12 *Egypt. J. Agron* . **Vol.38,** No2,pp.225-240 (2016)

Effect of Sowing Methods and Microelements Foliar Application on Bread Wheat Productivity and their Economical Feasibility

M.T. Said and F.A. Ameen[*]
Agronomy Department and [*]*Agricultural Economics Department, Faculty of Agriculture, Assiut University, Assiut, Egypt.*

TWO FIELD experiments were carried out at the Experimental Farm of Assiut University during the two successive winter seasons 2013/2014 and 2014/2015. The aim of this study was to investigate the effect of three sowing methods (*i.e* broad casting method, broad casting on the terraces with width 1.5 m and drilling on the terraces with width 1.5 m and the distance between rows 15 cm) and microelements foliar application (two levels) on two bread wheat cultivars and their economical visibility. The obtained results indicate that all measured traits exhibited significant differences in response to sowing methods; moreover, microelement foliar application scored significant differences in yield and yield components. drilling on terraces sowing method gave the highest mean value of grain and biological yields as compared with broad casting method, which is the common sowing method for wheat. Furthermore, cultivar Shandawel-1, developed in Upper Egypt, surpassed the other cultivar Misr-1 in its yield under the experiment conditions.

Keywords: Wheat, *Triticum*, Sowing method, Microelement foliar application .

Wheat is one of the most important cereal crops in the world especially in developing countries, as its production equals to 25.6 % of all cereals (FAO, 2013). In Egypt, the gap between production and consumption is about 48 % as wheat is the main source of carbohydrates (FAO, 2013). The limitation of water resources in Egypt led to develop new methods of wheat sowing to reduce the irrigation requirements of it without affecting its yield, which can maintain extra amount of water for reclaiming new soils to fill the gap of wheat production. During irrigation, water logging may cause great crop injury due to oxygen depletion, so that if we could save plants from this logging, crop yield could be enhanced. In spite of its need in small amounts, micronutrients are necessary for overall performance and health of the wheat plants (Rehm & Albert, 2006 and El-Fouly *et al.*, 2011). When plants do not receive sufficient amount of nutrients, symptoms of deficiency will appear on it and hence its growth, metabolism and reproductive phase will be affected (Potarzycki & Grzebisz, 2009). Intensive cropping systems usually led to reduction of soil fertility by the time. Microelements foliar application is very useful when roots cannot provide or absorb nutrients for any reason (Babaeian *et al.*, 2011and Parinaz *et al.*, 2012). By using the best sowing method with the appropriate method of fertilization the crop can find the best conditions for growth and gain the better yield. Therefore, the objective of this study was to investigate the effect of sowing methods and microelements foliar application on two bread wheat cultivars and their economical visibility.

Materials and Methods

Plant material and experiments

The present study was carried out at the Experimental Farm of Assiut University (lat. 27° 18' N, long 31° 16' and alt 53 m a.s.l.) during the two growing seasons 2013/2014 and 2014/2015 using two local bread wheat cultivars (CV) (*Triticum aestivum* L.), *i.e*., Misr-1 and Shandawel-1. The mechanical and chemical analyses of the experimental sites of the soil are presented in Table 1

TABLE 1. Some physical and chemical properties of experimental sites

Properties	**2013/2014**	**2014/2015**
Mechanical analysis		
Sand	26.20	26.60
Slit	24.20	23.00
Clay	49.60	50.40
Soil type	Clay	Clay
Chemical analysis		
pH	7.73	7.80
Organic matter %	1.74	1.62
Total N%	0.08	0.07
Total $CaCO_3$%	1.17	1.20

The above analysis was carried out by the Agricultural Research Center Soil, Water & Environment Res. Institute, Unit of Analysis & Studies. Sowing was done in November 20th and 25th in the first and second seasons, respectively. Nitrogen, P and K used at 220, 75 and 120 kg ha^{-1} according to the recommendation, from sources of urea (with 46% N), triple super phosphate (with 46% P_2O_5) and potassium sulfate (with 50% K_2O), respectively, were added to all treatments (plots). The field experiments were carried out using randomized complete block design (RCBD) with a strip plot arrangement of treatments with four replicates. Sowing methods and microelements foliar application were assigned to the strip plots in vertical and horizontal direction, while cultivars were arranged in the sub plots. Three sowing methods with 120 kg ha^{-1} seeding rate were used in this study as follows:

1. Broad casting method (SM_1).
2. Broad casting on the terraces with width 1.5 m (SM_2).
3. Drilling on the terraces with width 1.5 m and the distance between rows 15 cm (SM_3).

Microelement foliar application (4.0% zinc, 4.0% iron, 3.0% manganese, 0.5% copper, 1.5% boron, 0.05% molybdenum, 2.2% magnesium oxide and 1.3% sulphur) had been applied with 960 g ha^{-1} concentration using two doses one after 25 days after sowing followed by another dose after 20 days.

Characters, sampling and measurement

By the end of May after maturity, a sample of guarded plants from each sub plot was taken to measure traits including, plant height in cm, number of spikes m^{-2}, spike length in cm, spikelet number $spike^{-1}$ and 1000-kernel weight (g). Whole plots (3 x 3.5 m) were harvested and converted to t ha^{-1} for biological yield t ha^{-1}, grain yield t ha^{-1} and harvest index, in the two growing seasons. All cultural practices were done according to standard recommendations for sowing wheat in Upper Egypt. All data were analyzed using the analysis of variance (ANOVA) by MSTAT-C (1991) software package. Means were compared by revised Least Significant Difference (LSD) at 5% level of significant (Steel & Torrie, 1981).

Economic evaluation of the coefficients applied

To determine wheat farming feasibility according to three planting methods and with or without microelements foliar application, analysis was carried out on cost structure and revenue using the partial budget analyses. The analyses were done both to the total cost and cash cost using a price level and wage rate prevailing at the location (Table 10). Farming is financially and economically feasible if the gross B/C value is more than one. Formulation of the gross B/C is as follows (Benny & Andy, 2010):

Gross B/C Ratio was performed using the formula as follows:

$$\text{Gross } {}^{B}/_{C} = \frac{\mathbf{P} \times \mathbf{Q}}{\mathbf{Bi}}$$

where: **P** is Grain or straw price (LE/T), **Q** is Grain or straw yield (t / ha) and Bi is the production cost (LE/ ha)

Results and Discussion

Plant height

Results in Table 2 demonstrate that, there were significant variations in plant height in response to the sowing methods in the 1st season, while in the 2nd season it was highly significant. Moreover, cultivars and microelement foliar application had a highly significant and significant effect on plant height in the 1st and 2nd seasons, respectively. Broad casting method surpassed the other two methods and the tallest plants were 89.1 cm and 91.4 cm in the 1st and 2nd seasons, respectively. It might be due to the competition between plants, as in this method grains are not distributed in uniform spaces (Soomro *et al.*, 2009). From our results, we could find that cultivar Shandawel-1 was taller than cultivar Misr-1 in the two growing seasons (Table 3). Finally, microelement foliar application increased plant height by 4.1% and 2.4% in the 1st and 2nd seasons, respectively. This might be due to enhancing plant growth, which led to taller plants. Furthermore, there was significant interaction between cultivars and sowing method in the two growing seasons and the tallest plant (92.8 cm) have been observed on cultivar Shandawel-1 with broad casting method in the 1st season and broad casting on terraces in the 2nd season. In addition, there was highly significant interaction between sowing method and microelements application in the 2nd season only and the tallest plant (91.6 cm) was observed with broad casting method with foliar application. Moreover, the second order interaction was highly significant in the 1st season only and the tallest plant (92.8 cm) was obtained in broad casting sowing method with microelement foliar application in cultivar Shandawel-1.

TABLE 2. Effect of sowing methods (SM) and microelements foliar application (FA) on plant height of two wheat cultivars (CV) during 2013/2014 and 2014/2015 seasons

FA	Seasons	2013/2014				2014/2015			
	SM / CV	SM_1	SM_2	SM_3	Mean	SM_1	SM_2	SM_3	Mean
FA_0	Shandawel-1	89.3 ±1.6	87.3 ±2.9	86.2 ±1.0	87.6 ±1.1	92.5 ±0.9	88.3 ±0.9	89.3 ±1.5	90.0 ±0.8
	Misr-1	86.3 ±0.7	82.0 ±1.0	83.3 ±1.3	83.9 ±0.8	90.0 ±1.9	83.5 ±1.2	88.4 ±0.6	87.3 ±1.1
	Mean	87.8 ±1.0	84.7 ±1.7	84.8 ±0.9	85.7 ±0.8	91.3 ±1.1	85.9 ±1.1	88.8 ±0.8	88.7 ±0.7
FA_1	Shandawel-1	92.8 ±3.1	87.5 ±1.3	91.5 ±1.8	90.6 ±1.4	92.0 ±0.8	92.8 ±1.1	91.7 ±0.7	92.1 ±0.5
	Misr-1	88.0 ±3.4	90.3 ±0.4	84.8 ±0.2	87.7 ±1.2	91.2 ±0.6	87.1 ±0.6	89.9 ±0.0	89.4 ±0.6
	Mean	90.4 ±2.3	88.9 ±0.8	88.2 ±1.5	89.2 ±0.9	91.6 ±0.5	89.9 ±1.2	90.8 ±0.5	90.8 ±0.5
Shandawel-1		91.1 ±1.8	87.4 ±1.5	88.8 ±1.4	89.1 ±0.9	92.3 ±0.6	90.5 ±1.6	90.5 ±0.9	91.1 ±0.5
Misr-1		87.2 ±1.6	86.2 ±1.7	84.1 ±0.7	85.8 ±0.8	90.6 ±1.0	85.3 ±0.9	89.2 ±0.4	88.3 ±0.6
Mean		89.1 ±1.3	86.8 ±1.1	86.5 ±1.0	-	91.4 ±0.6	87.9 ±1.0	89.8 ±0.5	-
F_{test}	FA	**				*			
	CV	**				**			
R. $LSD_{0.05}$	SM	1.83				1.59			
	SM × FA	NS				0.69			
	FA×CV	NS				NS			
	SM × CV	2.02				2.29			
	SM × FA × CV	2.58				NS			

NS= non-significant.
*, ** = significant at 0.05 and 0.01 probability, respectively.

Number of spikes m^{-2}

The data in Tables 3 show that, number of spikes m^{-2} was affected significantly with sowing method and microelement foliar application in the two growing seasons, while, the effect of cultivars was not significant in both seasons. The highest mean value of spikes number m^{-2} was obtained from drilling on terraces method (547.5 and 524.6 spikes m^{-2} in the 1st and 2nd seasons, respectively), which exceeded all other two sowing methods. This might be due to uniform distribution of plants, which resulted in lower competition and better growing conditions. These results are in agreement with those obtained by Soomro *et al.* (2009). Foliar application with microelements had a significant and highly significant effect on plant height in the 1st and 2nd seasons, respectively as it increased number of spikes m^{-2} by 12.0 % and 12.8 % in the 1st and the 2nd seasons, respectively. This could be due to the enzymatic activity enhancement and microelements effectively increased photosynthesis (Masoud *et al.*, 2012). Likewise, the interaction between sowing methods and cultivars also have a significant effect on number of spikes m^{-2} in the first growing season only as the maximum spike density was observed in cultivar Misr-1 with drilling on terraces (565.4 spikes m^{-2}).

TABLE 3. Effect of sowing methods (SM) and microelements foliar application (FA) on number of spikes m^{-2} of two wheat cultivars (CV) during 2013/2014 and 2014/2015 seasons.

FA	Seasons / SM / CV	2013/2014				2014/2015			
		SM_1	**SM_2**	**SM_3**	**Mean**	**SM_1**	**SM_2**	**SM_3**	**Mean**
FA 0	Shandawel-1	473.0 ±33.1	489.5 ±18.9	515.2 ±27.1	492.6 ±15.0	464.0 ±7.8	483.0 ±27.9	461.0 ±12.4	469.3 ±9.9
	Misr-1	425.3 ±26.8	468.3 ±23.2	524.4 ±12.0	472.6 ±16.5	432.0 ±9.4	493.0 ±13.7	476.0 ±22.0	467.0 ±11.4
	Mean	449.1 ±21.5	478.9 ±14.4	519.8 ±13.8	482.6 ±11.1	448.0 ±8.3	488.0 ±14.4	468.5 ±12.0	468.2 ±7.4
FA 1	Shandawel-1	576.5 ±58.23	527.5 ±13.4	544.0 ±29.5	549.3 ±21.0	519.5 ±2.9	526.0 ±8.4	563.0 ±44.0	536.2 ±14.7
	Misr-1	457.0 ±31.7	530.5 ±23.3	606.3 ±7.9	531.3 ±22.1	463.5 ±43.5	499.0 ±7.3	598.5 ±8.1	520.3 ±21.9
	Mean	516.8 ±38.1	529.0 ±12.5	575.1 ±18.4	540.3 ±15.0	491.5 ±22.8	512.5 ±7.3	580.8 ±21.8	528.3 ±13.0
Shandawel-1		524.8 ±36.7	508.5 ±12.9	529.6 ±19.3	520.9 ±13.9	491.8 ±11.2	504.5 ±15.7	512.0 ±28.7	502.8 ±11.1
Misr-1		441.1 ±19.9	499.4 ±19.2	565.4 ±16.8	502.0 ±14.8	447.8 ±21.5	496.0 ±7.3	537.3 ±25.6	493.7 ±13.3
Mean		482.9 ±22.9	503.9 ±11.2	547.5 ±13.2	-	469.8 ±13.0	500.3 ±8.4	524.6 ±18.8	-
F_{test}	FA	*				**			
	CV	NS				NS			
R. LSD $_{0.05}$	SM	48.94				36.59			
	SM × FA	NS				NS			
	FA×CV	NS				NS			
	SM × CV	36.61				NS			
	SM × FA × CV	NS				NS			

NS= non-significant.
*, ** = significant at 0.05 and 0.01 probability, respectively.

Spike length (cm)

Result in Tables 4 highlight that, sowing methods affected spike length highly significant in the two growing seasons. The lowest mean value of spike length (11 cm) obtained from broadcasting method in the 1st season, however in the second season the lowest mean value (11.2 cm) was recorded by broad casting on terraces method. On the other hand, the highest mean value (12.2 cm) was obtained from drilling on terraces sowing method in the two growing seasons. The superiority of drilling method on terraces might be due to less number of spikes m^{-2}, which led to better growth conditions. These results are in agreement with those reported by Sikander *et al.* (2003). Microelement foliar application played a highly significant role in spike length in the two growing seasons, as spike length increased by 4% in both seasons. Narimani *et al.* (2010) had reported similar results. In the same trend, genetic diversity between the two cultivars affect spike length and cultivar Misr-1 surpassed Shandawel-1 in the two growing season. Finally, sowing method × cultivars had a highly significant effect on spike length in the two growing seasons; in addition, foliar application × sowing method had a highly significant and significant effect on spike length in the 1st season the 2nd seasons, respectively. Moreover, foliar application × cultivar had a significant effect on spike length in the two growing seasons. Also, the second order interaction had a highly significant on the spike length in the 2nd season only.

TABLE 4. Effect of sowing methods (SM) and microelements foliar application (FA) on spike length (cm) of two wheat cultivars (CV) during 2013/2014 and 2014/2015 seasons

FA	Seasons / SM / CV	2013/2014 SM₁	2013/2014 SM₂	2013/2014 SM₃	2013/2014 Mean	2014/2015 SM₁	2014/2015 SM₂	2014/2015 SM₃	2014/2015 Mean
FA 0	Shandawel-1	10.8 ±0.1	11.3 ±0.2	11.8 ±0.1	11.3 ±0.1	9.0 ±0.1	11.4 ±0.5	12.0 ±0.2	10.8 ±0.4
	Misr-1	9.8 ±0.1	12.3 ±0.3	12.5 ±0.3	11.5 ±0.4	12.5 ±0.2	10.7 ±0.2	11.6 ±0.2	11.6 ±0.2
	Mean	10.3 ±0.2	11.8 ±0.2	12.1 ±0.2	11.4 ±0.2	10.7 ±0.7	11.0 ±0.3	11.8 ±0.1	11.2 ±0.2
FA 1	Shandawel-1	11.6 ±0.1	10.9 ±0.5	11.4 ±0.2	11.3 ±0.2	11.8 ±0.1	11.4 ±0.5	12.2 ±0.1	11.8 ±0.2
	Misr-1	11.8 ±0.4	12.5 ±0.1	13.0 0.2	12.4 ±0.2	11.4 ±0.4	10.7 ±0.2	13.0 ±0.3	11.7 ±0.3
	Mean	11.7 ±0.2	11.7 ±0.4	12.2 ±0.3	11.9 ±0.2	11.6 ±0.2	11.0 ±0.3	12.6 ±0.2	11.7 ±0.2
Shandawel-1		11.2 ±0.2	11.1 ±0.2	11.6 ±0.1	11.3 ±0.1	10.4 ±0.5	11.4 ±0.3	12.1 ±0.1	11.3 ±0.2
Misr-1		10.8 ±0.4	12.4 ±0.1	12.8 ±0.2	12.0 ±0.2	11.9 ±0.3	10.7 ±0.1	12.3 ±0.3	11.6 ±0.2
Mean		11.0 ±0.2	11.7 ±0.2	12.2 ±0.2	-	11.2 ±0.4	11.0 ±0.2	12.2 ±0.2	-
F test	FA	**				**			
	CV	**				*			
R. LSD 0.05	SM	0.33				0.56			
	SM × FA	0.52				0.54			
	FA×CV	0.46				0.44			
	SM × CV	0.54				0.52			
	SM × FA × CV	NS				0.70			

NS= non-significant.

*, ** = significant at 0.05 and 0.01 probability, respectively.

Spikelet number spike^{-1}

It is evident from Table 5 that, sowing method had a highly significant effect on spikelet number spike^{-1} in the first growing season, while it was significant in the second growing season. The highest spikelet number spike^{-1} (21.7 and 22.0 in the 1st and 2nd seasons, respectively) was observed in sowing method drilling on the terraces. Moreover, microelement foliar application was significant in the two growing seasons and increased spikelet number spike^{-1} by 4% in both seasons. On the other hand, cultivars and all interactions hadn't any significant effect on spikelet number spike^{-1} in the two growing seasons, except the interaction between sowing method × foliar application in the 2nd season only, as it was significant and the highest mean value (22.4 spikelet spike^{-1}) was obtained from broad casting method with no foliar application. Moreover, second order interaction was significant in the second season only.

TABLE 5. Effect of sowing methods (SM) and microelements foliar application (FA) on spikelet number spike^{-1} of two wheat cultivars (CV) during 2013/2014 and 2014/2015 seasons

FA	Seasons	2013/2014				2014/2015			
	SM / CV	**SM_1**	**SM_2**	**SM_3**	**Mean**	**SM_1**	**SM_2**	**SM_3**	**Mean**
FA $_0$	Shandawel-1	18.8 ±0.3	20.0 ±0.4	22.0 ±0.4	20.3 ±0.4	22.3 ±0.2	18.5 ±0.0	22.5 ±0.9	21.1 ±0.6
	Misr-1	18.5 ±0.4	20.3 0.4	21.3 ±0.4	20.0 ±0.4	20.5 ±0.4	20.3 ±0.3	22.3 ±0.7	21.1 ±0.4
	Mean	18.7 ±0.2	20.1 ±0.3	21.7 ±0.3	20.2 ±0.3	21.4 ±0.4	19.4 ±0.4	22.4 ±0.5	21.1 ±0.4
FA $_1$	Shandawel-1	20.5 ±0.4	20.7 ±0.7	21.8 ±0.8	21.0 ±0.4	22.5 ±0.2	22.3 ±1.0	22.2 ±0.5	22.3 ±0.3
	Misr-1	20.3 ±0.8	20.7 ±0.6	21.8 ±0.6	20.9 ±0.4	22.2 ±0.3	21.2 ±0.7	21.2 ±0.4	21.5 ±0.3
	Mean	20.4 ±0.4	20.7 ±0.4	21.8 ±0.5	21.0 ±0.3	22.3 ±0.2	21.8 ±0.6	21.7 ±0.4	21.9 ±0.2
Shandawel-1		19.7 ±0.4	20.3 ±0.4	21.9 ±0.4	20.6 ±0.3	22.4 ±0.1	20.4 ±0.9	22.3 ±0.5	21.7 ±0.4
Misr-1		19.4 ±0.5	20.5 ±0.4	21.6 ±0.3	20.5 ±0.3	21.3 ±0.4	20.8 ±0.4	21.8 ±0.4	21.3 ±0.2
Mean		19.5 ±0.3	20.4 ±0.3	21.7 ±0.3	-	21.9 ±0.2	20.6 ±0.5	22.0 ±0.3	-
F $_{test}$	FA	*				*			
	CV	NS				NS			
R. LSD $_{0.05}$	SM	0.51				1.16			
	SM × FA	NS				1.31			
	FA×CV	NS				NS			
	SM × CV	NS				NS			
	SM × FA × CV	NS				1.78			

NS= non-significant.
*, ** = significant at 0.05 and 0.01 probability, respectively.

1000-kernel weight

Analysis of variance in Table 6 indicate that, sowing method had a highly significant effect on 1000-kernel weight in the two growing seasons. It increased from 41.1 g in the broad casting method to 44.9 g with drilling on terraces method in the first season, moreover in the second season, it increased by 9% under drilling on terraces method as compared to broad casting method. Similar finding was declared by Naresh *et al*. (2014). Foliar application with microelement affected 1000-grain weight highly significantl in the first season and significantly in the second season. 1000-kernel weight increased by 4% and 5% in the 1st and 2nd seasons, respectively. It seems that, microelement foliar application increase 1000-kernel weight due to enhancement of photosynthesis and more assimilate transferred to grains, which increased 1000-kernel weight (Safyan *et al.*, 2012). These results are in harmony with those obtained by Narimani *et al.* (2010). In the same trend, variation between the two genotypes had a significant effect on 1000-kernel weight in the first growing season and cultivar Misr-1 surpassed cultivar Shandawel^{-1}. Finally, all interactions were not significant except, sowing method × cultivar in the two growing seasons and the second order interaction in the 2nd season only.

TABLE 6. Effect of sowing methods (SM) and microelements foliar application (FA) on 1000-grain weight of two wheat cultivars (CV) during 2013/2014 and 2014/2015 seasons

FA	Seasons	2013/2014				2014/2015			
	CV / SM	SM_1	SM_2	SM_3	Mean	SM_1	SM_2	SM_3	Mean
FA_0	Shandawel-1	38.6 ±0.1	44.5 ±0.4	43.4 ±0.7	42.1 ±0.8	38.8 ±0.6	44.2 ±0.7	45.0 ±0.9	42.6 ±0.9
	Misr-1	41.7 ±0.3	43.1 ±0.4	44.7 ±0.9	43.2 ±0.5	42.0 ±0.5	43.4 ±0.9	42.5 ±0.3	42.6 ±0.4
	Mean	40.1 ±0.6	43.8 ±0.4	44.0 ±0.6	42.7 ±0.5	40.4 ±0.7	43.8 ±0.5	43.7 ±0.6	42.6 ±0.5
FA_1	Shandawel-1	41.7 ±0.3	45.6 ±0.2	45.5 ±0.3	44.3 ±0.6	41.9 ±0.6	45.7 ±0.5	46.2 ±0.2	44.6 ±0.6
	Misr-1	42.4 ±0.5	45.5 ±0.4	46.2 ±0.3	44.7 ±0.5	42.8 ±0.8	46.5 ±0.2	46.9 ±0.3	45.4 ±0.6
	Mean	42.0 ±0.3	45.6 ±0.2	45.8 ±0.2	44.5 ±0.4	42.4 ±0.5	46.1 ±0.3	46.6 ±0.2	45.0 ±0.4
Shandawel-1		40.1 ±0.6	45.1 ±0.3	44.4 ±0.5	43.2 ±0.5	40.4 ±0.7	45.0 ±0.5	45.6 ±0.5	43.6 ±0.6
Misr-1		42.1 ±0.3	44.3 ±0.5	45.4 ±0.5	43.9 ±0.4	42.4 ±0.5	44.9 ±0.7	44.7 ±0.9	44.0 ±0.5
Mean		41.1 ±0.4	44.7 ±0.3	44.9 ±0.4	-	41.4 ±0.5	44.9 ±0.4	45.2 ±0.5	-
F_{test}	FA	**				*			
	CV	*				NS			
R. LSD $_{0.05}$	SM	0.14				0.37			
	SM × FA	NS				NS			
	FA×CV	NS				NS			
	SM × CV	1.16				1.50			
	SM × FA × CV	NS				2.15			

NS= non-significant.
*, ** = significant at 0.05 and 0.01 probability, respectively.

These results could give an indicator that by choosing a good method for sowing wheat with good fertilizer application 1000-kernel weight might be improved.

Biological yield

There were highly significant variations in biological yield in response to the sowing methods in the 1st season, while in the 2nd season it was significant (Table 7). The highest biological yield (22.9 and 22.1 t ha^{-1} in the 1st and 2nd seasons, respectively) were obtained from drilling on terraces sowing method (Table 7). The same finding was reported by Hossain *et al.* (1992) and Naresh *et al.* (2014). On the same trend, microelement foliar application had a significant effect on biological yield in the 2nd season only and the biological yield increased by 10%. Masoud *et al.* (2012) and Mohtashami, & Hassanpour (2014) reported that, the highest biological and straw yield of wheat were obtained with microelements fertilization. Furthermore, cultivars had a highly significant effect on biological yield in both seasons and Shandawel-1 cultivar surpassed Misr-1 in the two growing seasons. In addition, all interactions were not significant, except significant effect of sowing method × cultivar and sowing method × foliar application × cultivar in the 1st season only.

TABLE 7. Effect of sowing methods (SM) and microelements foliar application (FA) on biological yield t ha^{-1} of two wheat cultivars (CV) during 2013/2014 and 2014/2015 seasons

FA	Seasons	2013/2014				2014/2015			
	SM / CV	SM_1	SM_2	SM_3	Mean	SM_1	SM_2	SM_3	Mean
FA_0	Shandawel-1	20.7 ±0.7	19.5 ±0.5	21.9 ±0.7	20.7 ±0.4	19.7 ±0.2	21.0 ±0.6	21.5 ±0.4	20.7 ±0.3
	Misr-1	17.1 ±0.7	18.6 ±0.8	22.4 ±0.8	19.4 ±0.8	18.6 ±0.5	20.2 ±0.7	20.6 ±1.0	19.8 ±0.5
	Mean	18.9 ±0.8	19.0 ±0.5	22.1 ±0.5	20.0 ±0.5	19.2 ±0.3	20.6 ±0.5	21.0 ±0.5	20.3 ±0.3
FA_1	Shandawel-1	21.2 ±0.7	20.2 ±0.7	24.3 ±0.6	21.9 ±0.6	20.8 ±0.9	22.1 ±0.7	23.6 ±1.0	22.2 ±0.6
	Misr-1	17.4 ±0.8	21.9 ±0.7	23.0 ±0.7	20.8 ±0.8	18.8 ±0.6	21.5 ±0.4	22.9 ±0.4	21.1 ±0.6
	Mean	19.3 ±0.9	21.1 ±0.6	23.6 ±0.5	21.3 ±0.5	19.8 ±0.6	21.8 ±0.4	23.2 ±0.5	21.6 ±0.4
Shandawel-1		21.0 ±0.5	19.9 ±0.4	23.1 ±0.6	21.3 ±0.4	20.3 ±0.5	21.6 ±0.5	22.5 ±0.6	21.4 ±0.3
Misr-1		17.3 ±0.5	20.2 ±0.8	22.7 ±0.5	20.1 ±0.6	18.7 ±0.3	20.9 ±0.5	21.8 ±0.7	20.4 ±0.4
Mean		19.1 ±0.6	20.1 ±0.4	22.9 ±0.4	-	19.5 ±0.3	21.2 ±0.3	22.1 ±0.5	-
F_{test}	FA	NS				*			
	CV	**				**			
R. LSD 0.05	SM	0.99				1.83			
	SM × FA	NS				NS			
	FA×CV	NS				NS			
	SM × CV	1.16				NS			
	SM × FA × CV	1.85				NS			

NS= non-significant.

*, ** = significant at 0.05 and 0.01 probability, respectively.

Grain yield

Data in Table 8 revealed that, sowing method had a highly significant effect on grain yield in both seasons. The highest mean value of grain yield (8.5 and 7.7 t ha^{-1}) was observed from drilling on the terraces sowing method in the first and the second seasons, respectively. These results are in agreement with those obtained by Abbas *et al.* (2009) and Safyan *et al.* (2012) and might be due to that, the better growth conditions help in providing enough nutrient with less competition for sun light, which enhance photosynthesis and finally increase the yield. Otherwise, it obvious from the obtained results that, microelement foliar application had a significant effect on grain yield in the second season only, hence grain yield increased by 8%. These results are in a harmony with Mohtashami & Hassanpour (2014). Moreover, there is no doubt that, cultivars due to their genetic differences affected grain yield as Shandawel-1 cultivar surpassed Misr-1 cultivar in both seasons. On the other hand, all interactions had no significant effect on grain yield, except significant effect of sowing method × cultivar in the first season only and foliar application × cultivar in the second season only.

TABLE 8. Effect of sowing methods (SM) and microelements foliar application (FA) on grain yield t ha^{-1} of two wheat cultivars (CV) during 2013/2014 and 2014/2015 seasons.

FA	Seasons	2013/2014				2014/2015			
	SM / CV	SM_1	SM_2	SM_3	Mean	SM_1	SM_2	SM_3	Mean
FA_0	Shandawel-1	6.1 ±0.3	6.9 ±0.2	8.7 ±0.1	7.2 ±0.3	5.8 ±0.2	7.3 ±0.1	7.3 ±0.1	6.8 ±0.2
	Misr-1	6.1 ±0.2	6.8 ±0.2	7.9 ±0.2	6.9 ±0.2	5.6 ±0.2	7.2 ±0.1	7.6 ±0.5	6.8 ±0.3
	Mean	6.1 ±0.2	6.8 ±0.1	8.3 ±0.2	7.1 ±0.2	5.7 ±0.1	7.2 ±0.1	7.4 ±0.2	6.8 ±0.2
FA_1	Shandawel-1	6.6 ±0.1	7.4 ±0.1	9.0 ±0.1	7.6 ±0.3	6.4 ±0.1	8.2 ±0.1	8.3 ±0.1	7.6 ±0.3
	Misr-1	6.2 ±0.2	7.1 ±0.1	8.4 ±0.0	7.3 ±0.3	5.8 ±0.3	7.6 ±0.1	7.7 ±0.6	7.0 ±0.3
	Mean	6.4 ±0.1	7.3 ±0.1	8.7 ±0.1	7.4 ±0.2	6.1 ±0.2	7.9 ±0.1	8.0 ±0.3	7.3 ±0.2
Shandawel-1		6.3 ±0.2	7.1 ±0.1	8.9 ±0.1	7.4 ±0.2	6.1 ±0.2	7.7 ±0.2	7.8 ±0.2	7.2 ±0.2
Misr-1		6.2 ±0.2	7.0 ±0.1	8.2 ±0.1	7.1 ±0.2	5.7 ±0.2	7.4 ±0.1	7.6 ±0.4	6.9 ±0.2
Mean		6.3 ±0.1	7.0 ±0.1	8.5 ±0.1	-	5.9 ±0.1	7.6 ±0.1	7.7 ±0.2	-
F_{test}	FA	NS				*			
	CV	**				*			
R. LSD 0.05	SM	0.30				0.62			
	SM × FA	NS				NS			
	FA×CV	NS				0.39			
	SM × CV	0.28				NS			
	SM × FA × CV	NS				NS			

NS= non-significant.

*, ** = significant at 0.05 and 0.01 probability, respectively.

Harvest index

Data in Table 9 show that, harvest index was affected significantly with sowing method in the first growing season, while, in the second season the sowing methods had a highly significant influence in this respect The highest values of the harvest index (37.3 and 35.8) were obtained by drilling on terraces sowing method and broad casting on terraces in the first and the second seasons, respectively. These results are in harmony with Sikander *et al.* (2003) findings. Microelement foliar application, cultivars and the interaction between foliar application of microelement and planting methods hadn't any significant effect in the two growing season. However, the interaction between sowing methods × cultivars had a highly significant effect in the 1st season only, and in the same season the second order interaction *i.e.*, planting methods × foliar application × cultivars achieved a significant effect on harvest index but in the second season they failed to implement any significant effect.

TABLE 9. Effect of sowing methods (SM) and microelements foliar application (FA) on harvest index of two wheat cultivars (CV) during 2013/2014 and 2014/2015 seasons

FA	Seasons	2013/2014				2014/2015			
	CV / SM	**SM_1**	**SM_2**	**SM_3**	**Mean**	**SM_1**	**SM_2**	**SM_3**	**Mean**
FA_0	Shandawel-1	29.7 ±1.9	35.3 ±1.6	39.9 ±0.9	35.0 ±1.5	29.2 ±1.2	34.7 ±1.2	34.0 ±0.3	32.6 ±0.9
	Misr-1	35.8 ±0.4	36.8 ±2.7	35.6 ±1.6	36.1 ±1.0	30.3 ±0.6	35.9 ±1.4	36.7 ±1.6	34.3 ±1.1
	Mean	32.8 ±1.5	36.1 ±1.5	37.8 ±1.2	35.5 ±0.9	29.7 ±0.6	35.3 ±0.9	35.4 ±0.9	33.5 ±0.7
FA_1	Shandawel-1	31.0 ±1.2	36.5 ±0.9	37.1 ±0.7	34.9 ±1.0	31.0 ±1.5	37.1 ±1.7	35.4 ±1.4	34.5 ±1.1
	Misr-1	36.0 ±1.2	32.7 ±1.3	36.6 ±1.1	35.1 ±0.8	30.7 ±0.9	35.3 ±1.1	33.5 ±2.0	33.2 ±0.9
	Mean	33.5 ±1.2	34.6 ±1.0	36.9 ±0.6	35.0 ±0.6	30.8 ±0.8	36.2 ±1.0	34.4 ±1.2	33.8 ±0.7
Shandawel-1		30.4 ±1.1	35.9 ±0.9	38.5 ±1.7	34.9 ±0.9	30.1 ±0.9	35.9 ±1.0	34.7 ±0.7	33.6 ±0.7
Misr-1		35.9 ±0.6	34.8 ±1.6	36.1 ±0.9	35.6 ±0.6	30.5 ±0.5	35.6 ±0.8	35.1 ±1.3	33.7 ±0.7
Mean		33.1 ±0.9	35.3 ±0.9	37.3 ±0.6	-	30.3 ±0.5	35.8 ±0.6	34.9 ±0.7	-
F_{test}	FA	NS				NS			
	CV	NS				NS			
R. LSD $_{0.05}$	SM	2.34				2.44			
	SM × FA	NS				NS			
	FA×CV	NS				NS			
	SM × CV	2.32				NS			
	SM × FA × CV	3.67				NS			

NS= non-significant.

*, ** = significant at 0.05 and 0.01 probability, respectively.

Economic efficiency indicators in case of not using of microelements foliar application

The ratio of income to cost represents the revenue on the unit of money invested, when this ratio is equal to or greater than one, the economic efficiency is achieved, and when it was less than one, indicates lower economic efficiency. When estimating the proportion of total income to the total cost of two wheat cultivar, Shandawel-1 and Misr-1 using three different cultivation methods without microelements foliar application (Tables 10 and 11). It turns out that the third method of sowing was the best way in both cultivars, with B/C about 1.84, 1.96 and 2.16 for SM_1, SM_2 and SM_3, respectively for cultivar Shandawel-1, while it reached about 1.70, 1.90 and 2.12 for SM_1, SM_2 and SM_3, respectively for the other cultivar.

When we compare the net return from wheat per hectare for our experiment for both cultivars Shandawel-1 and Misr-1 with a net return from wheat per hectare in the region, according to estimates by the Directorate of Agriculture in Assiut (Table 11), it showed that SM_3 was the best method with NGI 2.05 and 1.71 for Shandawel-1 and Misr-1, respectively.

Economic efficiency indicators in case of using microelements foliar application

When estimating the proportion of total income to the total cost of two wheat cultivars Shandawel-1 and Misr-1 using three different cultivation methods with microelements foliar application (Table 11). It turns out that, SM_3 was the best Sowing method in both cultivars, with B/C about 1.91, 2.07 and 2.33 for SM_1, SM_2 and SM_3, respectively for cultivar Shandawel-1, while it recorded about 1.69, 2.05 and 2.20 for SM_1, SM_2 and SM_3, respectively, using cultivar Misr-1

When we compare the net return from wheat per hectare for our experiment for both cultivars Shandawel-1 and Misr-1 with a net return from wheat per hectare in the region, according to estimates by the Directorate of Agriculture in Assiut (Table 2), it turns out that, SM_3 was the best method with NGI 2.05 and 1.86 for Shandawel-1 and Misr-1, respectively. From these findings we conclude that, SM_3 sowing method of wheat is the best method as compared with the other two methods in case of using microelements foliar application neither nor did not using it.

Conclusion

From our study we can notice that foliar application with microelements made an enhancement for wheat yield under the experiment conditions. In addition, by modifying the sowing method of wheat to be more uniform plant distribution and avoiding water logging during the growing season we can improve the amount of yield. Also Economic evaluation of the study showed that by using foliar application of micro elements with drilling on terraces sowing method we gain the highest profit.

TABLE 10. Production cost of sowing methods (SM) and microelements foliar application using two wheat cultivars during 2013/2014 and 2014/2015 seasons.

Cost component (LE/ha)		Shandawel-1			Misr-1		
		SM_1	SM_2	SM_3	SM_1	SM_2	SM_3
Seed		360.0	360.0	360.0	360.0	360.0	360.0
Tractor rent and soil preparation		912.0	1032.0	1152.0	912.0	1032.0	1152.0
Sowing		144.0	144.0	0.0	144.0	144.0	0.0
Pesticide		576.0	576.0	576.0	576.0	576.0	576.0
Fertilization		1776.0	1776.0	1776.0	1776.0	1776.0	1776.0
Cost of microelements foliar application		240.0	240.0	240.0	240.0	240.0	240.0
Harvesting		2400.0	2400.0	2400.0	2400.0	2400.0	2400.0
Land rent		8640.0	8640.0	8640.0	8640.0	8640.0	8640.0
Total cost with microelements foliar application		15048.0	15168.0	15144.0	15048.0	15168.0	15144.0
Total cost without microelements foliar application		14808.0	14928.0	14904.0	14808.0	14928.0	14904.0
Grain yield	(t /ha)	6.0	7.1	8.0	5.9	7.0	7.8
	(LE/t)	16800.0	19880.0	22400.0	16520.0	19600.0	21840.0
Straw	(Heml/ha)	14.3	13.2	13.7	12.0	12.4	13.8
	(LE/t)	11440.0	10560.0	10960.0	9600.0	9920.0	11040.0
Total revenue without microelements foliar application	(LE/ha)	28240.0	30440.0	33360.0	26120.0	29520.0	32880.0
Grain	(t /ha)	6.5	7.8	8.7	6.0	7.4	8.1
	(LE/t)	18200.0	21840.0	24360.0	16800.0	20720.0	22680.0
Straw	(Heml/ha)	14.5	13.4	15.3	12.1	14.4	14.9
	(LE/t)	11600.0	10720.0	12240.0	9680.0	11520.0	11920.0
Total Revenue with microelements foliar application	(LE/ha)	29800	32560	36600	26480	32240	34600

Heml=250 kg

Source: Ministry of agriculture and land reclamations, Economic Affairs Sector, 2015.

TABLE 11. Financial analysis and economic indicators of sowing methods (SM) and microelements foliar application using two wheat cultivars during 2013/2014 and 2014/2015 seasons

Financial profit	Shandawel-1			Misr-1		
	SM_1	SM_2	SM_3	SM_1	SM_2	SM_3
Without microelements foliar application						
Total cost	15384.00	15504.00	15480.00	15384.00	15504.00	15480.00
Total revenue	28240.00	30440.00	33360.00	26120.00	29520.00	32880.00
Net Profit	12856.00	14936.00	17880.00	10736.00	14016.00	17400.00
B/C Ratio	1.84	1.96	2.16	1.70	1.90	2.12
NGI	1.26	1.47	1.76	1.06	1.38	1.71
With microelements foliar application						
Total cost	15624.00	15744.00	15720.00	15624.00	15744.00	15720.00
Total revenue	29800.00	32560.00	36600.00	26480.00	32240.00	34600.00
Net Profit	14176.00	16816.00	20880.00	10856.00	16496.00	18880.00
B/C Ratio	1.91	2.07	2.33	1.69	2.05	2.20
NGI	1.39	1.65	2.05	1.07	1.62	1.86
Net Profit of wheat crop in Assiut Governorate season 2014-2015						
Total cost	11447.6	11447.6	11447.6	11447.6	11447.6	11447.6
Total revenue	21615.16	21615.16	21615.16	21615.16	21615.16	21615.16
Net Profit	10167.56	10167.56	10167.56	10167.56	10167.56	10167.56

NGI =Net gain investment
Source: Ministry of agriculture and land reclamations, Economic Affairs Sector, 2015.

Acknowledgments : The authors gratefully acknowledge to Prof. Dr. Elssady, A. Ali and Dr. Alhosein Hamada for their kind help during this study. Also authors gratefully thanks the staff of Agronomy Department farm at Assiut University for their excellent technical assistance.

Reference

Abbas, G., Ali, M.A., Abbas, G., Azam, M. and Hussain, I. (2009) Impact of planting methods on wheat grain yield and yield contributing parameters. *Journal of Animal & Plant Science,* **19**, 30-33.

Babaeian, M., Tavassoli, A., Ghanbari, A., Esmaeilian, Y. and Fahimifard, M. (2011) Effects of foliar micronutrient application on osmotic adjustments, grain yield and yield components in sunflower (*Alstar cultivar*) under water stress at three stages. *African Journal of Agriculture Research,* **6**, 1204-1208.

Benny, R. and Andy, S. (2010) Break even point and profitability analysis of rice farming trough integrated crop management in Lebak District, Banten, *Indonesian Journal of Agriculture*, **3,** 127-130.

El-Fouly, M. M., Mobarak, Z. M. and Salama, Z.A. (2011) Micronutrients (Fe, Mn, Zn) foliar spray for increasing salinity tolerance in wheat *Triticum aestivum* L. *African Journal of Plant Science*, **5**, 314-322

FAO (2013) http://www.fao.org (Computer search)

Hossain, M.A. and Maniruzzaman, A.F.M. (1992) Response of Wheat (*Triticum aestivum*) to method of sowing and fertilizer placement. *Indian Journal of Agronomy*, **37**, 710-715.

Masoud, B., Abdolshahi, R., Mohammadi-Nejad, G., Yousefi, K. and Tabatabaie, S.M. (2012) Effect of different microelement treatment on wheat (*Triticum aestivum* L.) growth and yield, *International Research Journal of Applied and Basic Sciences*, **3**, 219-223.

Ministry of Agriculture and Land Reclamations (2015), Economic Affairs Sector**.**

Mohtashami, R. and Hassanpour, B. (2014) Examination of the effects of microelements on bread wheat (*Triticum aestivum*) production in choram, iran. *Agriculture Science Developments*, **3**, 330-332.

Naresh, R. K., Tomar, S., Purushottam, S., Singh, S.P., Kumar, D., Pratap, B., Kumar, V. and Nanher, A.H. (2014) Testing and evaluation of planting methods on wheat grain yield and yield contributing parameters in irrigated agro-ecosystem of western Uttar Pradesh, India. *African Journal of Agricultural Research*, **9**, 176-182.

Narimani, H., Rahimi, M.M., Ahmadikhah, A. and Vaezi, B. (2010) Study on the effects of foliar spray of micronutrient on yield and yield components of durum wheat. *Archives of Applied Science Research*, **2**, 168-176.

Parinaz, K., Jalilian, J. and Pirzad, A. (2012) Effect of foliar application of micronutrients on yield and yield components of safflower under conventional and ecological cropping systems. *International Research Journal of Applied Basic Science,* **3**, 1460-1469.

Potarzycki, J. and Grzebisz, W. (2009) Effect of zinc foliar application on grain yield of maize and its yielding components. *Plant Soil Environment*, **55**, 519-527.

Rehm, G. and Albert, S. (2006) Micronutrients and production of Hard Red Spring Wheat. *Minnesota Crop News*, March **7**, 1-3.

Safyan, N., Naderidarbaghshahi, M.R. and Bahari, B. (2012) The effect of microelements spraying on growth, qualitative and quantitative grain corn in Iran. *International Research Journal of Applied Basic Science*, **3**, 2780-2784.

Sikander, K.T., Hussain I., Sohail, M., Kissana, N. S. and Abbas, S. G. (2003) Effects of different planting methods on yield and yield components of wheat. *Asian Journal of Plant Sciences*, **2**, 811-813.

Soomro, U. A., Rahman, M. U., Odhano, E.A., Gul, S. and Tareen, A. (2009) Effects of sowing method and seed rate on growth and yield of wheat (*Triticum aestivum*). *World Journal of Agriculture Science,* **5**, 159-162.

Steel, G. D. and Torrie, J. H. (1981) "*Principles and Procedures of Statistics"* 2*nd* (ed.) McGraw-Hill Book Company. Inc. N. Y. xxi – 633pp.

Received 2/7/2016;
accepted 16/8/2016)

تأثير طرق الزراعة والرش الورقي بالعناصر الصغري على إنتاجية قمح الخبز والجدوي الاقتصادية لها

محمد ثروت سعيد وفالح عبد النعيم امين *
قسم المحاصيل و* قسم الاقتصاد الزراعي - كلية الزراعة - جامعة أسيوط، - أسيوط – مصر.

أجريت تجربتان حقليتان في المزرعة البحثية لجامعة أسيوط خلال الموسمين الشتوي ٢٠١٤/٢٠١٣ و٢٠١٥/٢٠١٤. وكان الهدف من هذه البحث هو دراسة تأثير طرق الزراعة (ثلاث طرق و هم الزراعة بدار فى احواض والزراعة بدار على مصاطب ١,٥ متر واخيرا الزراعة بالتسطير على مصاطب) والرش الورقي بالعناصر الصغري (مستويين) على انتاجية صنفين من قمح الخبز و معرفة الجدوى الاقتصاديه لذلك ولخصت اهم النتائج في أن جميع الصفات التى تمت دراستها أظهرت اختلافات معنوية في الاستجابة لطرق الزراعة ،علاوة على ذلك سجلت معاملة الرش الورقي بالعناصر الصغري اختلافات معنوية في المحصول ومكوناته، كما وجد ان طريقة الزراعة بالتسطير على مصاطب حققت أعلى قيمة من متوسط محصول الحبوب والمحصول البيولوجي بالمقارنة بطريقة الزراعة البدار الأكثر شيوعا في زراعة القمح في مصر، اضافة الى ذلك فقد تفوق صنف شندويل-١ المربى تحت ظروف صعيد مصر على صنف مصر-١ في المحصول تحت ظروف التجربة.