Menoufia J. Soil Sci., Vol. 1 December (2016): 163 - 176

EFFECT OF SOIL AND FOLIAR APPLICATIONS OF NP COMPAINED WITH GA_3 ON YIELD COMPONENTS OF WHEAT

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Received: Aug. 24 , 2016 **Accepted: Oct. 18 , 2016**

ABSTRACT: *A field experiment was conducted during the two successive winter season 2014/2015 and 2015/2016 at a privet farm, Damas Village, Mitghamr, 30° 48′ 42″ N, 31° 19′ 0″ E Dakahliya Governorate, Egypt with wheat plants (Triticum aestivum L.,Sakha 93 C.) was grown in clay soil. The experimental design was a randomized complete block design with three replicates. The aim of the present study the effects of foliar spray and soil applications of N and P compaind with gibberellic acid GA_3 to reduce the environmental impact of use of mineral fertilizers on some vegetative growth characters of wheat plant on some macro-nutrients (N, P and K) content and uptake in grain and straw yields of wheat. Results indicated that plant height, number of tillers, dry weight, and weight of 1000 grains, grains, and straw yield affected by application of mineral fertilizer with GA_3 gave highest values compared with the treatment without foliar by GA3. Chlorophyll A, B, and carotenoids values were varied based on the types of applied fertilizers. Foliar spray of GA_3 significant increase in chlorophyll A, B, carotenoids of all studied treatments. The highest performance was attained with (T9) 50% N and 50% P of the recommended doses + foliar spray 6 % urea and 3% P without GA_3. On the other hand the above mentioned with GA_3 exhibited more pronounced increase. The highest carotenoids, Total sugars, T.S.C. and T.H.C. it was attained from (T9) followed (T8) 50% N and 50% P of the recommended doses + foliar spray 4 % of urea and 3% of P without GA_3 and with GA_3 respectively. Improve in the NPK and protein content of all treatment under study compared to the treatment control (T1) 100% of the recommended of mineral fertilizers, positive responses for all nutrients content of wheat grains and straw to foliar spray of GA_3, compared to without foliar GA_3 spraying.*

Key words: *Wheat plants, GA_3 foliar spray N, P mineral fertilizer*

INTRODUCTION

Foliar spray fertilization of crops can complement soil fertilization. *Fageria, et al., (2009)* However, the integration of soil application and foliar fertilization was most promising in enhancing the plant growth. The integration of recommended chemical fertilizers with foliar fertilizers further increased the plant growth. Hence, foliar fertilization is considered as an environmentally friendly fertilization technique. Urea can be supplied to plants through the foliage, facilitating optimal N management, which minimizes N losses to the environment.

Rama et al.,(2014) revealed that, foliar application could enhance decompensate such depression in the order GA_3> Si >SA affecting the leaves content of both chlorophyll A and B.It can be said that the N content was additionally, it was suppressed by the application of gibberellic acid GA_3 while enhanced by salicylic acid (SA) and silicon Si application. *Mahmoody and Noori (2014)* found that foliar application of GA_3 and nutrients had improved the productivity and stimulated enzyme protein synthesis. *Muhammad et al., (2006)* obtained that, significant increase was recorded in number of spikes m^{-2}, grains $spike^{-1}$, weight thousand grains, of biological yield and grain yield with foliar application of macro and micro nutrients. *Cline and Trought (2007)* observed that the increase in fruit weight following single applications of GA_3 was associated with greater longitudinal, suture,

and lateral fruit diameters in comparison with untreated control fruit. On the other hand applications of GA_3 increased the lateral diameter of the fruit, but had no effect on fruit longitudinal and suture diameters. Also GA_3 treatments increased fruit firmness by 5% compared with untreated control fruit. *Mosali et al., (2006)* found that foliar applications of P generally increased grain yield and P uptake versus no foliar P. Results also suggested that low rates of foliar applied P might correct mid-season P deficiency in winter wheat, and that might result in higher P use efficiencies. *Khan and Parveen (2012) and Saeed et al., (2012)* concluded that soil application of nitrogen at 100-120 kg N ha^{-1} and sulfur at 20-35 kg S ha^{-1} and foliar at 10 kg N ha^{-1} in split doses at various growth stages can be practiced to get appreciable growth and yield of wheat crop. *Gul et al., (2011)* studied that, the effect of foliar application of nitrogen (N), potassium (K) and zinc (Zn) solutions on the growth of wheat cultivar (variety) Ghazanive-98. i.e., emergence of plants m^{-2}, number of tillers m^{-2}, and plant height (cm). Results showed that number of plants emerged m^{-2}, number of tillers m^{-2}, and plant height (cm) were significantly affected Maximum values of emergence m^{-2}, number of tillers, and plant height, were recorded in those plots which were sprayed with 0.5% N, 0.5% K and 0.5% Zn at solutions two times, while the minimum were recorded in the control plots. *Fageria et al., (2009)* concluded that soil application method is more common and most effective for nutrients, which required in higher amounts. Soil applications of fertilizers are mainly done on the basis of soil tests, whereas foliar nutrient applications are mainly done on the basis of visual foliar symptoms or plant tissue tests. Hence, correct diagnosis of nutrient deficiency is fundamental for successful foliar fertilization. *Zaman et al. (2015)* added that foliar of urea application significantly increased plant height, branch, leaf number, leaf area, fresh and dry leaf weight, leaf N content and uptake by stevia. Most of the parameters were increased with the advancement of growth period from 30 to 60 days after planting. The foliar spray of 2.0g L^{-1} urea solution was found to be most effective for enhancing the growth, leaf yield and yield attributes of stevia plants. Further more increase in the concentrations of urea sprays (2.5 and 3.0g L^{-1},). N content in stevia leaves was significantly increased with the increased levels of concentration urea up to 3.0g L^{-1}. Conversely, the trend of N uptake did not follow the trend of N contents of stevia leaves. N uptake as expected increased as foliar application of urea increased up to 2.0 g L^{-1} and then decreased with further addition. *Abou-Amer and. Kewan (2014)* found that application of the highest rates of N and P increased the fodder, grain sorghum yields and improved the fodder quality. In addition, this treatment increased the soil and plant mineral content of N and P as well as sheep performance. In the same respect. *Zafar et al. (2007)* study the effect of different nutrients through foliar and/or soil application on wheat plant (*Triticumaestivum* L.). Different concentrations of nitrogen, phosphorus, potassium (NPK) i.e., Ammonium nitrite (NH_4NO_3), Dipotassiumphosphate (K_2HPO_4) and monpotassium phosphate (KH_2PO_4) were used. The effect of ammonium sulphate $(NH_4)_2SO_4$ through foliar application on the same plant was also studied. growth and yield of the plant increased when treatment was applied either through soil or through foliar and soil together, The increase was more pronounced in case of collective (soil and foliar) treatment. However, there was a gradual but regular increase with $(NH_4)_2SO_4$ treatment. Root length showed more or less the same effect, i.e., it increased in foliar + soil and only soil applied treatment, decreased in foliar applied treatment and slightly increased with $(NH_4)_2SO_4$ treatment. The effect on grain yield was some what similar i.e., it increased in foliar + soil and only soil applied treatment, decreased in foliar applied treatment. However, in

contrast to the effect on plant size the treatment with $(NH_4)_2SO_4$ decreased the grain yield. It was concluded that treatment through soil and foliar together yield better results.

The aim of this work is to study the effects of foliar spray and soil applications at different of rates relative to the recommended dose of N and P in the presence or absence gibberellic acid (GA_3), which reflect on reduce the environmental impact of use of mineral fertilizers on wheat yield.

MATERIALS AND METHODS

A field experiment was conducted during the two successive seasons winter of 2014/2015 and 2015/2016 at a privet farm, Damas Village, Mitghamr, 30° 48′ 42″ N, 31° 19′ 0″ E Dakahliya Governorate, Egypt The aim of the present study was to determine the efficiency of gibberellic acid GA3 foliar spray and different rates of nitrogen–phosphorus (N, and P) fertilizer applied to wheat plants (*Triticum aestivum L., Sakha 93 C*.), either to the soil or foliar spray. To achieve the mentioned target, experiment soil devoted to two groups, the first one contented of N and P mineral fertilizer with gibberellic acid GA_3 foliar application. The second group also contented of N and P mineral fertilizer without GA_3 foliar application, experimental treatments were carried out as follows:-

1. T1-100% of the recommended doses 80 kg N unit = 172 kg as urea and P ~ 200 kg as P_2O_5.
2. T2-100% N and 50% P of the recommended doses + foliar spray 2% P ~ 13.33 kg fed^{-1}without GA_3 and with GA_3.
3. T3- 100% N and 50% P of the recommended doses + foliar spray 3% P ~ 20.00 kg fed^{-1} without $GA_3$and with GA_3.
4. T4-100% N and 50% P of the recommended doses + foliar spray 4% P~ 26.67 kg fed^{-1} without $GA_3$and with GA_3.
5. T5-100% N and 50% P of the recommended doses + foliar spray 6% P ~ 40.00 kg fed^{-1} without GA_3 and with GA_3.
6. T6-50% N and 50% P of the recommended doses ~ 86 kg as urea and P ~ 100 kg as P_2O_5.+ foliar spray 4 % urea ~ 8.602 kg fed^{-1} 2% P ~ 13.33 kg fed^{-1} without GA_3 and with GA_3.
7. T7-50% N and 50% P of the recommended doses + foliar spray 6 % urea ~ 12.903 kg fed^{-1} 2% P ~ 13.33 kg fed^{-1} without GA_3 and with GA_3.
8. T8-50% N and 50% P of the recommended doses + foliar spray 4 % urea ~ 8.602 kg fed^{-1} 3% P ~ 20.00 kg fed^{-1} without GA_3 and with GA_3.
9. T9-50% N and 50% P of the recommended doses + foliar spray 6 % urea ~ 12.903 kg fed^{-1} 3% P ~ 12.903 kg fed^{-1} without GA_3 and with GA_3.

The experimental treatments were randomized complete block design, with three replicates, the plot size of 3.0 X 3.5 m and area of 10.5 m^2. Wheat grains sowing at (60 kg fed^{-1}) was done on November 14 and 15 in the first and second seasons of 2014/2015 and 2015/2016, respectively.The normal cultural practices for growing wheat crop were applied as recommended in dose the area under consideration. Control treatment applied full recommended doses of N, P and K fertilizer for wheat plants by Ministry of Agriculture, Egypt; N, fertilizer was applied as form urea (46.5% N) at the rate of 80 kg N fed^{-1} was added in two equal doses i.e., before the first and second irrigations, however, phosphorus was added at the rate of 30 kg P_2O_5 fed^{-1} as calcium super phosphate (15% P_2O_5) before sowing. Potassium as potassium sulphate (48% K_2O) at the rate of 24 kg K_2O fed^{-1} was applied before the first irrigation.

The other treatments were applied at 50% of the recommended doses of N and P as soil applications and then sprayed three once (i.e, at 30, 45and 60 days from sowing) with a volume 100 L fed^{-1} for each one of N

at the rate of phosphorus was spread at the rates of 2 and 3 % as calcium superphosphate. GA_3 was also sprayed at the rate 10 ppm liter^{-1}. It should be noted to mention that, the nitrogen and phosphorus fertilizers used were well milled, and then soaked in warm water for two days with continuous shaking, after that, is taken suspended to be nominated and took a clear solution before spraying.

Some physical and chemical characteristics of the experiment soil were analyzed before cultivation. Particle size distribution was determined according to *Piper (1950).* Calcium carbonate ($CaCO_3$) measured by the calcimeter method, according to *Nelson (1982).* Cation exchange capacity (CEC) was determined according to *Rhoades (1982). Soil reaction was* determined by pH meter in 1:2.5 soil water suspension, according to *Mclean (1982). Soil salinity* (EC) was determined in the saturated soil paste extract using electrical conductivity meter. Soluble ions also were determined in the saturated soil paste extract as follow: sodium and potassium were determined by flame photometer, calcium and magnesium were determined by titration with versenat (EDTA), chloride was determined by titration with silver nitrate $AgNO_3$. Carbonate and bicarbonate were determined by titration with sulphuric acid; sulphate was calculated by difference between anions and cations according to *Page et al., (1982).* Soil organic matter content was determined according to *Walkley and Black* method, *Black (1982).* Available (Fe, Mn and Zn) were extracted according to the method of *Soltanpour and Schwab (1991)* by mixture solution of Ammonium Bicarbonate and Di-ethylene Tri-amine penta Acetic Acid with adjusting at pH 7.6. Soil sample (20 gm) were shaken with 40 ml from the mixture solution to about 15 minutes then filtered. Available Fe, Mn, Zn, and Cu of soil were determination by using Inductively Coupled Plasma (ICP) Spectrometry (Ultima 2 JY Plasma) according to the procedure of *"Environmental Protection Agency" EPA. (1991).* Available nitrogen in soil was extracted by using KCl (2N) as extractable solution with the ratio of (5gm soil to 50 ml KCl), shaked for 30 min. and then filtered and determined using Kjeldahl method according to *AOAC (1990)*. The obtained data were recorded in Table (1).

Two samples were takin randomelly from wheat plants at every plot. The first sample was collected at 50 days from sowing to determine chlorophyll A and B, total carotenoids as mg g^{-1}, total sugars, total soluble carbohydrates as g 100 g^{-1} dry weight (D.W.), and total carbohydrates as g 100 g^{-1} (D.W.). Determine chlorophyll A and B were measured in fresh weight (F.W.). Leaf sample (0.5g) were homogenized with action (80% v/v), filtered and made up to a final volume of 5. mL. Chlorophylls concentration was calculated from the absorbance of the extract measured by spectrophotometer according to *Wetburn and Lichtenthaler (1984).* Total Sugar, total soluble carbohydrates and total carbohydrates were determined according to *AOAC (2012).*

Table (1). Some physical and chemical properties of the experimental soil (as an average of the two growing seasons).

Particle size distribution %			Texture class	OM %	$CaCO_3$%	pH (1:2.5) *	CEC (c mole kg^{-1})
Sand	Silt	Clay					
13.72	28.77	57.51	Clay	1.67	2.52	795	39.75

*soil water suspension

EC	Soluble Anions (m molc L^{-1})				Soluble cations (m molc L^{-1})				Available nutrients (mg kg^{-1})					
(dS m^{-1})	HCO_3^-	CO_3^{--}	Cl-	SO_4^{--}	Ca^{++}	Mg^{++}	Na^+	K^+	N	P	K	Fe	Mn	Zn
1.91	0.00	2.90	8.85	5.15	5.32	3.68	7.15	0.75	45.67	8.70	352.00	7.84	3.12	2.27

At harvesting of wheat plants (165 days), collected plant samples from each treatment by using 1 m^2 wooden frame to determine 1000-grain weight, grain and straw yields. Grain and straw yields placed in, oven dried at 70 ºC, up to a constant dry weight, milling after drying and prepared for digestion using H_2SO_4 and H_2O_2 as described by *Page et al., (1982).* The digests were then subjected to measurement the concentration of (N, P and K). N content in plant samples was determined by Kjeldahel technique, P content determined by spectrophotometer and K in plant samples was determined by flame photometer as described by *Ryan et al., (1996).* Protein percentage was calculated by multiplying N% by 6.25 (constant) according to *A.O.A.C. (1990).*

Statistical Analysis:

Data obtained for two seasons were average in mean value, the analysis of variance (ANOVA) was done and Least Significant Differences (L.S.D.) was calculated. The statistical analysis was done by using Co-stat program *SAS Institute (1994).*

RESULTS AND DISCUSSION

Data in Tables (2 a and 2 b.) show the effect of foliar GA_3 and soil application of N and P mineral fertilizers on plant height, number of tillers, dry weight of $plant^{-1}$, and weight of 1000 grains, grains, and straw yields. Resulted indicated that, application of mineral fertilizer with GA_3 gave highest values of the above mentioned parameters to compared the treatment without GA_3. This result may be due to the effect of GA_3 as growth regulator, it makes on increasing the availability of nutrients in plant.

These results agreement with *Hassanpouraghdam et at., (2011)* found that, foliar application of GA_3 affected growth characteristics chlorophyll content as well as leaves fresh and dry weight attained their greatest quantities under 300 mgl^{-1} GA_3 applications as well. Fresh and dry weight of plantswere significant differences between treatments compared with control, 200 and 300 mgl^{-1} GA_3 had the greatest sum of data. Nitrogen and phosphorous content were affected by the treatments with their highest concentrations possessed by 300 and 100 mgl^{-1} GA_3 applications respectively.

Table (2 a). Effect of foliar and soil application of N and P as well as GA_3 on plant height, number of tillers and dry weight of shoot of wheat plant.

Treat.	Plant height (cm)			Number of tillers ($plant^{-1}$)			Dry weight of shoot (g $plant^{-1}$)		
	Without GA_3	With GA_3	Mean	Without GA_3	With GA_3	Mean	Without GA_3	With GA_3	Mean
T1	99.10 k	110.6d	104.8d	6.05h	6.88c	6.46c	13.90j	15.90c	14.90c
T2	96.90m	107.6g	102.3g	5.42i	6.17g	5.80f	12.80n	14.60h	13.70h
T3	98.10i	108.9f	103.5f	5.95i	6.75c	6.35c	13.60kl	15.50c	14.55e
T4	98.30k	109.3e	103.8e	5.68k	6.50e	6.09e	12.90n	14.80g	13.85g
T5	98.7k	110.2d	104.4d	5.91i	6.72c	6.31d	13.50l	15.40e	14.45e
T6	99.2k	110.6d	104.9d	5.7j	6.55d	6.15e	13.20m	15.10f	14.15f
T7	101.1j	112.4c	106.8c	6.00h	6.81c	6.40c	13.70k	15.70d	14.70d
T8	102.4h	113.6b	108.0b	6.31f	7.14b	6.72b	14.13i	16.20b	15.17b
T9	105.1h	116.9a	111.0a	6.48e	7.39a	6.93a	14.60h	16.70a	15.65a
Mean	99.979b	111.12a		5.95b	6.77a		13.59b	15.54a	
LSD at 0.05	B=0.7933 AXB=0.9909			B=0.1458 AXB=0.1822			B=0.1458 AXB=0.1822		

* Means with the same letter are not significantly different A= (different sources from mineral fertilizers) B= Gibberellic acid (GA_3) AXB= interaction between deferent mineral fertilizers and gibberellic acid

Table (2 b.). Effect of foliar and soil application of N and P as well as GA_3 on 1000 grans weight, grain and straw yield of wheat plant.

Treat.	Weight of 1000 grains g			Grains yield kg fed^{-1}			Straw yield kg fed^{-1}		
	Without GA_3	With GA_3	Mean	Without GA_3	With GA_3	Mean	Without GA_3	With GA_3	Mean
T1	43.30g	49.90b	46.60b	2588i	2940c	27.64c	4831ij	5540c	5186c
T2	40.00j	45.10e	42.55f	2385l	2732g	2559f	4594m	5265f	4930f
T3	42.60h	49.00b	45.80c	2540j	2894d	2717d	4801j	5492d	5146d
T4	41.10i	46.10d	43.60e	2453k	2803d	2628e	4665l	5343e	5004e
T5	42.70h	47.90c	45.30d	2542j	2897d	2720d	4784k	5470d	5127d
T6	41.30i	46.50d	43.90e	2475k	2823e	2649e	4696l	5359e	5028e
T7	42.80h	48.40c	45.60c	2568ij	2921c	2745c	4866i	5545c	5206c
T8	44.30f	50.10b	47.20b	2651h	3024b	2838b	5015h	5717b	5366b
T9	45.90d	51.70a	48.80a	2776f	3151a	2964a	5125g	5815a	5470a
Mean	42.67b	48.30a		2553.1b	2909.4a		4820b	5505a	
LSD at 0.05	B=1.038	AXB=1.297		B=27.77	AXB=41.01		B=32.83	AXB=41.01	

* Means with the same letter are not significantly different A= (different sources from mineral fertilizers)
B= Gibberellic acid (GA_3) AXB= interaction between deferent mineral fertilizers and gibberellic acid

Concerning the effect of different application of mineral fertilizer the highest values were obtained by application in T9 for all tested parameters. In the case of the effect of interaction between different mineral fertilizer source with or without GA_3 the highest values obtained in T9 with foliar GA_3. The maximum values of grains and straw yields were 3151 and 5815kg fed^{-1} respectively, with application 50% N and P of the recommended doses + foliar spray 6 % urea 3% P with GA_3 (T9). These results are in harmony with those reported by *Khalid et al.(2013).*who found that application of growth regulators (GA_3) and salicylic acid (SA) alone or combined with salt ($CaCl_2$) significantly increased plant height, number of leaves, leaf area, number of runners, canopy spread, fresh and dry weight of strawberry plant.

Effect of nitrogen and phosphorus fertilizer at different rates and GA_3 on chlorophyll A, B, and carotenoids.

Tables (3 a and 3 b) illustrated that chlorophyll A, B, and carotenoids values were varied based on the types of applied fertilizers. On the other hand, application of GA_3 resulted in significant increase in chlorophyll A, B, carotenoids of all studied treatments.

The highest performance was attained with (T9) 50% N and 50% P of the recommended doses + foliar spray 6 % urea 3% P without GA_3 however, with GA_3 application exhibited a marked increase chlorophyll A, B, carotenoids compared to the treatment control (T1) 100% of the recommended N and P doses.

Chlorophyll A values were in descending order as follows: T9 with GA_3 > T7 with GA_3 > T9 without GA_3 > T8 with GA_3 > T7 without GA_3 > T5 without GA_3 > T1 with GA_3 > T5 with GA_3 > T3 with GA_3 > T6 with GA_3 > T4 with GA_3 > T1 without GA_3 > T2 and T5 without GA_3 > T3 without GA_3 and T2 with GA_3 > T4 and T6 without GA_3.

Table (3 a). Effect of foliar and soil application of N and P as well as GA_3 on chlorophyll A, chlorophyll B and carotenoids of wheat plant.

Treat.	Chlorophyll A (mg g^{-1} F.W.)			Chlorophyll B (mg g^{-1} F.W.)			Carotenoid (mg g^{-1} F.W.)		
	Without GA_3	With GA_3	Mean	Without GA_3	With GA_3	Mean	Without GA_3	With GA_3	Mean
T1	1.17h	1.37f	1.27d	0.85k	0.99c	0.92d	0.19j	0.24c	0.22c
T2	0.93i	1.07j	1.00g	0.81n	0.93g	0.87g	0.15p	0.19j	0.18h
T3	1.07j	1.24g	1.16e	0.84l	0.96e	0.90e	0.18m	0.23e	0.21e
T4	0.99k	1.15h	1.07f	0.82m	0.94f	0.88f	0.17n	0.21g	0.19f
T5	1.10ij	1.27g	1.18e	0.86j	0.98d	0.92d	0.19k	0.23d	0.21d
T6	1.01k	1.18h	1.10f	0.84l	0.96e	0.90e	0.16o	0.20h	0.18g
T7	1.81d	2.11b	1.96b	0.87i	0.99c	0.93c	0.19k	0.23e	0.21d
T8	1.64e	1.91c	1.77c	0.91h	1.04b	0.97b	0.20i	0.25b	0.23d
T9	1.91c	2.23a	2.07a	0.99c	1.14a	1.06a	0.22f	0.27a	0.25a
Mean	1.292b	1.503a		0.866b	0.992		0.186b	0.231a0	
LSD at 0.05	B= 0.04210 AXB=0.05259			B=0.001331 AXB=0.001663			B=0.001331 AXB=0.001663		

* Means with the same letter are not significantly different. A= (different sources from mineral fertilizers) B=Gibberellic acid (GA_3) AXB= interaction between deferent mineral fertilizers and gibberellic acid. DW=dry weigh

Table (3 b). Effect of foliar and soil application of N and P as well as GA_3 on total sugars, T.S.C. and T.H.C. of wheat plant.

Treat.	Total sugars (mg g^{-1} DW)			T.S.C. (mg g^{-1} D.W.)			T.H.C. (mg g^{-1} D.W.)		
	Without GA_3	With GA_3	Mean	Without GA_3	With GA_3	Mean	Without GA_3	With GA_3	Mean
T1	19.7g	21.9d	20.8d	22.5h	24.9b	23.70be	600.4jk	663.9de	632.2de
T2	17.6k	19.5h	18.6f	21.3j	23.6e	22.45d	568.2m	629.5h	598.8g
T3	20.4e	22.7b	21.5c	23.1f	25.6a	24.35b	614.1i	680.6b	647.3be
T4	18.5j	20.6e	19.6c	22.0ij	24.4c	23.20cd	584.8l	648.8fg	616.8f
T5	19.8g	22.1c	21.0cd	23.0g	25.5b	24.25bc	611.3ij	677.8b	644.5be
T6	18.8ij	20.8e	19.8e	22.3h	24.7b	23.5bcd	592.7kl	656.5el	624.6ef
T7	20.1f	22.2c	21.2c	22.9g	25.4b	24.15bc	608.7ij	669.9c	639.3cd
T8	21.1e	23.4b	22.3b	23.3f	25.8b	24.55ab	619.3hi	685.8b	652.5b
T9	21.9d	24.3a	23.1a	24.2d	26.9a	25.55a	643.2g	714.7a	679.0a
Mean	19.797b	21.944a		22.733b	25.200a		604.74b	669.72a	
LSD at 0.05	B=0.6013 AXB=0.7512			B=1.067 AXB=1.333			B=10.16 AXB=12.69		

Means with the same letter are not significantly different. A= (different sources from mineral fertilizers) B=Gibberellic acid (GA3) AXB= interaction between deferent mineral fertilizers and gibberellic acid. DW=dry weigh. T.S.C=total soluble carbohydrate T.H.C= total carbohydrate

Tables (3 a and 3 b.) showed that chlorophyll B exhibited the same trend of Chlorophyll A. application T (9) confirmed pronounced more affected that increase of Chlorophyll B in plant followed by T (8) > T (7) > T (5) > T(6) , T(4) and T2 > T(1) However, the highest values of carotenoids, total sugars, T.S.C. and T.H.C. it were attained from T (9) followed T (8) respectively, after harvesting of wheat plant.

These increases in total sugars, T.S.C. and T.H.C. this may be due to application of gibberellic acid (GA_3), increase growth stimulant also could be attributed to the great benefits of GA_3 on plant.

Concerning the effect of foliar spray by using GA_3 or without on total sugars, T.S.C. and T.H.C the results indicated that the highest values were more effective due to application of GA_3. As well as the effect of different applications from mineral fertilizer the highest values were obtained the following:-T (9) > T (8) compared the control T (1).

Effect of foliar and soil application of N and P combined with GA_3 on weight grains, straw (g plant $^{-1}$) and protein (%) content by grains of wheat plants.

Data in Table (4) indicated that, foliar spray by GA_3 more affected than without foliar spray on grains, straw (g.plants^{-1}) and protein % the highest obtained values were (8.62, 14.90) for grains, straw (g.plants^{-1}), respectively and (14.17%) for protein found in T9.

The interaction effect between foliar gibberellic acid (GA_3) and N and P mineral fertilizer rates the highest values found in the treatment T9 50% N and 50% P of the recommended doses + foliar spray 6 % urea ~ with GA_3.

Effect of nitrogen and phosphorus fertilizers combined with GA_3 on macro-nutrients (N, P and K) content and uptake by grains and straw of wheat plants.

With respect to the interaction effects between N and P rates and foliar spray of GA_3 on macro-nutrients (NPK) content and uptake by wheat plants Data in Tables (5 a, 5 b., 6 a and 6 b.) showed a marked improve in the N, P and K content and uptake by plants due to application of all treatment under study compared to the control (T1) treatment. Over the above, foliar application GA_3 on wheat plants resulted in a more pronounced increasing of N, P and K content and uptake.

Table (4). Effect of foliar and soil application of N and P combined with GA_3 on weight grains, straw (g plant $^{-1}$) and protein (%) content by grains of wheat plants.

Treat.	Grains (g plant ^{1})			Straw (g plant ^{1})			Protein (%)		
	Without GA_3	With GA_3	Mean	Without GA_3	With GA_3	Mean	Without GA_3	With GA_3	Mean
T1	7.72m	8.71c	8.22c	12.60k	14.20c	13.40c	12.37g	13.93c	13.15c
T2	7.270r	8.14i	7.70i	11.90o	13.30h	12.60g	10.27m	11.33j	10.90h
T3	7.760l	8.64e	8.20e	12.70j	14.10d	13.40c	12.27h	13.67d	12.97d
T4	7330q	8.21h	7.77h	12.00n	13.40g	12.70f	11.07l	12.37g	11.72g
T5	7.640o	8.56f	8.10f	12.50l	14.00e	13.25d	12.03i	13.47e	12.75e
T6	7.39p	8.33g	7.86g	12.10m	13.60f	12.85e	11.33k	12.77f	12.05f
T7	7.71n	8.70d	8.20d	12.60k	14.20c	13.40c	12.43c	13.93c	13.18c
T8	8.00k	8.98b	8.49b	13.10i	14.20c	13.90b	12.83f	14.33b	13.58b
T9	8.13j	9.11a	8.62a	13.30h	14.90a	14.10a	13.40e	14.93a	14.17a
Mean	7.661b	8.598a		12.533b	14.044a		12.00b	13.44a	
LSD at 0.05	B=0.001176	AXB=0.001663		B=0.05259	AXB=0.07438		B=0.9937	AXB=1.405	

Means with the same letter are not significantly different. A= (different sources from mineral fertilizers)
B=Gibberellic acid (GA3) AXB= interaction between deferent mineral fertilizers and Gibberellic acid.

Table (5 a).Effect of foliar and soil application of N and P combined with GA_3 on N, P and K content (%) and by grains of wheat plants.

Treat.	N%			P%			K%		
	Without GA_3	With GA_3	Mean	Without GA_3	With GA_3	Mean	Without GA_3	With GA_3	Mean
T1	2.17j	2.44c	2.31d	0.37cdefg	0.42abc	0.39ab	0.75h	0.84c	0.79c
T2	1.80p	2.02m	1.91i	0.29h	0.33gh	.31d	0.62o	0.70l	0.66i
T3	2.15k	2.40d	2.28e	0.36efg	0.41abcde	0.38bc	0.72j	0.81e	0.77c
T4	1.94o	2.17j	2.06h	0.32gh	0.45a	0.39bc	0.65n	0.73i	0.69h
T5	2.11l	2.36e	2.24f	0.35efg	0.40abcde	0.38bc	0.71k	0.80f	0.76f
T6	1.99n	2.24h	2.12g	0.33fgh	0.38cdefg	0.35c	0.67m	0.75h	0.71g
T7	2.18i	2.44c	2.31c	0.37defg	0.41abcd	0.39ab	0.73g	0.82d	0.78d
T8	2.25g	2.51b	2.38b	0.38bcdef	0.43ab	0.41ab	0.73g	0.87e	0.83b
T9	2.35f	2.62a	2.49a	0.40abvde	0.45a	0.42a	0.82d	0.90a	0.87a
Mean	2.104b	2.35a		0.353b	0.408a		0.717b	0.804a	
LSD at 0.05	B=0.001176	AXB=0.001663		B=0.03719	AXB=0.05259		B=0.001176 AXB=0.001663		

Means with the same letter are not significantly different. A= (different sources from mineral fertilizers)
B=Gibberellic acid (GA3) AXB= interaction between deferent mineral fertilizers and Gibberellic acid.

Table (5 b). Effect of foliar and soil application of N and P combined with GA_3 on N, P and K uptake (mg kg^{-1}) by grains of wheat plants.

Treat.	N uptake (mg kg^{-1})			P uptake (mg kg^{-1})			K uptake (mg kg^{-1})		
	Without GA_3	With GA_3	Mean	Without GA_3	With GA_3	Mean	Without GA_3	With GA_3	Mean
T1	167.5j	212.5c	190.0c	28.87k	36.77c	32.82c	57.90k	73.20c	65.55e
T2	130.9o	164.4k	147.6d	21.23q	26.93n	24.08i	45.07r	57.00l	51.03i
T3	166.8j	207.4d	187.1d	27.63m	35.07e	31.35e	55.87n	70.00e	62.93c
T4	142.2n	177.8i	160.0g	23.70p	29.87j	26.78h	47.67q	59.93j	53.80h
T5	161.2l	202.0e	181.6e	27.07n	34.07f	30.57f	54.23o	68.50f	61.37f
T6	147.0m	186.6g	166.8f	24.53o	31.23h	27.88g	49.50p	62.47h	85.98g
T7	168.1j	212.3c	190.0c	28.23l	36.00d	32.12d	56.27m	71.33d	63.80d
T8	180.0h	225.4b	202.7b	30.57i	38.70b	34.63b	62.40i	78.10e	7025b
T9	191.1f	238.7a	214.9a	32.37g	40.80a	36.58a	66.67g	83.80a	75.23a
Mean	161.52b	203.02a		27.133b	34.38l		55.063b	69.37a	
LSD at 0.05	B=0.9937	AXB=1.405		B=0.09839	AXB=0.1391		B=0.001176	AXB=0.001663	

Means with the same letter are not significantly different. A= (different sources from mineral fertilizers)
B=Gibberellic acid (GA3) AXB= interaction between deferent mineral fertilizers and Gibberellic acid.

Furthermore, a significant increase in the content of N, P and K in grains and straw percentage were achieved due to the foliar application of GA_3. Data in Tables (5 a, 5 b., 6 a and 6 b) revealed that, generally, there are positive responses for all nutrients content in grains and straw of wheat to foliar spray of GA_3, compared to without foliar

spray GA_3.The obtained results of the interaction effects between N and P rate and foliar GA_3 on, N, P and K in wheat plants. The highest content of N, P and K in grains of wheat plants were detected without foliar by GA_3 treatment compared with GA_3 which recorded (2.104 and 2.356 %), (0.353 and 0.408 %),(0.717 and 0.804 %) for N, P and K content,(161.522 and 203.022), (27.133 and 34.381), (55.063 and 69.370) for NPK uptake mg kg^{-1}, respectively. While the effect of individual application of N and P mineral fertilizer for content in straw were attained with T(9) (0.50 %) , for N, (0.21%) for P and (1.90 %) for K. While uptake by straw were (72.10, 29.65 and 269.1) mg plant $^{-1}$ for N, P and K respectively. This could be attributed to the fact that increasing available soil mineral during vegetative and reproductive growth of wheat plants increases yield and its components. These results are in agreement with those obtained by *Hamayun et al.,(2011)* when evaluating the effect of foliar and soil application of nitrogen, phosphorus and potassium (NPK) on yield component of lentil plants (*Lens culinaris Medic*), the best results were recorded from the plants treated with NPK through both soil and foliage. Optimal concentration of NPK for the various yield parameters was found to be 0.17% N, 0.21% P and 0.33% K for foliar and 0.35% N, 0.32% P and 0.50% K for soil application. Multiple applications of both soil and foliar application of NPK gave better results as compared to single application of NPK. Soil application was produced slightly improved results compared to foliar application when unaided.

The foliar application of nitrogen alone was more effective than NPK in producing higher number of seeds per pod. *Renata and Dariusz (2014)* evaluated the effect of different P and K fertilization at different level on nutritional status of winter wheat at development stages as well as on macronutrient contents in yield obtained (grain and straw).

Table (6 a).Effect of foliar and soil application of N and P combind withGA_3 on N, Pand K content (%) by straw of wheat plants.

Treat.	N%			P%			K%		
	Without GA_3	With GA_3	Mean	Without GA_3	With GA_3	Mean	Without GA_3	With GA_3	Mean
T1	0.45h	0.51c	0.49c	0.19h	0.20c	0.20c	1.59k	1.81c	1.70c
T2	0.35n	0.40l	0.38i	0.14m	0.16k	0.15i	1.33r	1.51o	1.42i
T3	0.43j	0.49e	0.46e	0.18j	0.31e	0.19c	1.56m	1.77f	1.67e
T4	0.39m	0.44i	0.42h	0.16l	0.18j	0.17h	1.43q	1.63j	1.53h
T5	0.42k	0.48f	0.40f	0.18j	0.19f	0.19f	1.55n	1.75g	1.65f
T6	0.40l	0.45h	0.43g	0.16l	0.18j	0.17g	1.46p	1.65i	1.56g
T7	0.44i	0.50d	0.47d	0.181i	0.21d	0.193d	1.57l	1.79d	1.68d
T8	046g	0.52e	0.49e	0.19f	0021b	0.201e	1.68h	1.90b	1.79b
T9	0.48f	0.54a	0.50a	0.19f	0.22a	0.21a	1.70e	2.02a	1.90a
Mean	0.424b	0.48a		0.1756b	0.197a		1.55b	1.759a	
LSD at 0.05	B=0.001176	AXB=0.001663		B=0.001176	AXB=0.001663		B=0.001176	AXB=0.001663	

Means with the same letter are not significantly different. A= (different sources from mineral fertilizers) B=Gibberellic acid (GA3) AXB= interaction between deferent mineral fertilizers and Gibberellic acid. Fertilizers)

Table (6 b.). Effect of foliar and soil application of N and P combined withGA_3 on N, P and K uptake (mg kg^{-1}) by straw of wheat plants.

Treat.	N uptake (mg kg^{-1})			P uptake (mg kg^{-1})			K uptake (mg kg^{-1})		
	Without GA_3	With GA_3	Mean	Without GA_3	With GA_3	Mean	Without GA_3	With GA_3	Mean
T1	56.70k	72.40c	64.55c	23.30k	29.70c	26.50c	200.3k	257.0c	228.7c
T2	41.70r	53.20n	47.85i	17.0r	21.80o	19.45i	158.3p	200.8k	179.6i
T3	54.60m	69.10e	61.85e	22.40m	28.30e	25.35e	198.1l	249.6e	223.9e
T4	46.80q	59.00j	52.90h	19.20q	24.10j	21.65h	171.6o	218.4j	195.0h
T5	52.50o	67.20f	59.85f	21.90n	27.60f	24.75f	193.8m	245.0f	219.4f
T6	48.40p	61.20h	54.80g	19.80p	25.20h	22.50g	176.7n	226.4h	201.6g
T7	55.40l	71.00d	63.20d	22.80l	29.10d	25.95d	197.8l	254.2d	226.0d
T8	60.30i	71.40e	68.35e	24.80i	31.30e	28.05e	220.1i	279.3b	249.7b
T9	63.80g	80.40a	7210a	26.20g	33.10a	29.65a	236.7g	299.5a	268.1a
Mean	53.356b	67.676a		21.944b			194.82b	247.80a	
LSD at 0.05	B= 0.09109	AXB=0.1288		B=0.06441AXB=0.09109			B= 1.008	AXB=1.425	

Means with the same letter are not significantly different. **Calculated uptake mg kg^{-1}= dry weight of shoot $plant^{-1}$mulipied by N or P or K % content A= (different sources from mineral fertilizers) B=Gibberellic acid (GA3) AXB= interaction between deferent mineral fertilizers and Gibberellic acid. Fertilizers)

The contents of N, P, and K, in wheat changed depending on the organ assessed and plant development stage. Irrespective of the years of observation, differentiated rates of P and K applied had no significant effect on N accumulation in wheat at full ripening stage. In contrast to N, the level of P and K fertilization significantly differentiated the contents of P and K in wheat grain and straw.

Conclusions and Recommendations:

Integration of soil application and foliar fertilization was most promising in enhancing the plant growthfoliar fertilization is considered as an environmentally friendly fertilization technique,so from previoustreatment applications the results showed that, the best treatment found with (T9) application rate 86 kgas urea, 100 kg calcium super phosphate P_2O_5 + foliar spray 12.9 ~ urea kg fed^{-1} and 20 kg P as P_2O_5 with gibberellic acid.

REFERENCES

A.O.A.C. (1990). Official methods of analysis of the Association of Official Analytical Chemists,. 15th Ed., Washington, D.C.

A.O.A.C. (2012). Official methods of analysis of AOAC international 19Th Edition .

Abou-Amer, A. I. and K. Z. Kewan (2014). Effect of NP fertilization levels on Sorghum (Sorghum bicolor L.). Yield and Fodder Quality for Animals Alex. J. Agric. Res. 59 (1): 51-59.

Black, C. A. (1982). Methods of soil analysis, Part I and II, Soil Sci. Soc. Am. Inc. Puble., Madsison, Wisc., USA.

Cline, J. A. and M. Trought (2007). Effect of gibberellic acid on fruit cracking and quality of Bing and Sam sweet cherries.Canadian Journal of Plant Science. 545-550.

EPA. (1991). Methods for the determination of metals in environmental Samples. 20460 pp. 23 - 29 and 83 -122.Office of

research and development Washington DC 20460.

Fageria, N. K., F. M. P. Barbosa, A. Moreira and C. M. Guimaraes (2009). Foliar fertilization of crop plants. Journal of Plant Nutrition, 32: 1044–1064.

Gul, H., S. Ahmad, S. Beena, M. Fida and A. Ijaz (2011). Effect of foliar application of nitrogen, potassium and zinc on wheat growth.Arpn Journal of Agricultural and Biological Science. 6(4): 56-58.

Hamayun, M., S. A. Khan, A. N. Kha., Z. K. Shinwari, N. Ahmad, Y. Kim and I. Lee (2011). Effect of foliar and soil application of nitrogen, phosphorus and potassium on yield components of lentil. Pak. J. Bot., 43(1): 391-396.

Hassanpouraghdam, M. B., A. B. Hajisamadi and A. Khalighi (2011). Gibberellic acid foliar application influences growth, volatile oil and some physiological characteristics of lavender (*Lavandulaofficinalis* Chaix.) Romanian Biotechnological Letters Vol. 16, No. 4, 632 2-6327.

Khalid, M.Q., C. Saman, S.Q. Usman and A. A. Nadeem (2013). Impact of exogenous application of salt and growth regulators on growth and yield of strawberry. *Pak. J. Bot*., 45(4): 1179-1185.

Khan, A. Z. and L. Parveen (2012). Growth factors and straw yield of wheat cultivars inrelation with nitrogen and sulfur fertilization. Arpn Journal of Agricultural and Biological Science. 7(1): 13-22

Mahmoody, M. and M. Noori (2014). Effect of gibberellic acid on growth and development plants and its relationship with abiotic stress. Intl J Farm & Alli Sci. Vol., 3 (6): 717-721.

Mclean, E. O. (1982). Soil pH and lime requirement In: "Method of Soil Analysis. Part 2, chemical and microbiological properties", A.L. Page, R. H. Miller and D. R. Keeney (Ed.), 2nd ed., pp.199-224, ASA Soil Sci Soc. Am.Inc., Madison, WI, USA.

Mosali, A., K. Desta, R. K. Teal, K. Freeman, K. L. Martin, J.W. Lawles and W. R. Raun (2006). Effect of foliar application of phosphorus on winter wheat grain yield, phosphorus uptake, and use efficiency. Journal of Plant Nutrition, 29: 2147–2163.

Muhammad, A., M. A. Chohan, S. Ali and R. G. S. Khan (2006). Response of wheat to foliar application of nutrients.Journal of Agricultural and Biological Science. 1 (4): 30-34.

Nelson, R. E. (1982). Carbonate and gypsum. In: "Methods of Soil analysis. Part 2, chemical and microbiological properties", A.L. Page, R. H. Miller and D. R. Keeney (Ed.), 2nd ed., pp.181-198, ASA Soil Sci Soc. Am.Inc., Madison, WI, USA.

Page, A. I., R. H. Miller and D.R. Keeny Eds. (1982). Methods of Soil analysis Part2 : chemical and micro-biological Properties 2nd Edition. 1982. pp. 539-579. Amer. Soc. of Agron. Madison, Wiscosin.USA.

Piper, C. S. (1950). Pp.59-73. Soil and plant analysis. Inter. Science Publishers Inc., New York.

Rama, T., Rashad and A. H. Rashad (2014). A comparison study on the effect of some growth regulators on the nutrients content of maize plant under salinity conditions. Annals of Agricultural Science 59(1): 89–94.

Renata, G. and G. Dariusz (2014). Effects of different phosphorus and potassium fertilization on contents and uptake of macronutrients (N, P, K, Ca, Mg) in winter wheat I. Content of macronutrientsJournal of Central European Agriculture, 15(4):169-187.

Rhoades, J. D. (1982). Cation exchange capacity. In; "methods of soil analysis. Part 2, chemical and microbiological properties", A.L. Page, R. H. Miller and

D. R. Keeney (Ed.), 2nd ed., pp.149-157, ASA Soil Sci. Soc. Am. Inc., Madison, WI, USA.

Ryan, J., S. Garabet, K. Harmsen and A. Rashid (1996). A Soil and Plant Analysis Manual Adapted for the West Asia and North Africa Region. ICARDA, Aleppo, Syria. pp140-142.

Saeed, B., H. Gul, A. Z. Khan and L. Parveen (2012). Growth factors and straw yield of wheat cultivars inrelation with nitrogen and sulfur fertilization. Arpn. Journal of Agricultural And Biological Science. 7(1):13-22.

SAS Institute (1994). SAS/STAT Users Guide: statistics. Vers. 6.04, 4th Ed. SAS Institute Inc., Cary, N. C., U.S.A.

Soltanpour, P.N. and A. P. Schwab (1991). Determination of nutrient availability element toxicity by AB-DTPA. Soil Test ICPS Adv. Soil Sci., 16: 165- 190.

Welburm, A. R. and H. Lichtenthaler (1984). Formulae and program to determine total carotenoid's and chlorophyll a and b of leaf extracts different solvents In: "Advances Phostosynthesis Research", Sybesma C. (Ed.), 11: pp.9-12, Mortinus Njihoff Dr.W junk Publishers, the Hague.

Zafar, J. and F. C. Muhammad (2007). Effects of soil and foliar application of differentconcentrations of NPK and foliar application of $(NH_4^+)_2SO_4$ on growth and yield attributes in wheat (*Triticum aestivum*. L). Pak. J. Pl. Sci., 13 (2): 119-128.

Zaman, M. M., M. A. H. Chowdhury and T. Chowdhury (2015). Response of stevia to foliar application of prilled urea J. Bangladesh Agril. Univ. 13(1): 39–46.

تأثير الإضافات الأرضية والرش بالنيتروجين والفوسفور بالإضافة إلى حمض الجبريليك على النمو ومحصول القمح

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الملخص العربى

أجريت تجربة حقلية خلال موسمين شتاء متتاليين ٢٠١٥/٢٠١٤ و٢٠١٦/٢٠١٥ فى مزرعة خاصة بقرية دماص ميت غمر محافظة الدقهلية، مصر تم فيها زراعة نبات القمح (صنف سخا ٩٣). تصميم التجربة كان فى قطاعات كاملة العشوائية للعامل A؛ مع العامل,B ، مع ثلاثة مكررات. لدراسة تأثير الرش والإضافات الأرضية بمعدلات مختلفة من الأسمدة المعدنية النيتروجينية والفوسفورية الموصى بها وكذلك الرش بحامض الجبريلك وذلك على بعض صفات النمو الخضرى لمحصول القمح وعلى المحتوى الكلى والممتص من (النيتروجين – الفوسفور– البوتاسيوم) فى كلاً من الحبوب والقش لمحصول القمح.

وأوضحت النتائج الآتى :- وجد أن طول النبات، عدد التفرعات ، والوزن الجاف، ووزن ١٠٠٠ حبة، ومحصول الحبوب والقش قد تأثر نتيجة إستخدام الأسمدة المعدنية مع الرش بحامض الجبريليك وأعطى أعلى القيم مقارنة مع بعض الإضافات بدون الرش بحامض الجبريليك. تفاوتت قيم كلوروفيل أ، ب، والكاروتين والتى إعتمدت على أنواع الأسمدة المضافة.الرش بحامض الجبريليك أعطى زيادة كبيرة فى كلوروفيل أ، ب، الكاروتين من جميع المعاملات التى شملتها الدراسة. أعلى القيم للقياسات السابقة من المعاملة (T9) (٥٠ % نيتروجين و ٥٠٪ فوسفور من التوصية السمادية الموصى بها + رش ورقى ٦٪ من اليوريا و٣٪ من السوبر فوسفات لكل فدان مع الرش أو بدون الرش بحامض الجبريلك).

أيضاً وجد أعلى زيادة ملحوظة للكاروتين، السكريات الكلية ، الكربوهيدرات الكلية الذائبة. و الكربوهيدرات الكلية. وقد تحققت من المعاملة (T9) يليها المعاملة (T8) (٥٠ % نيتروجين و ٥٠٪ فوسفورمن التوصية السمادية الموصى بها + رش ورقى ٤٪ من اليوريا و ٣٪ من السوبر فوسفات مع الرش أو بدون الرش بحامض الجبريلك) على التوالى. وجد زيادة فى نسبة النيتروجين والفوسفور والبوتاسيوم والبروتين بإضافة المعاملات محل الدراسة مقارنة مع معاملة الكنترول (T1). ووجد أن أعلى إستجابة لجميع محتوى العناصر الغذائية من محصول الحبوب والقش للقمح مع الرش مقارنة مع عدم الرش بحامض الجبريليك.