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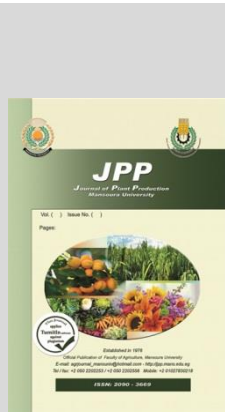
Effectiveness of Organic and Bio-Fertilization on Reduce Rates of Mineral Nitrogen Fertilizers and Impact on Productivity of some Wheat Cultivars

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ABSTRACT

Present study was conducted during two winter seasons of 2017/2018 and 2018/2019 in farm (Ghazala Village), Faculty of Agriculture, Zagazig University, to evaluate the impact of seven fertilization treatments *i.e.* F₁: humic acid (4 kg/fad), F₂: F₁+50% recommended dose of nitrogen (37.5 kg N/fad), F₃: commercial organic-fertilizer (3G-101), F₄: F₃+50% recommended dose of nitrogen (37.5 kg N/fad), F₅: yeast extract, F₆: F₅+ 50% recommended dose of nitrogen(37.5kg N/fad) and F₇: 75kgN/fad (recommended dose), on productivity of two wheat cultivars *i.e.* Shandawel-1 and Misr 2. Results alluded that Shendawel-1 cultivar surpassed Misr2 cv in each of chlorophyll content (SPAD unit), flag leaf area (cm²), spike length (cm), number of spikelets and grains/spike, 1000 grain weight (g), spike weight, number of spikes/m², biological, straw and grain yields as well as harvest index (HI). Treatment F₂ outperformed others in chlorophyll content. Treatment F₆ recorded the highest value in each of: flag leaf area, plant height, spike length, number of spikelets and grains/spike, 1000 grain weight, number of spikes/m², biological, straw and grain yields/fad and protein content. Treatment F₁ gave the lowest values for the previous traits, but give higher harvest index compared to treatment F₅. Grain yield/fad positively and significantly correlated with plant height, spike length, No. of spikeletes/spike, 1000 grain weight, spike weight and number of spikes/m².

Keywords: Wheat, cultivars, yeast extract, humic acid, organic fertilization.

INTRODUCTION

Wheat (*Triticum aestivum*, L) is one of the most important cereal crops used in human food and animal feed globally and in Egypt. Increasing wheat production is an essential national target.

Nutrition is essential for plant life and yield therefore, the mineral fertilization is a common agronomic practice that leads to improve crop productivity. Nitrogen is the most important nutrient supplied to most non-legume crops, including wheat. The important roles of N in the plant is its presence in the structure of protein and nucleic acids, which are important for building and formation substances in every cell. In addition, N is also found in structure of chlorophyll that enables plants to convert energy from sunlight by photosynthesis. Thus, N supply to the plant will influence the amount of protein, amino acids, protoplasm and chlorophyll formation. Moreover, it influences cell size, leaf area and photosynthetic activity (Azeez, 2009; Daneshmand *et al.*, 2012; Namvar *et al.*, 2012; Diacono *et al.*, 2013; Piccinin *et al.*, 2013). Therefore, adequate supply of N is necessary to achieve high yield potential in crops. N fertilizer is known to affect the yield and yield components of wheat (Kizilkaya, 2008; Wortman *et al.*, 2011). But, with the steadily prices increasing of chemical fertilizers especially nitrogen fertilizers, it has become an economic problem and expensive input, in addition soil and water pollution. So,

management methods that decrease requirements for agricultural chemicals are needed in order to avoid adverse environment impacts. So, it was an urgent need to studies about reducing the use of chemical fertilizers while maintaining the productivity of the unit area of wheat (Abdel-Lateef, 2018). Therefore, it is necessary to go to reduce the added quantities of chemical fertilizers and compensate by using organic or bio-fertilizers as a safe alternative and to maintain soil fertility and high productivity of the crop. Basha (2004) and Abdel- Aal *et al.* (2007) observed that combined application of organic and inorganic fertilizer increased the growth and yield of wheat than when any of the fertilizer was used alone.

Yeast extract was suggested to participate in a beneficial role during vegetative and reproductive growth through improving flower formation and their set in some plants due to its high auxin and cytokinins content and enhancement of carbohydrates accumulation (Mahmoud, 2001 and Bevilacqua *et al.*, 2008). Also, its stimulatory effects on cell division and enlargement, protein and nucleic acid synthesis and chlorophyll formation was reported (Wanas, 2002), in addition to its content of cryoprotective agent, *i.e.* sugars, protein, amino acids and several vitamins. Moreover, improving growth, flowering and fruit set by using foliar application with yeast extract was reported by Abou-Aly (2005) and Wanas (2006).

Humic acid is water-soluble organic acid naturally present in soil organic matter. It can be recognized that

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humic substances (HS) have many beneficial effects on soil structure and soil microbial populations, as well as, increase modify mechanisms involved in plant growth stimulation, cell permeability and nutrient uptake (Rahmat *et al.*, 2010). On the other hand, Delfine *et al.* (2005) investigated the effect of humic acid application on growth and yield of durum wheat, they specified that the application of humic acid caused a transitional production of plant dry mass with respect to unfertilized control. However, more research is needed to evaluate the effectiveness of humic acid as an organic fertilizer and to compare higher humic acid rates that an increase crop production (Daur, 2013).

Therefore, this experiment was conducted to study the effect of combined organic fertilizer, humic acid and commercial organic-fertilizer, biofertilizer "yeast" and urea form (50% N as a slow release nitrogen) on improving growth, yield, quality and its attributes and chemical constituents of wheat cultivars Misr2 and shandewel-1, under the conditions of the experimental farm, Faculty of Agriculture in Ghazala, Zagazig University, Sharkia Governorate.

MATERIALS AND METHODS

Site Description and Soil Analysis:

Two field experiments were conducted at the Experimental Farm (Ghazala Village), Zagazig district, Faculty of Agriculture, Zagazig University, Sharkia Governorate Egypt, during the two successive winter seasons of 2017/2018 and 2018/2019. The objective of these experiments were study the effectiveness of yeast extract, humic acid and organic fertilizer in reducing mineral nitrogen fertilizer rates and their impact on wheat productivity. The preceding crop was Rosell (*Hibiscus sabdarriffa*, L) in first season and corn (*Zea mays*) in second one. Before sowing, experimental soil samples were randomly collected from the top soil layer (0-30 cm) for estimating some mechanical and chemical properties of soil according to Jackson (1973). Mechanical and chemical analyses of soil (Table 1) were carried out in Central Laboratory Faculty of Agriculture, Zagazig University.

Table 1. Soil mechanical and chemical analyses of the experimental site.

Soil analyses	Averaged two seasons
Soil mechanical analysis	
Sand%	22.63
Clay %	46.70
Silt %	30.67
Soil texture	clay
Soil chemical analysis	
Organic matter%	1.04
Soil EC ds/m	1.88
p ^H	7.99
Available N (meg/l)	58.91
Available P (meg/l)	8.95
Available K (meg/l)	148.10

Studied Factors and Experimental Design:

Each experiment included fourteen treatments which were the combination of two wheat cultivars (Misr2

and Shandawel-1) and seven fertilization treatments as follows:-

- F1:** Humic acid (4 kg/fad), was applied as potassium humate-granules (MONBAND) 67.25% humic acid.
- F2:** F₁ +50% of recommended dose of nitrogen (37.5 kg N/fad).
- F3:** Commercial organic-fertilizer (3G -101) natural organic-fertilizer (chemical analysis of 3G -101 presented in Table 2).
- F4:** F₃ + 50% of recommended dose of nitrogen (37.5 kg N/fad).
- F5:** Yeast extract (20ml/L), was prepared from brewer's yeast (*Saccharomyces cerevisiae*), dissolved in water followed by adding sugar at a ratio of 1:1 and kept 24 hours for reproduction according to the methods of Morsi *et al.* (2008). Chemical analysis of yeast extract according to Mahmoud (2001) is presented in Table (3).
- F6:** F₅ + 50% recommended dose of nitrogen (37.5 kg N/fad).
- F7:** 75 kg N / fad (recommended dose), (fad = faddan= 4200 m²).

Table 2. Chemical analysis of the commercial organic-fertilizer (3G -101)

Structure	(%)	structure	(%)
Gibberellic	2	Cu	0.25
N	3	Mo	0,9
K	4.7	Mg	0,6
P	0.53	SL	0.35
Fe	0.4	S	1
zn	1.3	Si	0.01
Mn	0.5	Co	0.15

The source: label on the product bottle

Table 3. Chemical analysis of yeast extract

Amino acids mg/100g dry weight	Vitamins and carbohydrates mg/100g dry weight
Arginine	Vitam.B1 2.23
V	Vitam.B2 1.33
Isoleucine	Vitam.B6 1.25
leucine	Vitam.B12 0.15
Lysine	Thiamin 2.71
Methionine	Riboflavin 4.96
Phenyl alanine	Inositol 0.26
Threonine	Biotin 0.09
Tryptophan	Nicotinic acid 39.88
Valine	Pantothenic acid 19.56
Glutamic acid	P amino benzoic acid 9.23
Serine	Folic acid 4.36
Aspartic acid	Pyridoxine 2.90
Cystine	Total carbohydrates 23.20
Proline	Glucose 13.33
Tyrosine	1.49

The experimental design was a complete randomized blocks in three replications in each season, the experimental plot area was 9 m² (3 m x 3 m). Grains of wheat were obtained from Wheat Research Department, Algemmezah Research Station, Egypt.

Experimental Procedures:

The basal doses of P and K fertilizers as calcium superphosphate (15.5% P₂O₅) and potassium sulphate

(48%K₂O) were added at soil preparation. Sowing date was on 25 and 18 of November in the first and second seasons, respectively. Urea (46.5%) was used as source of nitrogen which was applied in two equal doses, before the first and second irrigation. Humic acid and yeast extract rates were sprayed three times during the growth period (30, 45 and 60 days after sowing). Treatments were sprayed handly. Other cultural practices for growing wheat were conducted as recommended.

Data Measurement

Yield and yield attributes

Chlorophyll content (Chl.) was determined quantitatively in five developed leaves at 75 days from sowing using a self-calibrating SPAD chlorophyll meter (Model 502, Spectrum Technologies, Plainfield, IL) as described by Monje and Bugbee (1992).

Flag leaf area (cm²), it was measured at 75 days from sowing according to Gardner *et al.* (1985) as follow:

Leaf area = leaf length x maximum leaf width x 0.75.

At harvest, ten random spikes were chosen in each plot to measure: spike length (cm), number of spikelets/spike, number of grains/pike, spike grain weight (g) and thousand grain weight (g), plant height (cm) (Mean of 10 plants) was also recorded at harvest. One square meter was randomly taken in each plot to measure each of: number of spikes/m² (No. of fertile tillers), biological, grain and straw yields and converted to ton/fad, as well harvest index (%) was calculated as a ratio of grain yield to biological yield (Abdel-Gawad *et al.*, 1987).

Chemical analysis

Grain nitrogen content (%), was estimated by the modified Kjeldahl's method according to AOAC (1980). Grain protein content was calculated by multiplying total nitrogen by 5.9. Protein yield (kg /fad), was calculated by multiplying the crude protein content by seed yield/fad (kg) and dividing by 100.

Statistical Analysis

The obtained data were analyzed with the appropriate method of statistical analysis of variance (ANOVA) as described by Gomez and Gomez (1984) by using MSTAT-C software, and the means were compared using least significant differences (LSD test) at 0.05 level of probability (Waller and Duncan, 1969). The error mean squares of randomized complete blocks design were Homogenous (Bartlett's test), the combined analysis was calculated for all studied traits in both seasons. Simple correlation coefficient was calculated between grain yield/fad., and the other attributes by using the data of combined analysis.

RESULTS AND DISCUSSION

Chlorophyll content (%) and Flag leaf area (cm²):

Cultivars variation

Results shown in Table 4 reveal that wheat cultivars differed significantly in chlorophyll content (%) and flag leaf area (cm²) during the second season and the combined analysis of both seasons, where Shandawel-1 cultivar was superior to Misr2 cultivar for both traits. These results may be due to the genetic variability between the two tested cultivars and the response of each to the environmental conditions during the growing seasons. The same trend emerged from the differences between cultivars in several studies such as Said and Abd El-Moneem (2016) where they found that Shandawel-1 had the highest content of chlorophyll in both seasons. Withal, Shambhoo *et al.* (2016) placed significant differences between wheat genotypes in total chlorophyll content. Moreover, Seleiman and Abdel-Aal (2018) recorded significant differences among the wheat cultivars in total chlorophyll and flag leaf area.

Table 4. Chlorophyll content (%) and flag leaf area (cm²) of wheat cultivars as affected by fertilization treatments and their interaction during 2017/ 2018 and 2018/ 2019 seasons and their combined.

Treatment	Chlorophyll content (%)			Flag leaf area(cm ²)		
	2017/ 2018	2018/ 2019	Comb.	2017/ 2018	2018/ 2019	Comb.
Cultivar :- (V)						
Misr 2	38.95	38.09 b	38.52 b	34.60	34.73 b	34.67 b
Shandawel-1	40.11	41.01a	40.66 a	35.70	36.04 a	35.87 a
F.test	NS	*	*	NS	*	*
Fertilization treatment: (F)						
F ₁	29.20 e	28.92 d	29.06 g	21.49 de	23.80 d	22.65 e
F ₂	45.58 a	44.63 a	45.11 a	36.89 d	34.89 c	35.89 d
F ₃	39.23 cd	39.57 c	39.40 e	21.57 e	23.56 d	22.57 e
F ₄	41.90 b	41.36 bc	41.63 c	39.70 c	38.32 b	39.01 c
F ₅	37.72 d	39.16 c	38.44 f	38.41 c	40.88 b	39.65 c
F ₆	42.20 b	42.65 b	42.43 b	45.16 a	43.23 a	44.20 a
F ₇	40.87 c	40.55 c	40.71 c	42.85 b	43.03 a	42.94 b
F test	*	*	*	*	*	*
Interaction:-						
VxF	NS	NS	*	NS	NS	NS

Where: F₁: humic acid, F₂:F₁ + 50%N (37.5 kg), F₃: Organic fertilizer, F₄:F₃ +50%N (37.5 kg), F₅: Yeast extract, F₆:F₅+ 50%N (37.5 kg) and F₇: Recommended dose (75 kg N/ fad).

Effect of fertilization treatments

Results recorded in Table 4 show that chlorophyll content (%) and flag leaf area (cm²) were affected significantly by different fertilization regimes in both seasons and their combined analysis. The treatment F₂

(humic acid + 50% recommended dose of nitrogen) recorded the maximum chlorophyll content (%), which valued 45.58, 44.63 and 45.11 in 1st, 2nd seasons and the combined, respectively. Treatment F₆ (yeast extract + 50% recommended dose of nitrogen) ranked second. From these

results, an increase in leaf content of chlorophyll could be observed in the fertilization treatments that combined 50% of the mineral fertilizer with any form of the biological or organic fertilizers that used in the study compared to the single addition of them. Increase in chlorophyll content referred to the favorable effect of humic acid and yeast extract for improving growth. Regarding to flag leaf area (cm²), F₆ recorded the highest value (44.20 cm²) followed by F₇ treatment (42.94 cm²). The minimum chlorophyll content (29.06 %) and flag leaf area (22.65 cm²) were recorded due to application humic acid only (F₁) (combined results). In this connection, El-Hawary *et al.* (2019) avowed that differences between plants fertilized with 215 kg N/ha and those received 145 kg N/ha plus foliar application of yeast extract were effectless regarding photosynthetic pigments. Otherwise, Mona, Dawood *et al.* (2013) on soybean, attested that all concentrations of yeast extract caused significant increases in chlorophyll a. Moreover, they added that yeast extract at 2, 3 and 4% caused significant increases in chlorophyll a+b.

Yield and yield attributes

Cultivars variation

The results present in Tables (5 ,6 ,7 and 8) clarify that there were significant differences between the two wheat cultivars (Misr2 and Shandawel-1) in spike length(cm), number of spikelets/spike, number of grains /spike, 1000 grain weight (g), number of spikes/m², grain weight/spike(g), biological, straw and grain yields (ton/fad) in combined analysis. While the differences between cultivars did not reach to significant level for characteristics of plant height (cm), harvest index (%), protein content (%) and protein yield kg/fad.

Results present in Table 5 show that Shandwel-1 cultivar was significantly superior over Misr2 cultivar in spike length and No. of spikelets/spike, the increase in these traits are mainly due to ability of cultivar in forming metabolites and its translocation from source to sink. Significant difference between wheat cultivars in spike length and No. of spikelets/spike were also recorded by EL- Hawary and Shahein (2015), Anwar *et al.* (2016), El-hag, Dalia (2016), Kandil *et al.* (2016), El-Hag, Dalia (2017), El -Hag, Dalia and El Mantawy, Rania (2017), Galelah *et al.* (2018) and El-Hawary *et al.* (2019).

Results presented in Table 6 show in general that, Shandawel-1 cv surpassed Misr2 cv in number of grains/spike, 1000 grain weight (g), number of spikes/m² and grain weight/spike (g). The disparity in 1000 grain weight and grain weight/spike among studied wheat cultivars might be due to the genetic makeup reflecting on grain filling rate and translocation of biochemical assimilates from source to sink. Several investigators observed significant differences among wheat cultivars in number of grains/spike, 1000 grains weight (g), number of spikes/ m² and grain weight/spike (g) such as Abd El-Kreem, Thanaa and Ahmed (2013), El-Hag, Dalia and El Mantawy, Rania (2017), Ali and Alsaady (2019) and El-Hawary *et al.* (2019).

Results illustrated in Table 7 exhibited that, Shandawel-1 wheat cultivar show superiority compared to Misr2 cultivar in biological, straw and grain yields/fad. The increase of shandawel-1 cv over Misr2 cv reached about

3.9 %, 3.1 % and 9.7 % in combined analysis for biological, straw and grain yields/fad, respectively. This superiority in biological and straw yields are to be expected since the same cultivar gained the highest mean values of plant height and number of spikes/m² consequently produced higher biological and straw yields. Also, the superiority of shandawel-1 cv in grain yield might be attributed to its superiority in yield components, i.e. number of spikes/m², No. of grains/spike and grain weight/spike (g). These results are in harmony with those obtained by Atia and Ragab (2013), Shambhoo *et al.* (2016), Osman and Nor Eidein, Gehan(2017), Galelah *et al.* (2018), El-Hawary *et al.* (2019) and Ibrahim *et al.* (2020).

Results shown in Table 8 reveal that the differences between cultivars in traits of the harvest index, grain protein content and protein yield do not reached to significant level, spite of, the high harvest index value for Shandawil-1 cv and the increase in protein content of Misr 2 cv. Studies conducted by Abd EL-Hameed and Ash-Shormillesy, Salwa (2005) and El-Hawary *et al.* (2019) recorded significant differences among barley cultivars in harvest index and protein content.

Effect of fertilization treatments

Results documented in Tables (5, 6, 7 and 8) clearly show the significant differences among fertilization treatments in each of plant height (cm), spike length (cm), number of spikelets/spike, number of grains/spike, 1000 grain weight (g), number of spikes/m², biologic, straw, grain and protein yields (ton/fad). Furthermore, grain weight/spike (g), harvest index (%) and protein content (%) showed significant response to fertilization treatments during the combined analysis. Perusal of the results in Table 5, it is obvious that the greatest value for each of plant height, spike length and number of spikelets/spike was in favor of fertilization regime included spraying with yeast extract + 50 % of recommended mineral fertilizer treatment (F₆) followed by F₇ treatment (100% mineral nitrogen) compared to other fertilization systems. Also, means comparison showed that spike length and number of spikelets/spike under either organic fertilizer 50% + mineral fertilizer (F₄) or yeast extract only (F₅) treatments were keeping and without significant variation than F₆ treatment, while, the lowest values were recorded by application of humic acid only (F₁) treatment in the two seasons and combined analysis. Enhancing effect of yeast on plant height may be due to that yeast is a natural source of phytohormones especially cytokinins which enhance cell division and cell enlargement, it gave the tallest plants according to enhancement of dry matter accumulation and stored in spike, therefore gave increase in spike length (El-Sheshtawy and Hager, 2015). Generally, from these results it becomes clear that fertilization with 50% mineral + (organic fertilizer) or 50% mineral + yeast extract gave the same result as adding 100% mineral. In this respect, El-Hawary *et al.* (2019) recorded no significant differences between plants fertilized with 215 kg N/ha and those received 145 kg N/ha plus foliar application of yeast extract compared to adding organic fertilizers alone (humic acid only) as it gave the lowest results. The stimulatory effect of yeast extract can be attributed to the increased

contents of different nutrients as well as the concentration of protein, vitamin B and natural plant growth regulators such as cytokynine (Table 3). The physiological roles of vitamins and amino acid in yeast extract can increase the metabolic processed levels of endogenous hormones which encourage the growth. These results are in agreement with those obtained by Hemdan *et al.* (2016), Seadh *et al.* (2017), El-Hawary *et al.* (2019) and Mokhtar *et al.* (2020).

The results presented in Table 6 show that F₆ treatment recorded the highest value in each of number of grains/spike, 1000 grain weight (g), number of spikes/m² and grain weight/spike(g), while F₁ treatment gave the lowest values in these traits. It is also evident from the aforementioned table that F₅ and F₇ treatments are similar in their effect on number of grains/spike and outnumber the other fertilization treatments. The difference between

fertilization treatments F₆ and F₇ did not reach to level of significance in No. of spikes/m², in addition, F₃ treatment gave the lowest grains weight/spike (2.251 g). El-Hawary *et al.* (2019) scored insignificant differences between plants fertilized with 215 kg N/ha and those received 145 kg N/ha plus foliar application of yeast extract regarding for 1000- grain weight. Such effects of fertilization treatments might have been due to the hormonal balance activating physiological and biochemical processes in plant, and also may be due to its effect on nitrogen metabolism in the plant which reflected on a better growth, more dry matter accumulation and stimulation the building of metabolic products accompanied with foliar nutrition plants with foliar fertilizers which contain yeast extract (Shehata *et al.*, 2012). Similar trends were obtained by Attia and Abd El Salam (2016) and AL-Amin *et al.* (2017).

Table 5. Plant height (cm), spike length (cm) and number of spikelets / spike of wheat cultivars as affected by fertilization treatments and their interaction during the 2017/ 2018 and 2018/ 019 seasons and their combined.

Treatment Cultivar :- V	plant height (cm)			spike length (cm)			Number of spikelets/ spike		
	2017/2018	2018/2019	Comb.	2017/2018	2018/2019	Comb.	2017/2018	2018/2019	Comb.
Misr2	107.16 b	109.12	108.14	12.84 b	12.87 b	12.85 b	22.46	22.23 b	22.35 b
Shandawel-1	108.91 a	111.63	110.27	13.62 a	13.51 a	13.56 a	23.17	23.83 a	23.50 a
F.test	*	NS	NS	*	*	*	NS	*	*
Fertilization treatment : F									
F ₁	95.32 e	97.89 e	96.605 f	12.37 c	12.70	12.54 c	22.07 c	21.97 c	22.02 d
F ₂	107.68 c	111.46 c	109.57 d	13.50 a	12.80	13.15 ab	22.67 bc	22.97 ab	22.82 bc
F ₃	99.27 d	101.66 d	100.46 e	12.63 bc	12.93	12.78 bc	22.42 bc	22.47 bc	22.44 cd
F ₄	110.27 bc	112.33 bc	111.30 cd	13.57 a	13.47	13.52 a	23.07 ab	23.00 ab	23.03 ab
F ₅	111.52 b	114.62 b	113.07 bc	13.30 ab	13.37	13.34 a	23.00 ab	23.47 ab	23.23 ab
F ₆	119.51 a	119.47 a	119.49 a	13.60 a	13.57	13.59 a	23.27 a	23.73 a	23.50 a
F ₇	112.67 b	115.19 b	113.93 b	13.63 a	13.47	13.55 a	23.23 a	23.63 ab	23.43 a
F test	*	*	*	*	NS	*	*	*	*
Interaction:-									
VxF	NS	NS	*	NS	NS	NS	NS	NS	NS

Where: F₁: humic acid, F₂:F₁ + 50%N (37.5 kg), F₃: Organic fertilizer, F₄:F₃ +50%N (37.5 kg), F₅: Yeast extract, F₆:F₅+ 50%N (37.5 kg) and F₇: Recommended dose (75 kg N/ fad).

Table 6. Number of grains /spike, 1000 grain weight (g), number of spikes / m2 and grain weight / spike (g) of wheat cultivars as affected by fertilization treatments and their interaction during the 2017/ 2018 and 2018/ 019 seasons and their combined.

Treatment Cultivar :- V	Number of grains /spike			1000 grain weight (g)			Number of spikes / m ²			Grain weight / spike (g)		
	2017/2018	2018/2019	Comb.	2017/2018	2018/2019	Comb.	2017/2018	2018/2019	Comb.	2017 /2018	2018/2019	Comb.
Misr2	64.38	66.15 b	65.26 b	36.40	37.13 b	36.77 b	346.30 b	364.4 b	350.3 b	2.347	2.538 b	2.443 b
Shandawel-1	66.65	69.33 a	67.99 a	37.59	38.29 a	37.94 a	352.50 a	381.3 a	371.9 a	2.505	2.695 a	2.600 a
F.test	NS	*	*	NS	*	*	*	*	*	NS	*	*
Fertilization treatment:F												
F ₁	63.92c	65.95bc	64.93bc	34.95 e	35.47f	35.21f	243.30 d	265.50 e	254.4 d	2.340	2.517	2.429 c
F ₂	64.7c	66.72c	65.71b	35.23d	35.69f	35.46ef	327.50 c	340.30 d	333.9 c	2.351	2.525	2.438 c
F ₃	60.77d	64.4d	62.58c	35.69d	36.08e	35.88e	355.70 b	374.30 c	365.0 b	2.175	2.328	2.251 d
F ₄	63.23	67.18b	65.20b	36.32cd	37.27d	36.80d	368.50ab	388.70 c	378.6 b	2.369	2.541	2.455 c
F ₅	66.65b	68.6b	67.62a	37.63c	38.58c	38.10c	373.20ab	403.30 b	388.3 b	2.470	2.687	2.578 b
F ₆	70.4a	71.47a	70.93a	40.31a	41.35a	40.83a	386.70 a	411.30ab	399.0 a	2.717	2.955	2.836 a
F ₇	68.93b	69.88b	69.40a	38.84b	39.55 b	39.19b	391.00 a	426.70 a	408.9 a	2.562	2.764	2.663 b
F test	*	*	*	*	*	*	*	*	*	NS	NS	*
Interaction:-												
VxF	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	*	*

Where: F₁: humic acid, F₂:F₁ + 50%N (37.5 kg), F₃: Organic fertilizer, F₄:F₃ +50%N (37.5 kg), F₅: Yeast extract, F₆:F₅+ 50%N (37.5 kg) and F₇: Recommended dose (75 kg N/ fad).

Table 7. Biological, straw and grain yield (ton /fad) of wheat cultivars as affected by fertilization treatments and their interaction during the 2017/ 2018 and 2018/ 2019 seasons and their combined.

Treatment	Biologic yield/ fad(ton)			Straw yield/ fad(ton)			Grain yield / fad(ton)		
	2017/ 2018	2018/ 2019	Comb.	2017/ 2018	2018/ 2019	Comb.	2017/ 2018	2018/ 2019	Comb.
Cultivar :- V									
Misr2	9.945	9.991 b	9.971 b	6.570 b	6.393	6.481 b	3.372 b	3.598 b	3.485 b
Shandawel-1	10.234	10.481 a	10.36 a	6.856 a	6.515	6.682 a	3.682 a	3.966 a	3.824 a
F.test	NS	*	*	*	NS	*	*	*	*
Fertilization treatment:									
F									
F ₁	6.650 d	6.891 f	6.770 f	4.243 c	3.846 c	4.044 d	2.407 f	3.045 e	2.726e
F ₂	9.420 c	9.608 e	9.514 e	6.243 b	6.043 b	6.143 c	3.177 e	3.557 d	3.367 d
F ₃	9.638 c	9.831 d	9.734 e	6.216 b	6.123 b	6.165 c	3.422 de	3.708 c	3.565 c
F ₄	9.893 c	10.055 d	9.974 d	6.291 b	6.255 b	6.272 c	3.602 cd	3.800 c	3.701 c
F ₅	11.275 b	11.454 c	11.364 c	7.443 a	7.434 a	7.446 b	3.812 bc	4.020 b	3.916 b
F ₆	12.095 a	12.073 a	12.084 a	7.900 a	7.806 a	7.853 a	4.195 a	4.267 a	4.268 a
F ₇	11.660 ab	11.750 b	11.705 b	7.660 a	7.672 a	7.665 ab	4.000 ab	4.078 b	4.039 ab
F test	*	*	*	*	*	*	*	*	*
Interaction:-									
VxF	*	*	*	NS	*	*	NS	NS	*

Where: F₁: humic acid, F₂:F₁ + 50%N (37.5 kg), F₃: Organic fertilizer, F₄:F₃ +50%N (37.5 kg), F₅: Yeast extract, F₆:F₅+ 50%N (37.5 kg) and F₇: Recommended dose (75 kg N/ fad).

Table 8. Harvest index (%), protein content (%) and protein yield (kg)/fad of wheat cultivars as affected by fertilization treatments and their interaction during the 2017/ 2018 and 2018/ 2019 seasons and their combined.

Treatment	Harvest index (%)			Protein content (%)			Protein yield (kg)/fad		
	2017/ 2018	2018/ 2019	Comb.	2017/ 2018	2018/ 2019	Comb.	2017/ 2018	2018/ 2019	Comb.
Cultivar :- V									
Misr2	33.92 b	36.01	34.96	9.96 a	10.29 a	10.12	335.72	370.23	352.68
Shandawel-1	35.97 a	37.84	36.92	9.15 b	9.41 b	9.28	336.94	373.20	354.86
F.test	*	NS	NS	*	*	NS	NS	NS	NS
Fertilization treatment:									
F									
F ₁	36.20	44.19 a	40.27 a	8.792	8.93	8.86 d	211.28 e	267.72 f	239.67 f
F ₂	33.73	37.05 b	35.40 bc	8.877	9.12	9.00 cd	282.02 d	315.75 e	298.89 e
F ₃	35.53	37.72 b	36.64 bc	8.985	9.26	9.12 c	307.47 c	333.16 cd	320.31 c
F ₄	36.40	37.79 b	37.10 b	9.813	10.27	10.04 a	353.27 c	372.89 de	363.08 d
F ₅	33.82	35.10 c	34.47 c	10.52	10.33	10.43 a	401.02 b	422.90 b	411.96 b
F ₆	34.67	35.34 c	35.01 bc	10.35	10.86	10.60 a	434.18 a	441.63 a	437.91 a
F ₇	34.31	34.71 c	34.51 c	9.533	10.22	9.876 b	381.32 b	388.76 bc	385.04 b
F test	NS	*	*	NS	NS	*	*	*	*
Interaction:-									
VxF	NS	NS	NS	*	NS	*	*	NS	NS

Where: F₁: humic acid, F₂:F₁ + 50%N (37.5 kg), F₃: Organic fertilizer, F₄:F₃ +50%N (37.5 kg), F₅: Yeast extract, F₆:F₅+ 50%N (37.5 kg) and F₇: Recommended dose (75 kg N/ fad).

Results recorded in Table 7 (combined analysis) show that the highest biological (12.084 ton/fad), straw (7.853 ton/fad) and grain (4.268 ton /fad) yields were obtained from F₆ treatment (yeast extract + 50% mineral nitrogen). F₁ fertilization treatment gave the lowest value for each of biological, straw and grain yields (6.770, 4.044 and 2.726 ton /fad, respectively). The relative increase present in biological, straw and grain yields were about (78.49%, 94.19% and 56.57%, respectively) when fertilized with F₆ treatment compared to F₁ treatment. Barnett *et al.* (1990) mentioned that, yeast extract may play a beneficial role in improving flower formation and their set of some plants as well as enhancing the accumulation of carbohydrate due to its high auxin and cytokinin contents. Other researchers found that grain yield of wheat

was increased by application of 50 % chemical fertilizer + 50% poultry manure (Al-Amin *et al.*, 2017), 75 kg mineral nitrogen (El-Seidy *et al.*, 2017). El-Hawary *et al.* (2019) ensured that non-significant differences were observed between plants fertilized with 215 kg N/ha and those received 145 kg N/ha plus foliar application of yeast extract respecting to grain yield.

It can be concluded that bio-fertilizers in combination with chemical fertilizer may increase availability and uptake of nutrient for wheat plants. The increment in yield and its components may be due to the increase in vegetative growth of plants and effects of bio-fertilizer on enhancing root growth and dry matter accumulation. Atta and Abd El-Salam (2016) and El-

Metwally *et al.* (2018) purported that the use of bio-fertilizers (yeast extract) may have additional benefits such as increasing the phytohormones *i.e.* Indole acetic acid (IAA), Gibberellins (GA3) and Cytokines like substances (CKs) which plays an important role in formation a large active root system and hence, increasing water and nutrients uptake, photosynthesis rate and translocation. The obtained results are in harmony with previous findings of Karimi and Marashi (2017), Khalilzadeh *et al.* (2018) and Singh *et al.* (2018).

Looking at the results in Table 8, it is clear that the highest values of grain protein content (10.60%) and protein yield (437.91kg/fad) were obtained due to application of F₆ treatment, during the combined analysis without significant differences among F₄, F₅ and F₆ concerning grain protein content (%). The lowest values recorded for protein content and protein yield were obtained when plants fertilized by the treatment F₁ (8.86 % and 239.67 kg/fad, respectively). The increase present in protein content was about (19.64 %) and about (82.71%) for protein yield when fertilized by F₆ treatment compared to F₁ treatment. The increase in the protein content when adding treatment F₆ is due to contribution of yeast to produce the growth hormones and the role of nitrogen fertilizer to support a photosynthetically active of wheat canopy ensuring grain yield and to produce storage protein in the wheat grain (Gaballah and Gomaa, 2004). Other researchers found that protein yield of wheat was increased by application of 50 % chemical fertilizer + 50% poultry manure (Al-Amin *et al.*, 2017), 75 kg mineral nitrogen (El-Seidy *et al.* 2017). However, El-Hawary *et al.* (2019) found that non-significant differences were observed between plants fertilized with 215 kg N/ha and those received 145 kg N/ha plus foliar application of yeast extract for grain yield. Results at the same Table clear that the highest value for harvest index was recorded by adding F₁ treatment with an increase of about (16.82%) compared to F₅ treatment. On the other hand, F₅ treatment, F₇ and F₆ produced the lowest values of harvest index in the second season and combined analysis, The increase of harvest index caused by added humic acid (F₁) may be due to increasing grain yield per fad as a ratio from biological yield per fad, thus increased harvest index (El-Sheshtawy and Hager 2015).

Interaction effect

Results in Table (4), show that interactions effect between cultivars and fertilization treatments was significant on chlorophyll content (combined analysis) and was insignificant on flag leaf area in both seasons and combined analysis. From Fig.1, it is clear that, the highest value for chlorophyll content was resulted from the interaction between Shandawel-1 cultivar with F₆ fertilization treatment (foliar with yeast extract+ 50% mineral nitrogen), while the lowest one was obtained with F₁treatment (plants foliated with humic acid only).

Results in Table 5 show that the interaction relationships between the two wheat cultivars and the seven fertilization treatments under study were significant in each of plant height, grain weight/spike, biological, straw and grain yields/fad and protein content. Interaction effect was nonentity on each of, spike length, number of

spikelets/spike, number of grains/spike, 1000 grain weight and number of spike/m² in both seasons and combined analysis.

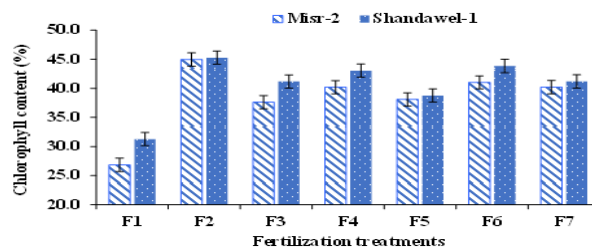


Fig. 1. Chlorophyll content of wheat as influenced by interaction between cultivars and fertilization treatments in the combined analysis.

From Fig. 2 it could be noted that the tallest plants were resulted from shandawel-1 cultivar when fertilized by F₆ fertilization treatment (yeast extract +50% mineral nitrogen), while the shortest plants were obtained from the same cultivar with F₁ fertilization treatment (humic acid only).

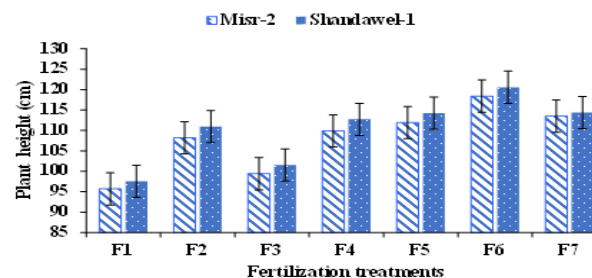


Fig. 2. Plant height (cm) of wheat as influenced by the interaction between cultivars and fertilization treatments in the combined analysis.

Fig. 3 views that shandawel-1 and Misr2 cultivars recorded the maximum grain weight/spike when fertilized by F₆ treatment, while, F₃ fertilization treatment recorded the minimum values of grain weight/spike for the two cultivars.

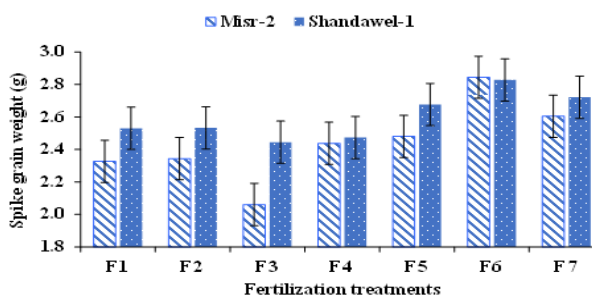


Fig. 3. Spike grain weight (g) of wheat as influenced the interaction between cultivars and fertilization treatments in the combined analysis.

Fig. 4 show that both shandawel-1 and Misr2 cultivars recorded the best values for biologic yield/ fad when fertilized by F₆, F₇ and F₅ treatments, respectively, where fertilization treatments were arranged as follows F₆ > F₇ > F₅ , while, F₁ fertilization treatment both cultivars interaction recorded lowest value for biologic yield/ fad.

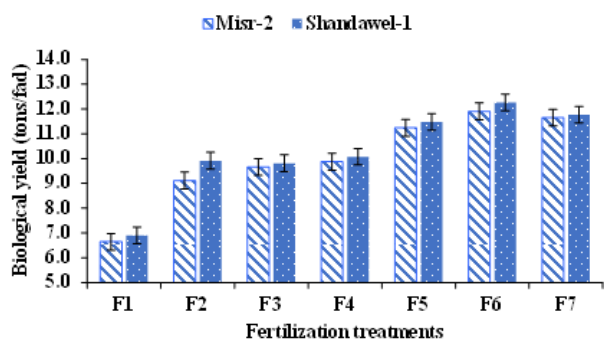


Fig. 4. Biological yield/fad (ton) of wheat as influenced the interaction between cultivars and fertilization treatments in the combined analysis

Also, the interaction effect between the seven fertilization treatments and the two wheat cultivars in the straw and grain yields/fad (Fig. 5 and Fig. 6) took the same trend as biological crop where the best values were obtained by F₆, F₇ and F₅ treatments, respectively for the two cultivars. The lowest values for straw and grain yields/fad were recorded by the two cultivars when fertilization with the F₁ treatment was done where fertilization treatments were arranged as follows F₆ > F₇ > F₅ > F₄ > F₃ > F₂ > F₁.

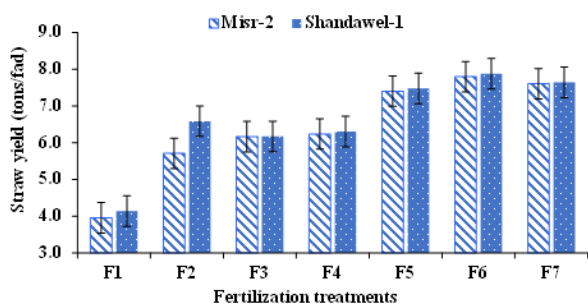


Fig. 5. Straw yield /fad (ton) of wheat as influenced the interaction between cultivars and fertilization treatments in the combined analysis

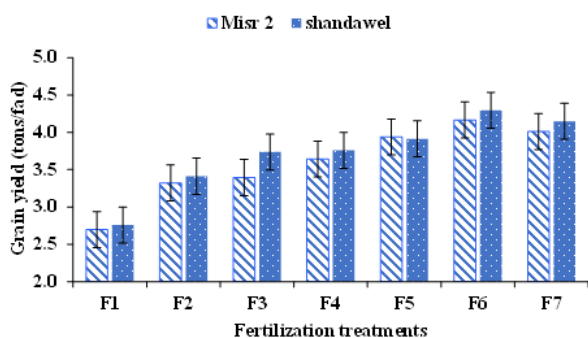


Fig. 6. Grain yield (ton)/ fad of wheat as influenced the interaction between cultivars and fertilization treatments in the combined analysis

It can be noticed from Fig. 7 that the tested cultivars showed various responses to fertilization systems for protein content. It is interesting to note that the most pronounced interaction for increasing protein content was happened when the plants of cultivar Misr2 were fertilized by F₆ treatment. Moreover, Shandawel-1 cultivar ranked

second rank when its plants received the same fertilization treatment, while F₁ fertilization treatment recorded the minimum values for protein content in both cultivars. The fertilization treatments were ranked as follows: Misr2 F₆ > F₅ > F₇ > F₄ > (F₃, F₂) > F₁ and Shandawel-1 F₆ > F₅ > F₄ > F₇ > F₃ > F₂ > F₁.

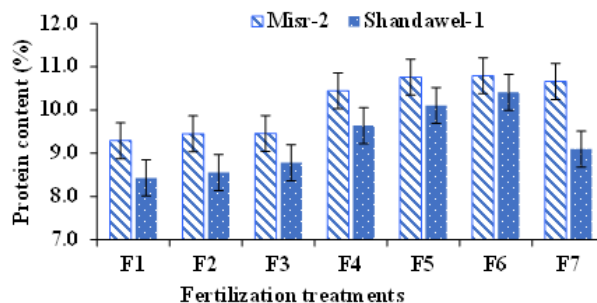


Fig. 7. Protein content % of wheat as influenced the interaction between cultivars and fertilization treatments in the combined analysis.

Yield analysis

Correlation study

The inter relationships among grain yield of wheat and its attributes as affected by the studied factors as simple correlation are shown in Table (9). It is evident that correlation between grain yield and all yield attributing characters (plant height, spike length, No. of spikelets/spike, 1000 grain weight, spike weight and No. of spikes/m²) was positive and significant. The correlation was positive and highly significant regarding number of spike/m² (**0.9078). These results are in agreement with those reported by Abd El-Hameed and Ash-Shormillesy, Salwa (2005), Athar *et al.* (2016) and Ebrahimnejad and Rameeh (2016).

Also, plant height was positive and significant correlated with each of spike length, No. of spikelets /spike, 1000 grain weight, Spike weight and number of spikes/m². Weak relation was seen between plant height and No. of grains/spike (0.2596).

In addition, there were positive and significant correlation between spike length and the following characters: No. of spikelets/spike, 1000 grain weight, spike weight and number of spikes/m², and not significant with No. of grains/spike only.

Number of spikelets /spike showed positive and significant correlation coefficient with each of 1000 grain weight, spike weight and number of spike/m², while positive and not significant with number of grains/spike (0.3043). Number of grains/spike appeared positive and highly significant correlation coefficient with spike weight while that correlation with number of spikes/m² was negative and not significant with 1000 grain weight.

Besides, 1000 grain weight showed positive and highly significant correlation coefficient with spike weight and positive and significant with number of spikes/m².

Moreover, spike weight showed weak relation with number of spikes / m².

Table 9. Simple correlation coefficient between grain yield (ton/fad) and other characters of wheat for combined analysis.

Characters	Plant height	Spike length	No. of spikelets /spike	No. of grains/spike	1000 grain weight	Spike weight	No. of spike /m ²
1-Grain yield	0.7711*	0.4433*	0.5697*	0.1861	0.7891*	0.6009*	0.9078**
2- Plant height		0.5010*	0.5029*	0.2596	0.7244*	0.5997*	0.7058*
3- Spike length			0.6136*	0.2932	0.4706*	0.4408*	0.4232*
4-No. of spikelets /spike				0.3043	0.5717*	0.5341*	0.5652*
5- No. of grains/spike					0.3919*	0.8165**	-0.0358
6- 1000 grain weight						0.8503**	0.6636*
7- Spike weight							0.3976
8- No. of spike /m ²							--

CONCLUSION

The results obtained from this study summarized that wheat yield influenced strongly by cultivar differences, fertilization treatments. Shandawel-1 was superior in all traits nearly. Moreover, the results showed that applying F6 fertilization treatment (50% mineral nitrogen + foliar yeast extract) gave the best value for wheat yield and its attributes compared with 100% recommended does from mineral nitrogen or other organic fertilizer treatments under this study. That is, it is possible to reduce the addition of chemical nitrogen fertilizers by 50% and foliar with yeast extract while obtaining the same yield from the wheat crop. Thus, we can contribute to reducing soil and water pollution with low additions of mineral fertilizers and reduce production costs on farms.

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فاعلية التسميد العضوي والحيوي في خفض معدلات الأسمدة النيتروجينية المعدنية وتأثيرها على إنتاجية بعض أصناف القمح.

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أقيمت تجربتان حقلية خلال الموسم الشتوي من عامي 2018 و 2019 م بالمزرعة التجريبية (بقرية غزالة) التابعة لكلية الزراعة - جامعة الزقازيق - محافظة الشرقية، بهدف دراسة فاعلية استخدام صور مختلفة من الأسمدة وهي: أسمدة عضوية (حمض الهيومك والمخصب 3G 101)، أسمدة حيوية (مستخلص الخميرة) ومقارنتها بالصورة الكيماوية (الأسمدة النيتروجينية) في خفض المعدلات المستخدمة من الأسمدة النيتروجينية المعدنية بغرض الحد من التلوث وتقليل تكاليف الإنتاج لصنفين من القمح (مصر 2 وشندويل 1) وكانت معاملات الدراسة كما يلي :- F₁: الرش بحامض الهيومك فقط، F₂: F₁ + 50% من الجرعة الموصى بها من السماد النيتروجيني (37.5 كجم نتروجين)، F₃: الرش بمخصب عضوي تجاري (3G101)، F₄: F₃ + 50% من الجرعة الموصى بها من السماد النيتروجيني (37.5 كجم نتروجين)، F₅: الرش بمستخلص الخميرة، F₆: F₅ + 50% من الجرعة الموصى بها من السماد النيتروجيني (37.5 كجم نتروجين)، F₇: 75 كجم نتروجين / فدان. واستخدم تصميم القطاعات كاملة العشوائية في ثلاث مكررات. وتتلخص أهم النتائج المتحصل عليها فيما يلي :- وجود اختلافات معنوية بين صنفى الدراسة في غالبية الصفات تحت الدراسة في كلا الموسمين وتحليل التباين المشترك. أظهر الصنف شندويل 1- تفوق معنوي علي الصنف مصر 2 في كل من: محتوى الأوراق من الكلوروفيل، مساحة ورقة العلم، طول السنبل، عدد السنبيلات/سنبل، عدد حبوب السنبل، وزن الحبة، وزن الـ 1000 حبة، وزن حبوب السنبل، عدد السنبال / م²، المحصول البيولوجي، القش والحبوب/فدان في حين لم يصل الفرق بين صنفى الدراسة إلي مستوي المعنوية في كل من: ارتفاع النبات، دليل الحصاد، نسبة البروتين في الحبوب ومحصول البروتين/فدان. تفوقت المعاملة F₂ (حامض الهيومك + 50% من الجرعة الموصى بها من الأسمدة النيتروجينية) في صفة محتوى الكلوروفيل حيث أعطت أعلى القيم يليها المعاملة F₆ (مستخلص الخميرة + 50% من الجرعة الموصى بها من الأسمدة النيتروجينية) بينما أعطت المعاملة F₁ (حامض الهيومك فقط) أقل القيم لمحتوي الكلوروفيل. سجلت المعاملة F₆ (مستخلص الخميرة + 50% من الجرعة الموصى بها من الأسمدة النيتروجينية) أعلى القيم في كل من: مساحة ورقة العلم، ارتفاع النبات/سم، طول السنبل/سم، عدد السنبيلات/سنبل، وزن الـ 1000 حبة، عدد السنبال/م²، المحصول البيولوجي، القش والحبوب/ فدان ومحتوي البروتين بينما أعطت المعاملة F₁ (الرش بحمض الهيومك فقط) أقل القيم للصفات السابقة في حين أعطت أعلى قيمة لصفة دليل الحصاد بالمقارنة بالمعاملة F₅ التي أعطت أقل قيمة لصفة دليل الحصاد وكذلك المعاملات F₆ و F₇. يتضح أيضا أن المعاملات السامة F₄، F₅ و F₆ تشابهت في تأثيرها علي صفة نسبة البروتين بالحبوب. كذلك لم تكن الفروق معنوية بين المعاملات F₆ و F₇ في صفات طول السنبل، عدد السنبيلات/سنبل، عدد حبوب السنبل، عدد السنبال/م² ومحصول القش والحبوب/ فدان. أي أنه يمكن تقليل إضافة الأسمدة النيتروجينية الكيماوية بنسبة 50% والرش بمستخلص الخميرة مع الحصول علي نفس الإنتاجية من محصول القمح. وبذلك نقل من تلوث التربة والمياه بالإضافة المنخفضة من الأسمدة المعدنية وخفض تكاليف الإنتاج. أظهر محصول الحبوب/ فدان ارتباط موجب ومعنوي جداً مع صفة عدد السنبال/ م²، وارتباط معنوي وموجب مع كل من ارتفاع النبات، طول السنبل، عدد السنبيلات/ سنبل ووزن الـ 1000 حبة. التوصية: توصي الدراسة بزراعة صنف القمح شندويل 1- وخفض الكمية المضافة من الأسمدة النيتروجينية المعدنية إلى النصف والرش بمستخلص الخميرة للحصول علي أعلى إنتاجية من القمح وبالتالي الحد من تلوث التربة والمياه بالأسمدة الكيماوية.