	878.8
	I_3	58.1	212.4	200.9	495.7	259.0	708.1	84.9	212.9	227.4	487.8	312.3	700.7
P_3	I_1	48.0	159.0	154.4	403.2	202.4	562.2	83.8	188.1	190.3	468.8	274.0	656.8
	I_2	42.0	151.1	126.6	343.2	168.6	494.3	66.1	168.7	158.7	407.7	224.8	576.3
	I_3	30.2	130.9	104.4	292.2	134.6	423.1	53.9	145.3	119.4	317.0	173.3	462.3
LSD,05		NS	26.03	21.15	NS	22.45	27.87	NS	NS	NS	NS	NS	NS

P_1=Flat planting in rows P_2=Flat Broadcasting P_3=Raised beds broadcasting
I_1=40% ASMD I_2=60% ASMD I_3=80% ASMD,

Effect of planting methods and weed control treatments interaction on fresh weight of grassy, broad- leaved and total weeds at 60 and 90 days after planting:

Data in Table 8 reveal that fresh weight (gm^{-2}) of grassy, broad- leaved and total weeds at 60 and 90 DAP, were significantly affected by planting methods and weed control treatments interaction, and such findings were true in 1st and 2nd seasons. It is obvious that Brominal w + Topik treatment as interacted with RBB resulted in the lowest values of grassy, broad- leaved and total weeds at 60 and 90 DAP in 1st and 2nd seasons.

Table 8. Effect of planting methods and weed control treatments interaction on fresh weight of grassy, broad-leaved and total weeds at 60 and 90 days after planting in 2014/2015 and 2015/2016 seasons.

Treatments		2014/2015						2015/2016					
Planting methods	Weed control	Grassy weeds (gm^{-2})		Broad-leaved weeds (gm^{-2})		Total weeds (gm^{-2})		Grassy weeds (gm^{-2})		Broad-leaved weeds (gm^{-2})		Total weeds (gm^{-2})	
		Days After Planting (DAP)											
		60	90	60	90	60	90	60	90	60	90	60	90
	W_1	24.0	62.9	61.2	175.7	85.2	238.7	34.4	69.0	77.7	195.9	112.1	264.9
	W_2	25.3	77.4	68.8	182.0	94.1	259.4	38.1	78.1	94.8	236.4	132.8	314.6
P_1	W_3	18.8	63.1	46.0	157.7	64.8	220.8	32.6	60.3	57.7	148.2	90.3	208.6
	W_4	54.7	160.1	132.0	331.7	186.7	491.7	73.1	158.3	166.2	378.1	239.3	536.4
	W_5	208.3	789.3	614.1	1528.3	822.4	2317.6	286.3	838.4	697.9	1546.7	984.2	2385.1
	W_1	30.9	87.2	96.1	234.9	126.9	322.1	47.4	86.9	117.7	256.1	165.2	342.9
	W_2	33.3	93.1	105.9	243.4	139.2	336.4	51.3	98.2	132.9	290.3	184.2	388.5
P_2	W_3	23.8	67.6	73.1	182.9	96.8	250.5	40.2	71.9	84.3	185.8	124.5	257.7
	W_4	65.6	197.7	181.4	421.3	247.0	619.0	113.5	206.4	217.4	464.8	330.9	671.2
	W_5	241.7	895.7	785.1	1761.4	1026.8	2657.1	325.6	906.2	872.6	1836.1	1198.1	2742.3
	W_1	12.2	44.0	32.4	115.8	44.6	159.8	25.9	53.0	54.7	165.0	80.6	218.0
	W_2	13.0	50.1	40.6	130.8	53.6	180.9	27.1	60.1	64.8	192.7	91.9	252.8
P_3	W_3	8.3	30.2	23.8	112.6	32.1	142.8	19.7	43.1	33.0	104.2	52.7	147.3
	W_4	23.3	78.9	80.2	223.9	103.6	302.8	39.1	91.1	108.4	282.4	147.6	373.6
	W_5	143.4	531.7	465.4	1147.9	608.9	1679.6	227.9	589.4	519.7	1244.7	747.6	1834.1
LSD,05		9.58	39.32	25.02	38.81	39.81	52.61	16.90	61.38	41.23	136.70	42.58	156.70

P_1=Flat planting in rows P_2=Flat Broadcasting P_3=Raised beds broadcasting
W_1=Pallas W_2=Atlantis W_3=Brominal w + Topik W_4=Hand weeding W_5=Un-weeded.

Effect of irrigation techniques and weed control treatments interaction on fresh weight of grassy, broad-leaved and total weeds at 60 and 90 days after planting:

Data in Table 9 reveal that fresh weight (gm^{-2}) of grassy, broad-leaved and total weeds at 60 and 90 DAP, were significantly affected by irrigation techniques and weed control treatments interaction, and such findings were true in 1st and 2nd seasons. It is obvious that Brominal w + Topik treatment as interacted with 80% ASMD resulted in the lowest values of grassy, broad- leaved and total weeds at 60 and 90 DAP in 1st and 2nd seasons.

Table 9. Effect of irrigation techniques and weed control treatments interaction on fresh weight of grassy, broad- leaved and total weeds at 60 and 90 days after planting in 2014/2015 and 2015/2016 seasons.

Treatments		2014/2015						2015/2016					
Irrigation techniques	Weed control	Grassy weeds (gm^{-2})		Broad- leaved weeds(gm^{-2})		Total weeds (gm^{-2})		Grassy weeds (gm^{-2})		Broad- leaved weeds(gm^{-2})		Total weeds (gm^{-2})	
		Days After Planting (DAP)											
		60	90	60	90	60	90	60	90	60	90	60	90
	W_1	32.2	80.3	81.1	221.2	113.3	301.5	49.2	89.7	108.3	255.8	157.4	345.4
I_1	W_2	33.2	92.9	89.3	230.2	122.4	323.1	52.8	100.7	123.8	286.6	176.6	387.3
	W_3	24.9	69.3	63.2	192.1	88.1	261.4	40.1	74.4	80.1	174.4	120.2	248.9
	W_4	61.8	183.7	167.6	388.9	229.3	572.6	98.4	180.2	201.5	452.1	299.9	632.3
	W_5	240.2	868.8	718.3	1654.7	958.6	2523.5	356.1	948.7	810.2	1835.4	1166.3	2784.1
	W_1	21.9	66.8	62.7	178.2	84.6	244.9	34.3	69.2	83.7	214.3	118.0	283.6
I_2	W_2	24.2	73.4	71.8	175.3	96.0	248.7	36.9	76.7	98.6	257.3	135.6	333.9
	W_3	15.8	54.5	47.7	147.1	63.6	201.6	31.5	56.8	59.4	151.9	90.9	208.7
	W_4	47.7	144.8	128.6	320.3	176.3	465.2	71.8	151.3	163.9	372.7	235.7	524.0
	W_5	200.3	757.9	610.7	1454.8	811.0	2212.7	273.8	772.0	685.2	1531.6	959.1	2303.6
	W_1	13.0	47.1	45.8	127.1	58.8	174.2	24.3	50.0	58.1	146.9	82.4	196.9
	W_2	14.2	54.3	54.2	150.7	68.4	205.0	26.6	59.1	70.2	175.5	96.8	234.6
I_3	W_3	10.2	36.9	31.9	114.1	42.1	151.0	20.9	44.1	35.4	111.8	56.4	155.9
	W_4	34.1	108.1	97.5	267.7	131.6	375.8	55.5	124.3	126.7	300.6	182.2	424.9
	W_5	152.9	590.0	535.7	1328.1	688.6	1918.1	209.8	613.4	594.7	1260.4	804.4	1873.9
LSD, 05		9.58	39.32	25.02	38.81	39.81	52.61	16.90	61.38	41.23	136.70	42.58	156.70

I_1=40% ASMD, I_2=60% ASMD, I_3=80% ASMD,
W_1=Pallas, W_2=Atlantis, W_3=Brominal w + Topik, W_4=Hand weeding, W_5=Un-weeded

Effect planting methods and irrigation techniques interaction on Tillers No. $plant^{-1}$, plant height, 1000-grain weight and straw and grain yields:

Data in Table 10 illustrate that plant height and 1000-grain weight was significantly influenced due to planting methods and irrigation techniques interaction in 1st and 2nd seasons. Higher values e.g. 100.77 cm and 57.13 g resulted from Raised Bed Broadcasting planting method and 60% ASMD irrigation regime interaction in 1st season, and the corresponding values in 2nd season were 99.67 cm and 58.39 g, respectively. In addition, data reveal that grain yield was significantly altered due to the abovementioned interaction and exhibited the highest figure (18.27 ardab fed^{-1}) in 1st season. In 2nd season grain yield still exhibiting the highest value comprised 18.76 ardab fed^{-1}, however, the difference did not reach the significance level.

Table 10. Effect planting methods and irrigation techniques interaction on tillers No. plant^{-1}, plant height, 1000-grain weight and straw and grain yields in 2014/2015 and 2015/2016.

Treatment		2014/2015					2015/2016				
Planting methods	Irrigation Techniques	Tillers No. plant^{-1}	Plant height (cm)	1000-grain weight (g)	Straw yield (tonfed^{-1})	Grain yield (ard.fed^{-1})	Tillers No. plant^{-1}	Plant height (cm)	1000-grain weight (g)	Straw yield (tonfed^{-1})	Grain yield (ard.fed^{-1})
	I_1	5.73	92.95	51.79	6.94	15.99	5.80	93.90	53.05	6.72	16.38
P_1	I_2	5.47	97.88	53.99	7.29	17.01	5.07	99.07	55.25	7.06	17.42
	I_3	4.00	92.23	51.33	6.86	15.73	4.53	93.55	52.59	6.64	16.16
	I_1	4.13	93.48	50.46	6.61	14.99	4.13	91.89	51.72	6.40	15.40
P_2	I_2	3.27	94.62	51.33	6.99	16.12	3.60	92.75	52.59	6.76	16.53
	I_3	2.93	92.30	50.12	6.63	14.74	3.20	91.89	51.39	6.41	15.16
	I_1	6.47	97.37	53.86	7.48	17.56	6.93	98.33	55.13	7.23	17.98
P_3	I_2	5.80	100.77	57.13	7.72	18.27	6.40	99.67	58.39	7.47	18.76
	I_3	4.80	95.71	53.66	7.40	17.35	5.33	97.79	54.93	7.16	17.76
LSD,05		NS	1.19	0.27	NS	0.16	NS	0.63	0.57	NS	NS

P_1=Flat planting in rows, P_2=Flat Broadcasting, P_3=Raised beds broadcasting,
I_1=40% ASMD, I_2=60% ASMD, I_3=80% ASMD.

Effect of planting methods and weed control treatments interaction on Tillers No. plant^{-1}, Plant height, 1000-grain weight and straw and grain yields:

Data in Table 11 exhibit that all of the measured traits were significantly altered due to planting methods and weed control treatments interaction, and the highest figures, except tillers No. plant^{-1} trait, were attained under Raised Bed Broadcasting planting method and Brominal w + Topik treatment, and such finding were true in 1st and 2nd seasons. The highest values of plant height, 1000-grain weight, straw and grain yields in 1st season comprised 103.39 cm, 59.33g, 8.40 ton fed^{-1} and 20.30 ardab fed^{-1}, respectively. The corresponding values in 2nd were 103.71cm, 60.60g, 8.12 ton fed^{-1} and 20.72 ardab fed^{-1}, respectively. in the same order of the studied traits. Although tillers No. plant^{-1} trait did not significantly influence due to planting methods and weed control treatments interaction, higher values (7.67 and 8.22) of that trait were observed under Pallas treatment as interacted with Raised Bed Broadcasting planting method, respectively, in 1st and 2nd seasons.

Table 11. Effect of planting methods and weed control treatments interaction on tillers No. plant^{-1}, plant height, 1000-grain weight and straw and grain yields in 2014/2015 and 201/2016.

Treatment		2014/2015					2015/2016				
planting method	Weed control	Tillers No. plant^{-1}	Plant height (cm)	1000-grain weight (g)	Straw yield (tonfed^{-1})	Grain yield (ard.fed^{-1})	Tillers No. plant^{-1}	Plant height (cm)	1000-grain weight (g)	Straw yield (tonfed^{-1})	Grain yield (ard.fed^{-1})
	W_1	7.00	99.42	56.19	7.59	17.90	6.44	100.22	57.46	7.34	18.32
	W_2	5.78	98.59	56.02	7.56	17.80	5.89	99.73	57.29	7.31	18.22
P_1	W_3	5.67	101.82	56.79	7.75	18.37	5.78	103.19	58.06	7.50	18.80
	W_4	4.44	87.29	48.96	6.40	14.34	4.56	89.14	50.22	6.18	14.71
	W_5	3.11	84.64	43.88	5.88	12.81	3.00	85.26	45.13	5.68	13.22
	W_1	4.78	98.54	54.30	7.21	16.78	4.78	96.36	55.57	6.98	17.18
	W_2	4.00	97.60	54.14	7.18	16.68	4.33	95.77	55.41	6.95	17.09
P_2	W_3	3.67	99.10	54.97	7.50	17.63	4.22	99.41	56.23	7.26	18.04
	W_4	2.67	89.53	46.59	6.28	13.49	2.67	85.11	47.84	6.07	13.90
	W_5	2.11	82.56	43.18	5.55	11.84	2.22	84.22	44.43	5.37	12.26
	W_1	7.67	101.82	58.7 0	8.27	19.91	8.22	102.67	59.97	8.00	20.32
	W_2	7.33	101.30	58.79	8.18	19.67	8.00	101.80	60.06	7.92	20.09
P_3	W_3	6.67	103.39	59.33	8.40	20.30	7.67	103.71	60.60	8.12	20.72
	W_4	3.78	93.42	51.18	6.93	15.99	3.89	93.19	52.44	6.70	16.41
	W_5	3.00	89.80	46.41	5.87	12.77	3.33	91.60	47.68	5.67	13.29
LSD,05		0.754	1.733	0.461	0.129	0.123	0.513	0.588	0.429	0.136	0.143

P_1=Flat planting in rows, P_2=Flat Broadcasting, P_3=Raised beds broadcasting,
W_1=Pallas, W_2=Atlantis, W_3=Brominal w + Topik, W_4=Hand weeding, W_5=Un-weeded.

Effect of irrigation techniques and weed control treatments interaction on Tillers No. plant^{-1}, plant height, 1000-grain weight and straw and grain yields

Data in Table 12 show that plant height, straw and grain yields were significantly affected due to irrigation techniques and weed control treatments interaction in 1st and 2nd seasons. The highest values of such traits were observed under 60%ASMD irrigation regime as interacted with Brominal w + Topik treatment, and amounted to 103.62 cm, 8.18 ton fed^{-1} and 19.65 ardab fed^{-1} in 1st season, respectively. In 2nd season. the corresponding values were 103.81cm, 7.91 ton fed^{-1} and 20.06 ardab fed^{-1}, respectively. The abovementioned interaction significantly influenced 1000-grain weight trait in 2nd season with the highest value reached to 59.78 g, whereas the value in 1st season still the highest (58.51 g), however, the difference did not reach to the significance level.

Table 12. Effect of irrigation techniques and weed control treatments interaction on tillers No. plant^{-1}, plant height, 1000-grain weight and straw and grain yields.

Treatment		2014/15					2015/16				
Irrigation technique	Weed control	Tillers No. plant^{-1}	Plant height (cm)	1000-grain weight (g)	Straw yield (tonfed^{-1})	Grain yield (ard.fed^{-1})	Tillers No. plant^{-1}	Plant height (cm)	1000-grain weight (g)	Straw yield (tonfed^{-1})	Grain yield (ard.fed^{-1})
I_1	W_1	7.67	99.23	55.90	7.59	17.91	7.33	99.02	57.17	7.35	18.33
	W_2	6.67	98.29	55.76	7.57	17.83	6.89	98.09	57.02	7.32	18.25
	W_3	5.78	101.07	56.36	7.76	18.40	6.56	101.57	57.62	7.51	18.81
	W_4	4.00	88.80	48.17	6.44	14.48	4.11	88.07	49.42	6.23	14.85
	W_5	3.11	85.61	44.00	5.69	12.27	3.22	86.78	45.26	5.50	12.68
I_2	W_1	6.44	102.62	57.70	7.95	18.96	6.44	101.42	58.97	7.69	19.37
	W_2	5.56	101.98	57.71	7.90	18.82	6.11	100.99	58.98	7.64	19.24
	W_3	5.56	103.62	58.51	8.18	19.65	6.00	103.81	59.78	7.91	20.06
	W_4	3.89	93.99	50.84	6.65	15.10	3.78	91.79	52.11	6.43	15.51
	W_5	2.78	86.57	45.97	5.99	13.14	2.78	87.80	47.22	5.79	13.67
I_3	W_1	5.33	97.93	55.59	7.53	17.71	5.67	98.80	56.86	7.28	18.13
	W_2	4.89	97.22	55.49	7.45	17.49	5.22	98.22	56.76	7.21	17.91
	W_3	4.67	99.62	56.22	7.71	18.25	5.11	100.93	57.49	7.46	18.69
	W_4	3.00	87.46	47.71	6.51	14.24	3.22	87.59	48.98	6.30	14.66
	W_5	2.33	84.82	43.50	5.61	12.01	2.56	86.50	44.77	5.43	12.42
LSD,05		NS	1.306	NS	0.129	0.123	NS	0.588	0.429	0.136	0.143

I_1= 40% ASMD I_2= 60% ASMD I_3= 80% ASMD W_1= Pallas, W_2= Atlantis, W_3= Brominal w + Topik, W_4= Hand weeding, W_5=Un- weeded

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دور طرق الزراعة وتقنيات الري ومعاملات مكافحة الحشائش على محصول القمح والحشائش المصاحبة وإنتاجية مياه الري

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[١] قسم بحوث المقننات المائية والري الحقلي – معهد بحوث الآراضي والمياه والبيئة

[٢] المعمل المركزي لبحوث الحشائش – مركز البحوث الزراعية – جيزة – مصر

أقيمت تجربة حقلية بمحطة البحوث الزراعية بالجميزة (وسط دلتا النيل- مصر) في الموسمين الشتويين ٢٠١٤/٢٠١٥ و ٢٠١٥/٢٠١٦ لدراسة تأثير طرق الزراعة (بدار علي المصاطب – تسطير – بدار عادي) ، تقنيات الري (الري عند استنفاذ ٤٠ أو ٦٠ أو ٨٠% من الرطوبة الميسرة (في ٦٠ سم عمق من قطاع التربة) ومعاملات مكافحة الحشائش (مبيد بلاس، مبيد اطلانتس، مبيد برومينال + مبيد توبك ، نقاوة يدوية ومعاملة المقارنة) والتفاعلات المختلفة بينهم علي محصول القمح والحشائش المصاحبة وكذا الاستهلاك المائي وانتاجية مياه الري. اختبرت المعاملات تحت الدراسة في التصميم الاحصائي القطع المنشقة مرتين في ثلاث مكررات حيث مثلت طرق الزراعة ، تقنيات الري ومعاملات مكافحة الحشائش في القطع الرئيسية ، الشقية والتحت شقية ، علي التوالي. أهم النتائج يمكن ذكرها كما يلي:- أعطت الزراعة بدار علي المصاطب أقل قيم للوزن الطازج للحشائش عريضة وضيقة الاوراق ومجموعهما، مقارنة بطريقتي الزراعة في سطور أو بدار.سجلت قيم منخفضة للاستهلاك المائي مع الزراعة بدار علي المصاطب قدرت ١٤.٧ و ١٨.٢% (متوسط الموسمين) أقل مما سجلت مع الزراعة في سطور أو بدار، علي التوالي. كان أداء نباتات القمح أفضل مع الزراعة بدار علي المصاطب حيث سجلت القيم الأعلي من عدد الافرع نبات-١، ارتفاع النباتات، وزن ال ١٠٠٠ حبة ومحصولي الحبوب والقش. علاوة علي ذلك سجلت قيم عالية لانتاجية مياه الري وصلت١٤.٧ و ١٨.٢% (متوسط الموسمين) زيادة عنها عند الزراعة في سطور أو بدار، علي التوالي.- أظهر الري عند استنفاذ ٨٠% من الرطوبة الميسرة (في ٦٠ سم عمق من قطاع التربة) قيما منخفضة للوزن الطازج للحشائش عريضة وضيقة الأوراق ومجموعهما ، وكذا أرقاما منخفضة للاستهلاك المائي لنباتات القمح قدرت ب ١٠.٣٨ و ٥.٤٢% (متوسط الموسمين) أقل من تلك التي سجلت مع الري عند استنفاذ ٤٠ و ٦٠% من الرطوبة الميسرة، علي التوالي. كان أداء نباتات القمح أفضل عند الري عند استنفاذ ٦٠% من الرطوبة الميسرة حيث سجلت ارقاما عالية لإرتفاع النباتات، وزن ال ١٠٠٠ حبة ومحصولي الحبوب والقش. سجلت القيم الأعلي من انتاجية مياه الري عند استنفاذ ٨٠% من الرطوبة الميسرة حيث وصلت الزيادة الي٢٢.٤٦ و ٢٣.٦٠% (متوسط الموسمين) عن استنفاذ ٤٠ و ٦٠% من الرطوبة الميسرة، علي التوالي.- أدي استخدام مبيد برومينال+ مبيد توبك لمكافحة الحشائش الكلية المصاحبة للقمح الي الحصول على قيم منخفضة للوزن الطازج للحشائش عريضة وضيقة الاوراق ومجموعهما كما أظهرت قيما للاستهلاك المائي أقل من معاملة المقارنة ب ١٧.٧٢ و ٩.٦٩% ، علي التوالي في موسمي الزراعة. أعطي استخدام مبيد برومينال + مبيد توبك قيما عالية لارتفاع النباتات، وزن ال ١٠٠٠ حبة ومحصولي الحبوب والقش وانتاجية مياه الري التي تراوحت بين ٤.٧٦ الي ٨٣.٣٣% و ٣.٣٣ و ٦٥.٣٣ ، علي التوالي في موسمي الزراعة. مقارنة بمعاملات مكافحة الحشائش الاخري.- -أدى التفاعل بين طريقة الزراعة (بدارعلي المصاطب) والري (عند استنفاذ ٨٠% من الرطوبة الميسرة) للحصول على أقل القيم من الوزن الطازج للحشائش عريضة وضيقة الاوراق ومجموعهما. كما أظهر هذا التفاعل زيادة معنوية لارتفاع النبات، وزن ال ١٠٠٠ حبة في الموسمين ومحصول الحبوب في الموسم الاول. أعطى التفاعل بين الري عند استنفاذ ٨٠% من الرطوبة الميسرة واستخدام برومينال+ توبك لمقاومة الحشائش قيما منخفضة من الوزن الطازج للحشائش عريضة وضيقة الاوراق ومجموعهما ومن جهة اخري أظهر قيما أعلي لارتفاع النباتات، وزن ال ١٠٠٠ حبة ومحصولي الحبوب والقش في كلا موسمي النمو. أدى التفاعل بين طريقة الزراعة علي المصاطب واستخدام مبيد برومينال+ مبيد توبك لمقاومة الحشائش قيما منخفضة من الوزن الطازج للحشائش عريضة وضيقة الاوراق ومجموعهما ومن جهة اخري أعطي قيما أعلي لارتفاع النبات، وزن ال ١٠٠٠ حبة ومحصولي الحبوب والقش في كلا موسمي النمو.- توصى الدراسة بزراعة القمح بدار علي المصاطب مع الري عند استنفاذ ٨٠% من الرطوبة الميسرة واستخدام مبيد برومينال+ مبيد توبك لمقاومة الحشائش الكلية المصاحبة والحصول على قيم مقبولة للمحصول وللاستهلاك المائي وانتاجية مياه الري.