

**IMPROVEMENT OF WHEAT PRODUCTIVITY BY USING
SOME BIOFERTILIZERS AND ANTIOXIDANTS**

BY

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Abstract

Two field experiments were conducted from Res. Expt. Cent., Fac. Agric., Moshtohor Benha Univ. during 2005/2006 and 2006/2007 growing seasons. To study the effect of bio and mineral NPK levels (Complete strength C.S, half strength and quarter strength) and antioxidants treatments (0, Vit. C, Vit E and mixture Vit. C+E) on growth, yield and yield component and chemical composition of wheat plants cv sakha 93. Results showed that. Studied wheat characters (i.e. growth, yield and yield component and chemical composition) were positively affected increased with increasing mineral NPK fertilizer up to CS and combination with biofertilizers in both seasons. Wheat grains soaking and spraying with Vit.C at 150 mg/l increased growth parameters, grain yield components and chemical composition in wheat plants during in both seasons. The interaction between CS mineral NPK and biofertilizer with Vit.C increased growth, yield and yield components and chemical composition of wheat plants during first and second seasons.

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INTRODUCTION

Wheat plant (*Triticum aestivum*. L) is the most important plant in family poaceae, from cereal crops because it has an international nutritional human feeding. The wheat plants considered one of the main cereal crops not only in Egypt but also all over the world.

In Egypt, the production of wheat grains is insufficient for local consumption. Egyptian Ministry of Agriculture is trying to close up or reduce the increasing gap between production and consumption of wheat grains. That is could be achieved by increasing wheat yield per unit area either by introducing high yielding varieties and/ or using new methods to increase the yield for example by using biofertilizers and antioxidants.

Biofertilizers one of the important management that assist to increase productivity and the reduction of using chemical fertilizers and alteration by biofertilizer treatments.

Nitrogen, phosphorus and potassium are a major essential macronutrients for plant growth and development and soluble p and k fertilizers are commonly applied to replace removed minerals. When phosphate is added into soils as a fertilizer in relatively soluble and plant available forms, it is easily converted into insoluble complexes with calcium carbonate, aluminum silicate consequently, to achieve optimum crop yields either by soluble phosphate fertilizers or biofertilizers have to be applied at high rates which cause unmanageable excess of phosphate application and environmental and economic problems.

Biofertilizers mean that some microorganisms to be added to the soil as inoculum during plant growth. Biofertilizers increase growth characteristics (e.g. plant height, tillers number and leaf area) by active biosynthesis of growth regulators and production of growth regulators by many microorganisms especially those being fixing nitrogen (*Zaghloul et al. 1996; Vessey, 2003 and Han et al, 2006*).

Bacteria solubilizing phosphate is one important in Egyptian soil because that bacteria provide the soil to change in the alkaline case to acidity one thereby assay phosphorus uptake by the plant.

Bacteria solubilizing potassium to assay the potassium uptake by the roots. All microorganisms solubilizing phosphorus and potassium produced of Glycolic acid thereby could decrease alkalinity.

On the other hand, antioxidants is one of new methods to assist the plant to tolerate any environmental conditions and increased plant growth, cell cycle through plant growth and plant protect of any ROS (Reactive Oxygen Species) and increased Rubisco sub unit, photosynthetic pigments thereby increased chlorophyll contents , increased photosynthetic rate, increased productivity by plants (**Chen and Gallie, 2006 and Inskbashi and Iwaya, 2006**).

In this respect, ascorbic acid (Vit.C) is the major antioxidant in plant known to increase the productivity. Also, alpha tocopherol is the major antioxidant that play a role to protect the plant in environmental stress conditions.

The main objectives of the present study are:

The first objective is the minimizing of using chemical fertilizers and exchange that by biofertilizer treatments.

-Reduction of using chemical fertilizers because they cause pollution of soil and human food and exchange that with fixing nitrogen bacteria (*Azospirillum brasilense*)

Decrease amount of applied phosphorus fertilizer and exchange that by using the bacteria that solublize phosphorus compounds (*Bacillus megaterium* *vr phosphaticum*) loading to decrease soil alkalinity and assay phosphorus uptake by plant.

Minimizing the amouant of potassium fertilizer and exchange that by (*Bacillus circulans*) and increase mineral uptake by plant.

The second objective of this study:

Increase the growth and yield by using certain antioxidants, i.e., ascorbic acid (Vit. C) and alpha tocopherol (Vit. E) to stimulate the growth and grain yield in wheat plants.

MATERIAL AND METHODES

Two filed experiments were carried out at the Experimental farm station of the faculty of Agriculture, Moshtohor, Benha University during the two growing including winter seasons of 2006 and 2007.

To find out the response of wheat (*Triticum aestivum* L) sakha 93 cv to some biofertilizers treatment (*Azospirillum brasilense*, *Bacillus megaterium* vr *phosphaticum* and *Bacillus circulanus*) ,chemical fertilizers including nitrogen, phosphorus and potassium at strength of 1/4, 1/2 and full recommended rates (i.e. 100kg N/ fed, 23.5 kg P₂O₅/ fed and 48 kg K₂O/fed) with four levels of antioxidants (i.e. Vit.C, (Ascorbic acid) at 150 mg /l, Vit.E+selenium (α Tocopherole) 150 mg /lSel(600 μ g/l) and mixer of Vit.C+E 150 mg / l respectively on wheat productivity.

The Experimental design split plot design with three replications was followed. The main plot of biofertilizers with chemical fertilizers (six treatments) and the sub plot included the antioxidants (four treatments) the plot area used was 1/400 fed 3 x 3.5 m² (i. e.10.5 m²).

The Experimental treatments:

A- Bio and chemical fertilizers

1- Control.

2- Biofertilizers (i.e. *A. brasilense*, *B. megaterium* and *B. circulanus*).

3- Recommended rates of chemical fertilizers (i. e. N, P and K full recommended).

4- 1/4 strength with biofertilizers (i. e. *A. brasilense*, *B. megaterium* and *B. circulanus*).

5- 1/2 strength with biofertilizers (i. e. *A. brasilense*, *B. megaterium* and *B. circulanus*).

6- Complete strength of N, P and K as recommended for wheat cultivation with biofertilizers (i.e. *A. brasilense*, *B. megaterium* and *B. circulanus*).

B-Antioxidants :

A-Zero

B- Vit.C (Ascorbic acid) at 150 mg /l.

C-Mixture of Vit. E (α Tocopherole) at 150 mg /L +Sel 600 μ g/l).

D- Mixture of Vit C 150 mg /l.+VE (α Tocopherole) 150 mg /l +Sel 600 μ g/l).

Table (1):Physical and chemical properties of the experimental soil during 2006 and 2007 seasons.

Properties	Seasons	
	2006	2007
	Pre-planting	Pre-planting
Chemical analysis		
E.C.	2.19	2.21
pH (1 :2.5)	8.15	8.13
CaCO ₃ %	3.51	3.00
O.M %	2.16	2.23
N % (total)	0.170	0.173
N(ppm) (available)	52.08	53.64
P % (total)	0.110	0.115
P(ppm) (available)	19.5	20.67
K % (total)	0.61	0.62
K(ppm) (available)	939.78	997.34
Soluble cations and anions (ppm)		
Ca ⁺⁺	186.6	191.6
Mg ⁺⁺	41.04	42.84
K ⁺	45.63	46.80
Na ⁺	190.44	192.28
Cl ⁻	221.88	250.28
Co ₃ ⁻⁻	0.00	0.00
H Co ₃ ⁻	346.48	364.17
So ₄ ⁻⁻	492.96	465.12
Particle size distribution (mechanical analysis)		
Course sand %	7.26	6.59
Find sand %	26.91	27.64
Silt %	13.85	12.60
Clay %	51.98	53.17
Texture grade	Clay	Clay

Methods:

The preparation of sowing land as recommended for wheat plant. The assigned levels of phosphorus in form of super phosphate (15.5% p₂o₅) and levels of potassium (potassium sulphate 48 %K₂o) were applied before sowing through the preparation of sowing land, respectively.

Sowing took place on November 27th and 25th in the first and second seasons; respectively. Wheat seeds were drilled in rows apart at seeding rate of 70 kg/ fed in the two seasons.

Grains soaking and inoculation:

The grains weight per plot was 175 g and soaking time was 3 hours with 70 ml of antioxidant treatments (Vit.C, Vit..E and mixture of Vit.C+E). After soaking grains were inoculated by biofertilizers (inoculation with A. brasilense, B. megaterium and B. circulanus at 10 g/175 g seeds (plot) respectively, that gave a concentration of 10⁹ cell/g).Source of inoculum was Agriculture ministry, Agriculture Research Center, Giza. Egypt. Inoculated and soaked grains were sow at the same time.

Managements through growth:

Nitrogen was added in form of ammonium nitrate (33.5 %N) two time before first and second irrigation after sowing, respectively. The bacterial inoculation was mixed with sand and it was also added before first and second irrigation. The antioxidants treatments were added as foliar spray at 60 and 100 days after sowing with rates 500 ml / plot and 2.2 L/ plot, respectively, in the first and second foliar sprays.

All treatments were replicated in the first and second seasons, respectively.

Sampling and collecting data

Morphological, photosynthetic pigments, spikeling stage and yield characteristics:

1- External morphology :

Different morphological characteristics of wheat plants at 70, 110 days after sowing and at harvest were measured and/ or calculated. Nine plants from each treatment were randomly taken for the following measurements.

- Plant height (cm).
- Number of tillers/ plant.
- Number of leaves/ plant.
- Total fresh weight of shoots (g)/ plant.

- Total leaf area (cm² /plant) using the disk methods according to **Derieux *et al.* (1973)**.

The samples then were dried in oven at 70o C for 48 hours till weight stability, the dry weight of tillers (including main stem) and leaves were estimated.

Also, the percentages of dry matter distribution in different plant organs were calculated.

2- Photosynthetic pigments:

Chlorophyll a, b and carotenoids were calorimetrically determined in fresh leaves of wheat plants at 70 and 110 days after sowing during two seasons according to the methods described by **Wettstein (1957)** and calculated as mg/g fresh weight.

3- Heading stage characteristics at 110 days:

For studying the heading stage behavior of various treatments ten plants per each treatment were randomly taken, labeled and the following data were recorded.

- Spike length (cm)/ spike.
- Number of spikelets /spike.
- Number of spikes/ plant.

4- Yield characteristics:

At harvest, three plants randomly were taken /plot from each treatment for estimation of the following yield parameters:.

- Number of spikes/ plant
- Spike weight (g)/ (main spike).
- Number of grains /main spike.
- Number and weight of spikelets in the lower (basic), medium (middle) and upper (terminal) second and third of the spike.
- Number and weight of fully grains / main spike (g).
- Number and weight of semi fully grain / main spike (g).
- Number and weight of the lowest fully grain / main spike (g).
- Grain yield (g)/ plant.
- Straw yield (g)/ plant.
- Number of grains/ gram.
- Weight of 1000 grains (g)

- Harvest Index (H.I)

$$\text{H.I} = \frac{\text{Economical yield}}{\text{Biological yield}} \quad \text{Gardner et al (1985)}$$

At harvest, on area of 1/4 m² wheat plants /plot from each treatment with three replicates were taken for estimation of the following :-

- Grain yield kg/ fed.
- Straw yield kg/ fed.
- Biological yield (the dry weight of shoots including spikes)*

* Biological yield did not included the dry weight of roots.

5- Chemical analysis:

Dry shoots at the age of 70 days, flag leaf at 110 days after sowing and the produced grains at harvest time in 2007 season were taken to determine their chemical constituents.

I- Total Nitrogen and crude protein:

Total nitrogen was determined in the dry matter of wheat plants at 70,110 day after sowing and grains at harvest by using wet digestion according to **Piper (1947)**, using microkjedahl as described by **Horneck and Miller (1998)**, then calculated as mg/g dry weight. Then the crude protein was calculated according to the following equation:

Crude protein= Total nitrogen x 5.75 by **A.O.A.C. (1990)**

II- Phosphorus:

It was determined calorimetrically by using ammonium molybdate and ascorbic acid indicator according to the methods of **Sandell (1950)** and calculated as mg/g dry weight.

III- Potassium:

It was determined by the flame photometer model carlzeiss according to the methods described by **Horneck and Hanson (1998)** and calculated as mg/g dry weight.

IV-Nutrient uptake:

NPK uptake were evaluated after determination of NPK by Dry matter x concentration according to **Chapman and pratt (1961)**

V- Total carbohydrate:

Total carbohydrate was determined in dry matter of shoots and flag leaf of wheat plants at 70,110 days after sowing and grains at harvest in 2007 season by using phenol-Sulphoric acid method described by **Dubois et al. (1956)** and calculated as mg/g dry weight.

6- Endogenous Phytohormones:

Endogenous Phytohormones were quantitatively determined in wheat leaves at 70 days after sowing at 2007 season. The method of **Koshioka et al. (1983)** was used for HPLC {High- Performance Liquid Chromatography} determination of auxin (IAA), gibberellic acid (GA3) and abscisic, (ABA) and Cytokinins were determined by HPLC according to **Nicander et al. (1993)**

Extraction procedure:

For hormonal analysis, 10 g of the fresh weight of leaves were cut to small pieces and macerated, extracted twice with 96 % methanol then twice with 40 % methanol, each for 24 hours Shindy and Smith (1975) . The methanolic extract was filtered and evaporated in a rotary evaporator at 40 o C to an aqueous solution. The solution was adjusted to pH 8.6 and extracted 4 times with 100 ml ethyl acetate. The alkaline ethyl acetate solution were mixed together and purified with an hydrous sodium sulphate (one tea spoon / 100 ml). The ethyl acetate fraction was filtered and evaporated to dryness, the residue dissolved in 4 ml absolute methanol. This extraction was used for determination of cytokinine, according to **Nicander et al. (1993)** . The aqueous solution was acidified to pH 2.6 -2.8 and extracted as described above, this extraction was used for the determination of gibberellic acid (GA3), indole -3-acetic acid (IAA) , abscisic acid (ABA) by HPLC according to the methods described by **Koshioka et al. (1983)**. The identification of Phytohormones was accomplished by comparing the peaks retention times with the retention times of authentic substances. The quality of individual plants hormones was determined by comparing the peak area produced by a known weight of the plant material with the standard curves of the authentic substances which expressed the relation between the different concentration and their peak areas.

All results for endogenous Phytohormone were calculated as mg/100g F.W.

Statistical analysis:

Data of morphological, heading and yield characteristics were statistically analyzed by using the least significant differences test (L.S.D) according to **Sendecor and cochran (1980)**.

RESULTS AND DISCUSSIONS

A- Effect of biofertilizers and NPK mineral fertilizers on growth:

1- Plant height :

Data in Table (2) show the effect of biofertilizers (bio) and mineral NPK fertilizer levels on plant height. It could be noticed that different applied bio and mineral NPK fertilizer levels increased this trait at 70,110 and 155 days (i.e. at harvest) of plant age during 2006 and 2007 seasons, That increase was parally with the advancing of plant age since reached its maximum at 155 days of plant age (i.e. at harvest). The highest value was existed with the combination of bio and complete strength CS of mineral NPK fertilizer (at 155 days) in both seasons . This value was reached 88.91 and 91.5 cm/ plants in 2006 and 2007 seasons, respectively . Also , clearly, it could be noticed that this final obtained increase of plant height was preceded with the same in first and second samples of measurements with bio and half strength of mineral NPK fertilizer. That maximum increase was obtained with the half strength of mineral NPK chemical fertilizers combined with bio during 70 and 110 days of plant age in 2006 and 2007 seasons. On the other hand, separated applications of each of bio and mineral NPK increased plant height but with less extent.

In this respect, the obtained increase of this trait could be attributed to the high merestematic activity and cell elongation by different growth promoters and the reduction of growth inhibitors as well as more oration of nutrient availability by

different applied microorganisms that reversed upon improving plant growth including plant height. This interpretation will be confirmed after words in the part of hormones determination (Table 21) Other studies on wheat plants also nearly got similar results by **Atia and Aly, (1998) ,Toaima et al.(2000) ,Ghallab and Salem, (2001), Hassan et al, (2002), Saleh , (2003) and Abdel-Hamed (2005) .**

2-Number of tillers/ plant:-

Data in Table (3) show that number of tillers /plant was increased with the increasing of mineral NPK fertilizers Level (i.e. CS ,half and Quarter levels) and also when combined with bio fertilizers at 70 and 155 days (i.e. at harvest) during 2006 and 2007 seasons. The highest value was existed with combination of bio and CS of mineral NPK fertilizers that reached high significant level of increase in this trait. In other words this value with C.S of mineral NPK combined with bio reached to 155.2 and 148.1 % more than the control (100%) during first and second samples of measurements in both seasons. It could also be noticed that this final obtained increase in this trait was preceded with the same in first and second samples of measurements, but maximum increase was obtained with the half strength of mineral NPK fertilizer combined with biofertilizers at 155 days of plant age (i.e. at harvest).

In this respect, the obtained increase in this trait could be attributed to the high formation and activity of endogenous cytokinins and other growth promoters as well as the reduction of growth inhibitors (as well as mentioned in Table 21) and

nutrient availability existed by different applied microorganisms. That beneficial effects reversed upon the increase in the number of tillers / plant

In this respect also **Zaghloul *et al.*, (1996), Ghallab and Nesime (1999), Ghallab and Salem (2001), Mashhor *et al* (2002) and Abdel-Mawly and El-Sharkawy (2005)** nearly got similar results on wheat plants.

3- Number of leaves / plant

As shown in Table (4) indicated that different applied bio and mineral NPK fertilizer levels and combination of bio and mineral NPK levels increased number of leaves / plant at 70 and 110 days of plant age during 2006 and 2007 seasons . That increased was parally with the advancing of plant age. The highest value was existed with combination of bio and CS of mineral NPK fertilizers that reached to the high significant levels of increase in this trait during 70 and 110 days of plant age in both seasons . In the other words C.S. of mineral NPK fertilizer with bio reached to 142.4,114.7,121.1 and 110.2 % in first and second samples of measurements in both seasons, respectively more than value of control (100%). However separately applications of each bio and mineral NPK fertilizers also, increased this trait but with less extent.

In this respect the obtained increase in this trait could be attributed to that encouragement of different aspects of wheat growth and development especially the increase of each of plant height and the number of tillers as well.

In this respect, **Zeidan *et al.* (2005)** reported that combination of bio and mineral NPK increased number of leaves

/plant. Also, **Ali, et al, (2004) and Abdel Hamed, (2005)** nearly got similar results on wheat.

4-Fresh weight of shoots :-

As shown in Table (4) fresh weight of shoots was significantly increased with the increasing of mineral NPK fertilizers levels (i.e. CS, half strength and quarter strength) and combination with biofertilizers at 70 and 110 days of plant age during 2006 and 2007 seasons. The highest value was existed with combination of bio with C.S of mineral NPK fertilizers in first and second samples of measurements. This value was reached to 173.2, 129.2, 148.1 and 142.9 % in first and second samples of measurements in both seasons, respectively.

This significantly favorable effects of combination between mineral NPK fertilizers and biofertilizers may be explained on the basis that the beneficial effects of bacteria on the nutrient availability, vital enzymes hormonal stimulating effects on plant growth or the increasing of the photosynthetic activity may provide principal evident for this view.

In this respect **Bashan and Levanonry (1990) and Zeidan et al. (2005)** nearly got similar results on wheat plants

5- Dry weight of shoots :-

Data in Table (5) show that dry weight of shoots significantly increased with application of each mineral NPK fertilizer levels (i.e. CS strength and quarter strength levels) and biofertilizers and combination of bio and mineral NPK levels at 70 and 110 days of plant age during 2006 and 2007 seasons . The highest value was existed with combination of bio and C.S. mineral NPK fertilizers, this value was reached to 250,118,158

and 149 % during first and second samples of measurements in both seasons, respectively.

In this respect the obtained increased of this trait it could be attributed that beneficial effects of the combination of CS mineral NPK and biofertilizers may be explained on effects of bacteria on the nutrient availability vital enzymes and hormonal stimulating effects on plant growth and accumulation of dry mater thereby increased dry matter of wheat plants. In this respect also **Ghallab and Salem, (2001)**, **Koreish et al. (2004)** and **Abdel- Hamed, (2005)** nearly, got similar results on wheat plant.

6- Total leaf area/ plant :-

Data in Table (5) indicate that combination of bio and complete strength. CS of mineral NPK fertilizers increased total leaf area / plant in first and second samples of measurements during 2006 and 2007 seasons. This value reached to 140, 129.6; 145.3 and 143.9 % at the 70 and 110 days of plant age, respectively more than value of control (100%). Meanwhile each of bio and mineral NPK independently increased this trait but by less extent.

This increase may be due to the superiority of using biofertilizer combined with mineral NPK CS recommended that provide beneficial effects in nutrient availability and synthesis of different elements to increase this trait. **Mengel and Kirkby, (1979)**. That could be reflected upon more expanded formed Leaves and the vigorous vegetative growth as well as improvement of photosynthetic formation, partitioning allocation and translocation as well as. **Banziger et al, (1994)** and **Sabry et al, (1994)** and many others.

In this respect also Sharma *et al* , (1994) and Frederick and Comberato, (1995) **nearly got similar results on wheat plants. The above mentioned results are also being more clear when calculated as a percentage of control (Tables of growth behavior).**

II - Yield characteristics:

1- Number of spikelets.

As Shown in Table (6) non significant differences was the dominant results of all applied treatments on number of spikelets /main spike during first and second samples in 2006 and 2007 seasons. This results are in agreement with **Sabry et al, (1994)**).

2- Spike Length:-

As shown in Table (6) spike Length cm/ main spike increased with increasing mineral NPK fertilizers during first and second samples in both seasons. The highest value was existed with the combination of bio and complete strength CS mineral NPK fertilizers in both seasons. On the other hand separately application of each bio and mineral NPK fertilizer levels increased this trait but to less extent.

In this respect, the obtained increase of this trait may be due to that increase in plant height and the number of leaves and area as well; that could be accompanied with the increase in spike lengths. This could also be attributed to the encouragement of different aspects and development of wheat growth including

this trait. In this respect also **Sushila and Gajendra, (2000)** and many others nearly got similar results on wheat.

3- Number and weight of second and third basic spikelets/ main spike:-

Data in Table (7) show the effect of bio and mineral NPK fertilizer levels on number and weight of second and third basic spikelets. It could be noticed that different applied of each bio and mineral NPK fertilizers and their combination increased this trait during 2006 and 2007 seasons. The highest value was existed with combination of bio and complete strength of mineral NPK fertilizers during both seasons.

This value was reached to 3.6 and 3.6 grains / spikelet in second basic spikelet and weight of 0.19 and 0.22 g/ grains in first and second seasons, respectively. The meanwhile third spikelet gave 3.25 and 3.42 grains / spikelet and weight of 0.23 and 0.22 g /grains during. Both seasons, respectively. Meanwhile, control value of second basic spikelet was reached 2.75 and 3.25 grains/spikelet and weight of 0.18 and 0.17 g/ grains in first and second seasons , respectively. Meanwhile control of third basic spikelet / was reached. 2.75 and 3.25 grains/spikelet and weight of 0.14 and 0.18 g/grains during both seasons, respectively. On the other hand separately application of each bio and mineral NPK fertilizer levels also increased this trait but by less extent.

In this respect, the obtained increase of this trait may be due to increase of total leaf area of wheat plant, that logically to be reversed upon both photosynthesis efficiency and

photosynthetic translocation into grains (sink) thereby that could be increase fully grain and grain weight as well.

4-Number and weight of second and third middle spikelets/ main spike:-

As shown in Table (8) different applied of each bio and NPK chemical fertilizers significantly increased number and weight of second and third middle spikelet during 2006 and 2007 seasons. The highest value was existed with combination of bio with complete strength NPK chemical fertilizers in second middle spikelet this value was gave 3.83 and 4.00 grain / spikelet and weight of 0.19 and 0.21 g/ grains in first and second seasons, respectively. Meanwhile, control value was reached 3.25 and 3.85 grains/ spikelets and weight of 0.16 and 0.18 g / grains in both seasons, respectively. However third middle spikelet increased with combination of bio and CS mineral NPK fertilizer during 2006 and 2007 seasons; gave 3.67 and 3.45 grains / spikelet and weight of 0.19 and 0.19 g / grains during first and second seasons, respectively.

Yet, control value gave 3.05 and 3.00 g / spikelet and weight of 0.15 and 0.14 g / grains during first and second seasons, respectively.

In this respect the obtained increase of this trait may be due to increase in total leaf area of wheat plants (Table 5) and photosynthetic allocation into middle grains as sink organs.

5- Number and weight of second and third terminal spikelets/ main spike:-

Data in Table (9) show the effect of bio and mineral NPK fertilizer levels on number and weight of second and third

terminal spiklet during 2006 and 2007 seasons. It could be noticed that different applied of bio and mineral NPK chemical fertilizers levels increased this trait during 2006 and 2007 seasons. Also, combination of bio and CS mineral NPK fertilizer showed the greatest increased of this trait. This number of second terminal spiklet was reached to 2.77 and 2.88 grain / spiklet and weight of 0.18 and 0.18 g / grains during first and second seasons, respectively. Also, third terminal spiklet was reached 2.67 and 2.33 grains / spikelet and weight of 0.18 and 0.14 g / grains during first and second seasons, respectively. Meanwhile, control value was reached to 2.50 and 2.58 grains / spiklet and weight of 0.09 and 0.11 g/ grains and the third terminal spiklet number was reached 2,- and 2.08 grains / spiklet and weight of 0.11 and 0.12 g / grains spikelet during first and second seasons, respectively.

In this respect the obtained increased of this trait may be due to that high photosynthetic translocation i into grains and direct beneficial effects of microorganism with CS mineral NPK fertilizers to the nutrient availability and vital enzymes to assistant increased of this trait.

6- Number and weight of fully grains / Main spike :-

Data in Table (10) clearly show that number and weight of fully grains/ main spike increased with increasing NPK fertilizers level. It could be noticed that combination of bio with CS mineral NPK fertilizer high significantly increased this trait in first season but in second seasons no significant. This value was reached 32,- and 25.389 grains / main spike and weight of 1.88 and 1.51 g/ main spike. Meanwhile control value reached

18.177 and 19.67 g/ main spike during first and second seasons, respectively.

Increases of this trait with combination of biofertilizer and CS mineral NPK may be due to that beneficial effects of increasing total leaf area/ plant and preceded with an increase of leaves number (Table 4 and 5) that could increase photosynthetic rate and photosynthates translocation into grains and increased fully grains. Also, with the effect of microorganisms on nutrient availability, vital enzymes and stimulating any material to development of wheat grain and increased of fully grains in this respect Here, El-Dsouky (2005) nearly got similar results on wheat plants.

7- Number and weight of semi fully grains/ main spike:-

As shown in Table (10) different applied bio and mineral NPK fertilizers and their combination increased number and weight of middle fully grains / main spike during 2006 and 2007 seasons. The highest value was existed with the combination of bio with CS mineral NPK fertilizers in both seasons. This value was reached 25.67 and 23.16 grains per main spike and weight was reached 1.99 and 1.154 g / main spike during 2006 and 2007 seasons , respectively. Meanwhile control value was reached to 21.667 and 18.417 grains / main spike and weight gave reached 1.595 and 0.942 g /main spike during 2006 and 2007 seasons , respectively.

It is of interest to note that the obtained increase of this trait was a direct response of mineral and biofertilizer to increase translocation rate of photosynthate into grains.

8-Number and weight of lowest filled grains / main spike.

Data in Table (11) showed that number and weight of weak filled grains decreased with increasing mineral NPK fertilizers levels and combined with bio fertilizers. Also, combination of bio and CS mineral NPK fertilizers showed lowest decrease of this trait during 2006 and 2007 seasons. This trait since it reached 15.33 and 17.67 grain / main spike and weight 0.47 and 0.57 g/main spike during 2006 and 2007 seasons, respectively. Meanwhile, control value was reached 20.50 and 20.25 grains/main spike and weight was reached 0.67 and 0.74 g/main spike during first and second seasons, respectively.

9-Spike fertility.

Data in Table (11) show the effect of bio and mineral NPK fertilizer levels on spike fertility during 2006 and 2007 season. It could be noticed that different applied bio and mineral NPK fertilizers increased this trait during both seasons. The highest value was existed with combination of bio and half strength mineral NPK fertilizers at harvest during the tow seasons. The above mentioned results are also being more clear when calculated as a percentage of control (Table 11) It is of interest to note that the obtained increase of this trait could be consider as a direct response to the combination of bio and half strength mineral NPK fertilizers on fertility of tillers and that increased number of spikes / plant and the beneficial effects may be due to the known physiological effects of this from on increasing of the endogenous Cytokinins **Smicklas and Below, (1992) and Wang & Below, (1995)**. Also, in this respect other studies have been got nearly similar effects of this treatment on the spike formation of wheat plant. **Mohamed, (1994) and El-Bana, (1999)**.

10- Number of grains per gram:-

Data in Table (12), showed that each of bio and mineral NPK fertilizers levels decreased number of grains during 2006 and 2007 seasons. Also bio and CS of mineral NPK fertilizers slightly decreased this trait, this value reached 19.17 and 19.92 grains / one gram during first and second seasons , respectively.

Increment of this trait, during both seasons could be increased the number of fully grain (Table 10).

11- Weight of 1000 grains:-

As shown in Table (12) the weight of thousand grains was increased with increasing of mineral NPK fertilizers levels, bio and combination of bio and mineral NPK levels during 2006 and 2007 seasons. The highest value existed with bio and CS mineral NPK fertilizers. This value reached to 52.98 and 50.37 g / thousand grains during 2006 and 2007 seasons, respectively. Meanwhile control value was 49.16 and 43.05 g / thousand grains during first and second seasons , respectively.

In this respect, the obtained increase of this trait could be attributed to the increase in number and weight of grains(Table 10) due to that increase 1000 grain weight. Other studies also , nearly got similar results on wheat plants Abdel-Hamed, (1999), Ghallab and Nesium, (1999), Ali, *et al*, (2004, El-Dsouky (2005) and Han, *et al*(2006) and many others.

12- Grain weight / main spike:-

As for weight of grains per main spike; Table (13) indicates that different applied of bio and mineral NPK fertilizer levels and their combination increased weight of grains / main

spike during 2006 and 2007 seasons. Also, combined of bio and CS of mineral NPK fertilizers showed the greatest increase of this trait during first and second seasons, but that increase during second seasons reached to the high level of significance. This value was 4.361 and 3.233 g /main spike during first and second seasons , respectively. Meanwhile control value was 3.56 and 2.55 g/ main spike during first and second seasons , respectively.

Increase of grains weight could be partially attributed to the increase of grains number / main spike and increase of Thousand grain weight (Table 12) as well as to that increase in chlorophyll biosynthesis (Table 15 and 16) and increases of total leaf area (Table 5). All of that could reversed on both photosynthesis efficiency and photosynthates translocation into grains (i.e. sink organs). Similar results were obtained on wheat plants by Mohamed,(1994), Sushila and Gajendra , (2000) Ghallab and Salem, (2001), Abdel- Hamed, (2005) and Han, *et al* (2006).

13-Number of grains / main spike:-

As shown in Table (13) number of grains /main spike was positively responded to different applied bio and mineral NPK fertilizer levels during 2006 and 2007 seasons.

In this respect bio combined with CS mineral NPK showed increase of this trait since this value was 70.83 and 65.75 grains/main spike during first and second seasons, respectively. On the other hand lowest increase was obtained with single biofertilizers since value reached 66.40 and 62.50 grains / main spike during first and second seasons , respectively.

The obtained results could be attributed to the role of bio and mineral NPK fertilizers on spike fertility and increase of grains weight/ main spike and increased number of spikelet/ main spike (Table, 6) may be due to increased number of grains/ main spike. Other studies also nearly got similar results by Mohamed, (1994) and Ali , *et al*,(2004) on wheat plants.

14- Grain and straw yield:-

a-Grain yield:-

Data in Table (12) and (13) show that different applied of bio and mineral NPK levels increased grain yield g / plant and grain yield per fed during 2006 and 2007 seasons. The highest value was existed with combined bio and CS mineral NPK fertilizers during 2006 and 2007 seasons. This value reached to 21.613 and 19.442 g / plant and 2153 and 2712 kg Per fed during first and second seasons,

respectively .Meanwhile control value reached 11.75and 12.242 g/plant and 1836 and 2318 kg per fed during first and second seasons, respectively.

In this respect, the obtained increase of this trait could be attributed to there beneficial effects and direct response of biofertilizers and complete strength of mineral NPK fertilizers and their combination on increase of photosynthetic and translocation rates into grains as well as increased spike fertility/plant (Table 11), total leaf area, increase of photosynthates production (Table 15 and 16) and their translocation into grains and increase fully grains and number and weight of grains/ spike (Table, 10 and 13). Other studies, nearly got similar results Sushila and Gajendra, (2000), Ghallab and Salem, (2001) and Ali, *et al*, (2004) on wheat.

b-Straw yield:-

Data in Table (13) and (14) also clearly indicate that straw yield was similarly responded as well as in case of grain yield. Since, combination of bio and C.S mineral NPK fertilizers increased straw yield per plant and per fed as well.

In this respect also Sushila and Gajendrya,(2000) reported that straw yield increased with combined bio and CS mineral NPK fertilizers.

15- Biological Yield:

Data in Table (14) indicate that combination of bio with CS mineral NPK fertilizers increased biological yield per plant and per fed during 2006 and 2007 seasons. This value reached 48.10 and 49.57 and 5893.2 and 7676.1 kg/fed during first and second seasons, respectively. Meanwhile control value reached 34.12 and 30.14 g/plant and 5139.4 and 5812.1 kg/fed during first and second seasons respectively. On the other hand, application of bio and NPK levels also increased this trait but by less extent. Although, existed increase of this trait was obtained either with combination or separately treatments. In this respect also Ghallab and Salem, (2001) and Ali, *et al*, (2004) nearly got similar results on wheat. The above mentioned results are also being more clear when calculated as a percentage of control (Tables of yield characters).

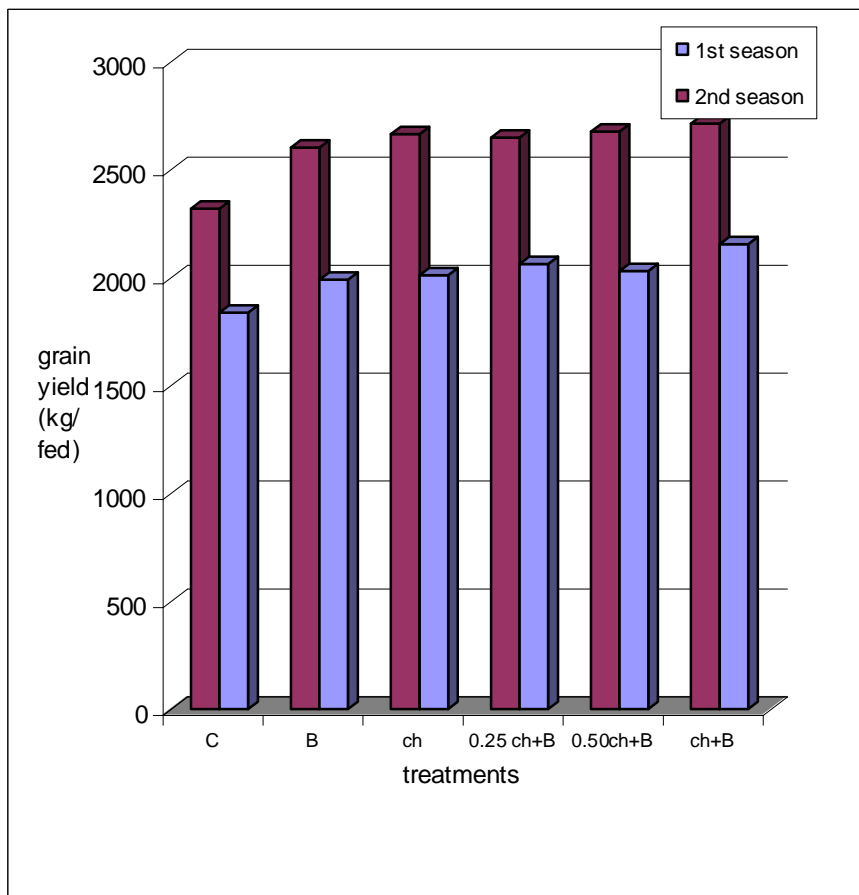


Fig (1) Show the effect of bio and NPK mineral fertilizer on grain yield (kg/ fed).

Ab: C-Control B-Biofertilizers Ch:-Chemical fertilizer

1/2 Ch+B:- half complete strength+ Biofertilizers Ch+B:-Chemical fertilizer +Biofertilizers

II- Chemical analysis of wheat plants:

1- Photosynthetic Pigments:-

Data in Table (1^o) and (1^v) indicate that different photosynthetic pigments i.e., chlorophyll a, b and carotenoids were positively responded to the different applied bio and mineral NPK fertilizer levels and their combination during 2006 and 2007 seasons. Also, combination of bio and CS mineral NPK fertilizer gave the highest value in tow seasons.

Also, the simulation of photosynthetic pigments formation could be attributed to the vigours growth obtained in (Tables 2,3 ,4 and 5) . Hence increasing of chlorophylls and carotenoids content enhanced photosynthetic efficiency and increased dry matter accumulation.

Also, this enhancement could be indicator for expectable high grain yield. In this respect also Ghallab and Salem, (2001) and Abdel- Hamed, (2005), EL- Dsouky (2005) and Han *et al*, (2006). nearly got similar results on wheats and Cucumber and Pepper plants respectively.

2- NPK content:-

Data in Table (1^v) clearly indicate NPK content in shoots of wheat at 70 days of plant age and flag leaf at 110 days of plant age during 2007 season. Different applied of bio and mineral NPK fertilizer levels obviously increased nitrogen concentration in shoots and flag leaf at 70 and 110 days of plant age. Also, it could be noticed that this positive effect nearly was the same with different levels. The highest value existed with combined of bio and CS mineral NPK. This value reached 42.72 and 41.27

mg/g dry weight at first and second samples of measurements during 2007 season, respectively. Meanwhile control value was 25.03 and 27.3 mg/g dry weight at first and second samples of measurements during 2007 season, respectively.

As for P content in shoots at 70 days and flag leaf at 110 days of plant age during 2007 season, this content showed an increase with different applied of bio and mineral NPK levels. This trait was increased with increasing mineral NPK levels since the highest value existed with combined of bio and CS mineral NPK fertilizers this value reached 2.14 and 1.61 mg/g dry weight in the first and second sample of measurements during 2007 season, respectively. Meanwhile control value reached 1.07 and 1.09 mg/g dry weight at first and second samples of measurements during 2007 season, respectively.

As for K content in shoots at 70 days and flag leaf at 110 days of plant age during 2007 season; different applied bio and mineral NPK levels positively affected K content. The highest value was existed with bio combined of with CS mineral NPK in first and second samples of measurements. This value reached 49.58 and 22.99 mg/g dry weight at first and second samples of measurements during 2007 season, respectively.

It could be noticed that NPK concentrations in shoots at 70 and flag leaf at 110 day of plant age during 2007 seasons was increased. That was accompanied with an increase in the rate of wheat growth under the applied of different bio and mineral NPK levels.

In this respect , the obtained increase of this trait could be attributed to that beneficial effects of combination of bio and CS mineral NPK fertilizers on nutrient availability, vital enzymes and accumulation of essential nutrients in both samples and increased NPK concentration in shoots and flage leaf. Other studies, also nearly got similar results on wheat Abdel-Azeem, (1998), Faid, (2000), Ghallab and salem, (2001), Yassen, (2002) and Han *et al*, (2006).

3- NPK uptake :

As shown in Table (1[^]) different applied bio and mineral NPK fertilizer levels increased NPK uptake in shoots and flage leaf at 70 and 110 days of plant age during 2007 seasons, respectively. The highest value was existed with combined bio and CS mineral NPK fertilizers in first and second samples of measurements during 2007 seasons, respectively.

The obtained increase of this trait could be attributed to the positive effect of bio and CS mineral NPK upon nutrient availability and uptake by plant thereby increased uptake of NPK.

In this respect also Abdel-Azeem, (1998), Abdel- Hamed, (1999), Faid, (2000), Sonbol *et al*, (2000), Ghallab and salem, (2001), Yassen, (2002) and Abdel- Hamed, (2005) nearly got similar results on wheat plants and Cucumber and Pepper plants respectively..

4- Total carbohydrate:

Data in Table (19) show that total carbohydrates was increased with increasing mineral NPK fertilizer levels and biofertilizers treatments in shoots and flage leaf at 70 and 110 days of plant age during 2007 season.

The highest value was existed with combined bio and CS mineral NPK. This value was 285.00 and 594.30 mg/ g dry weight at first and second samples of measurements during 2007 seasons, respectively. Meanwhile control value was 127.90 and 574 mg /g dry weight during first and second samples of measurements during 2007 season, respectively.

In this respect the obtained increase of this trait could be attributed to that increase in total leaf area, (Table 5) photosynthetic pigments (Table 15 and 16), photosynthates rate and increase of translocation rate of different photosynthate produced from source organs (i.e. leaves) to the sink organs during plant growth. carbohydrates synthesis and enhanced plant growth. Also, application could simulative. In this respect also Abdel-Hamed, (1999), Abdel-Hamed,(2005) and Han *et al*, (2006). Nearly got similar results on wheats.

5- Crude protein

With regard to the content of crude protein in shoots and flag leaf at 70 and 110 days of plant age during 2007 season. As indicated in Table (19) it could be noticed that a strict increase of this content (245.64 and 237.27 mg/g dry weight) at first and second samples of measurement during 2007 seasons, was achieved. The highest value was existed with combination of bio and CS mineral NPK fertilizers application. Meanwhile, control value was 143.73 and 156.98 mg/g dry weight in shoots and flag leaf at 70 and 110 days of plant age during 2007 seasons, respectively. Also it could be noticed that different levels of each NPK and biofertilizers increased of this trait during first and second samples of measurement during 2007 season.

The above mentioned results about content of crude protein and photosynthates production and stimulating effects on plant growth by applied microorganisms and CS mineral NPK fertilizers could increase crude protein in wheat grains.

In this respect , also Banziger *et al*, (1994) and Ghallab and Salem, (2001) nearly got similar results on wheat plants.

IV-Chemical composition of wheat grains :-

1- NPK content:-

As shown in Table (20) different applied bio and mineral NPK fertilizers increased NPK contents in grain wheat during 2007 season. The highest value existed with bio combined with CS mineral NPK fertilizers this value was 28.59, 1.56 and 6.32 mg/g dry weight N,P and K, during 2007 season, respectively.

Meanwhile control value was 25.0, 0.68 and 4.9 mg/g dry weight N,P and K during 2007 season, respectively. Also. data of the present study could be attributed to that increase of translocation into sink (grains) and beneficial effects of bacteria on NPK availability hence grain content and increase NPK contents in grains.

Other studies nearly got similar results of these studies are Hanafy, *et al* , (1995), Ghallab and Salem, (2001) and Abdel- Hamed, (2005) .

2- Total carbohydrate and crude protein:-

Data in Table (20) show the effect of bio and mineral NPK fertilizer levels and their combination on total carbohydrate and crude protein contents in grains at 2007 seasons. It could be noticed that different applied bio and mineral NPK fertilizer

levels (i.e. Quarter strength, half strength and CS levels) and combination with biofertilizers increase total carbohydrates and crude protein contents in grains during 2007 season. The highest value was existed with combination of bio and CS mineral NPK this value was 798.3 mg/g total carbohydrate and 164.4 mg/g dry weight crude protein in wheat grains during 2007season, respectively .Meanwhile control value gave 671.9 mg/g total carbohydrate and 148.93 mg/g dry weight crude protein during 2007 season, respectively.

In this respect, the obtained increase of this trait could be attributed to that increase of total leaf area, (Table 5) photosynthetic pigments (Table 15 and 16) thereby an increase photosynthates production, photosynthetic rate and translocation into grains. All of that reversed upon an increase total carbohydrates and crude protein in grains. In this respect also Ghallab and Salem, (2001), Ali, *et al*, (2004) and Abdel- Hamed, (2005) nearly got similar results on wheat plants. The above mentioned results are also being more clear when calculated as a percentage of control (Tables of chemical composition of wheat plant and grains).

V- Endogenous Phytohormones content:-

Data in Table (21) show that Phytohormones content (i.e. Auxin, Gibberellins, cytokinines) was increased with combination of bio and complete strength CS of mineral NPK fertilizers. But reduced growth inhibitor (Absisic acid) concentration in wheat leaves at 70 days of plant age. Although, separately application of bio and mineral NPK fertilizers increased this content but by less extent. The above mentioned results are also being more clear when calculated as a percentage of control (Table 21).

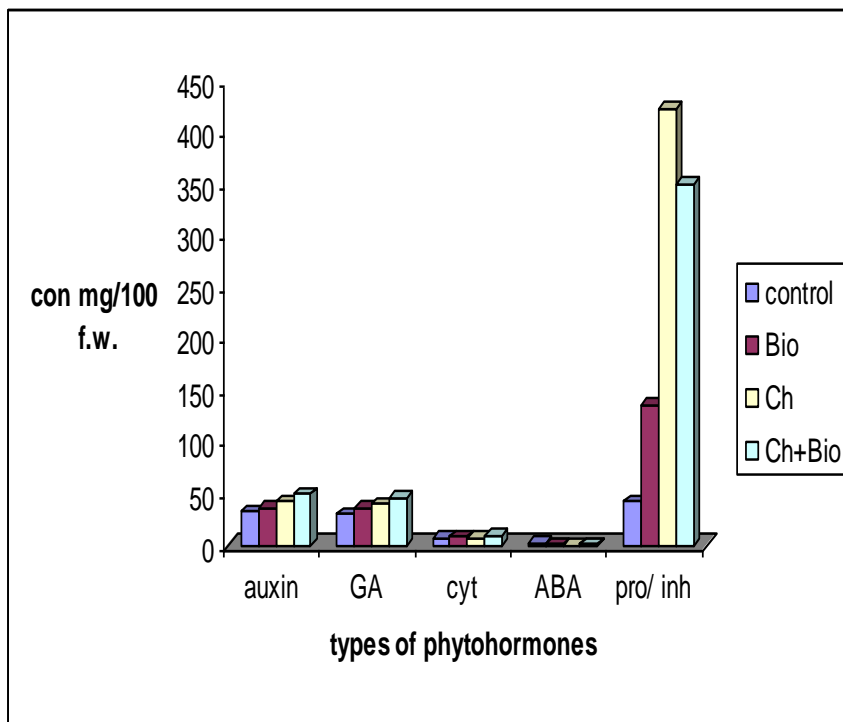


Fig (2) Show the effect of bio and mineral fertilizers on Phytohormones contents

C:- control B:- Biofertilizers Ch:- Chemical fertilizers

Ch+Bio:- Chemical fertilizers +Biofertilizers

GA- Gibberellins Cyt:- Cytokinins

ABA:- Absisic acid Pro/inh:- promoter/ to inhibitor

In this respect the obtained increase of this content may be due to beneficial effects of bio and mineral NPK to improve different aspects of wheat growth, including production of more photosynthates and a greater part of them to be allocated for grains. Thereby, economic yield was increased (i.e. weight of yielded grains).

B -Effect of Antioxidants

I-Growth characteristics:-

1- Plant height:-

Data in Table (22) show the effect of antioxidant treatments (i.e. o, vitamin C , vitamin E and mixture of vitamin C+ E) on plant height at 70, 110 and 155 (i.e. at harvest) days of plant age during 2006 and 2007 seasons . It could be noticed that different applied antioxidants increased plant height at 70,110 and 155 days of plant age in both seasons. The highest value was existed with vitamin C(Vit.C) in both seasons. Vit.C at 110 days of plant age high significantly increased plant height during both seasons. Yet, the other two samples did not reach to the level of significance.

In this respect, the obtained increase of this trait may be due to the stimulating effect of Vit C on vegetative growth and regarded in attract amount to maintain normal growth to increase plant growth including increase plant height.

Other studies ,nearly got similar results by Anton, *et al*, (1999), Arisha, (2000), Bardisi, (2004) and Inskbashi and Iwaya (2006).

2- Number of tillers/ plant:-

Data in Table (23) indicate that different applied antioxidants increased number of tillers/ plants at 70,110 and155 days (at harvest) of plant age during 2006 and 2007 seasons . The highest value was existed with Vit.C at 70,110 and 155 days (i.e. at harvest) of plant age during 2006 and 2007 seasons. It could be noticed that the 2nd sample of measurements and at harvest showed high significantly increase of this trait compared with the control in both seasons.

The obtained increase of this trait could be attributed to induce many stimulating effects on plant growth and some physiological processes and cytokinines synthesis and enhancing cell division to increased plant growth leading to an increase of tillering plants. This interpretation will be confirmed in the part of hormone determination (Table,41). The obtained results are in accordance with those of Anton and Bassiem, (1998) and Ishibash and Iwaya (2006).

3- Number of leaves/ plant:-

As shown in Table (24) different applied antioxidants, high significantly increased number of leaves / plant at 70 and 110 days of plant age during 2006 and 2007 seasons .It could be noticed that highest value was existed with Vit.C in first and second samples during both seasons. Meanwhile the mixture of Vit.C+E ranked the second in this respect when compared with the control.

The simulative effect of Vit.C on number of leaves may be due to that Vit. C is regarded in a tract amount to mention normal growth Oertill, (1987) including this trait

(leaves/plant) and increased plant height and tillers number/ plant (Table 22,23) may be due to that of increase this trait. Other studies nearly got similar results by Anton, *et al*, (1999).

4-Fresh weight of shoots

Data in Table (24) clearly indicate that different applied antioxidants treatment increased fresh weight during 2006 and 2007 seasons. The highest value was existed with Vit.C this value reached to the level of high significantly increase of this trait at first sample in second season

In this respect, the obtained increase of this trait could be attributed to that induce of many stimulating effects on growth and activation of some physiological processes to increase plant growth and increase plant height, number of tillers/plant, number of leaves/ plant (Table,22,23 and 24) and due to increase fresh weight of shoots / plant. Other studies nearly got similar results by Anton and Bassiem, (1998), Bardisi, (2004), El-Bassuonay, (2005) and Inskbashi and Iwaya (2006).

5- Dry weight of shoots :-

As shown in Table (25) different applied antioxidants increased dry weight of shoots / plant at 70, 110 days of plant age during 2006 and 2007 seasons. The highest value was existed with Vit.C. This value reached to the level of high significantly increase of dry weight of shoots in first and second samples of measurements during both seasons.

The above mentioned positive effect of Vit. C could be attributed to the stimulative effect of Vit.C on photosynthetic production, dry matter accumulation and leaf carbohydrates

content Dhopte and lall, (1987) and Bardisi, (2004) **Therefore dry weight of shoots was increase and that increased was preceded with vegetative growth (Table, 22,23 and 24). Other studies nearly got similar results by Anton, *et al.* (1999) and Inskbashi and Iwaya (2006).**

6- Total leaf area/ plant:-

Data in Table (25) indicated that different applied antioxidants increased total leaf area / plant at 70 and 110 day of plant age during 2006 and 2007 seasons. The highest value was existed with Vit.C that reached 1142.,1324.8,1149.1 and 1321.8 cm/ plant at first and second samples of measurements during first and second seasons, respectively. is value high significantly increased at first samples in both seasons. Meanwhile control value only was reached 837.8, 1081.9, 837.8 and 1074.4 cm/ plant at first and second samples of measurements during first and second seasons, respectively.

In this respect, Vit.C one of the most important vitamin having stimulation effects on plant growth, cell division in different plants Thereby increased plant growth including total leaf area/ plant and increased plant height, tillers number and leaves number could be expected (Table, 22,23 and 24) and that may be due to increased total leaf area/plant. Other studies nearly got similar results by **Bardies, (2004) and El-Bassuonay, (2005)**. The above mentioned results are also being more clear when calculated as a percentage of control (Tables of growth behavior).

11- Yield characteristics :-

1- Number of spikelets/ Main spike :-

Data in Table (2⁶) show that different applied antioxidants increased number of spiklet / main spike at 110 and 155 days (at harvest) of plant age during 2006 and 2007. seasons. It could be noticed that highest value was existed with Vit.C that reached to high significantly level during second samples in both seasons.

In this respect, the obtained increase of this trait may be due to that induced stimulating effects on plant growth and role of Vit.C on spike fertility due to increased spikelets number/ spike.

Other studies nearly, got similar results by Anton *et al.* (1999), Bardisi, (2004) and Inskbashi and Iwaya (2006).

2- spike length:

As shown in Table (26) different applied antioxidants (i.e.Vit.C, Vit .E and mixture of Vit.C+E) increased spike length during 2006 and 2007 seasons. The highest value was existed with Vit.C that reached to high significantly level in first season but in second season no significant existed.

The obtained increase of this trait may be due to the enhancement and stimulating some growth factors to increase plant growth and increased plant height (Table, 22) due to that increase of spike length Anton and Bassiem, (1998).

3- Number and weight of second and third basic spikelets/ main spike (in first spike third, basal one):-

Data in Table (27) indicated that different applied antioxidants significantly increased number and weight of second and third basic spikelets in 2006 and 2007 seasons. The highest value was existed with Vit.C in both seasons.

In this respect, the obtained increased of this trait it could be attributed to that role of Vit.C on fertility and increased fully grain of wheat plants. Other studies, nearly ,got similar results by Anton and Bassiem (1998) and Bardisi, (2004) .

4- Number and weight of second and third middle spikelets/ main spike (in second spike third, middle one):-

As shown in Table (28) all antioxidants treatment (i.e. Vit.C, Vit. E and mixture of Vit.C+ E) increased number and weight of second and third middle spikelets in 2006 and 2007 seasons . It could be noticed that the highest value was existed with Vit.C in both seasons.

The obtained increase of this trait it could be attributed to the high activity of photosynthetic rate and increased total leaf area/ plant (Table, 25),hence increase photosynthates production and their translocation into sink (grains) of wheat plants.

5- Number and weight of second and third terminal spikelets/ main spike (in third spike third upper one):-

Data in Table (29) show that numbers and weight of second and third terminal spikelets positive affected by application of each antioxidants (i.e. Vit.C, Vit.E and mixture of Vit.C+E) in 2006 and 2007 seasons The highest value was existed with Vit.C in both seasons.

In this respect, Vit.C induced many stimulating effect, on fullfility of grains and increased grains weight.

6- Number and weight of fully grains / Main spike:-

Data in Table (30) different applied antioxidants treatment showed high significantly increase in number and weight of fully grain/ main spike in 2006 and 2007 seasons. The maximum increase of this trait was existed with Vit.C in both seasons. The highest value was reached 35.60 and 28.70 gains/ main spike and 1.74 and 1.38 g/ main spike in both seasons. .Meanwhile control value was reached 24.60 and 20.20 grains/ main spike and 1.39 and 0.99 g in both seasons, respectively.

The obtained increase of this trait it could by attributed to the role of Vit.C on increasing photosynthetic rate and photosynthesis production and their translocation into grains thereby increased grains.

7-Number and weight of semi fullfility grains / Main spike:-

As shown in Table (30) all antioxidants application increased number and weight of middle fully grains /main spike during 2006 and 2007 seasons. The highest value of this trait was existed with Vit.C compared with the control.

The highest increase of this value may be due to that increment on plant growth brought more photosynthesis and photosynthates production in which translocated to the grain and increased grains fullfility.

8- Number and weight of lowest fullfility grains /main spike:-

Data in Table (31) show that number and weight of lowest fullfility of grains / main spike decreased with application of

antioxidants treatments (i.e. Vit.C, Vit.E and mixture of Vit C+E) in 2006 and 2007 seasons. The highest reduction of this trait was existed with Vit.C.

The obtained decrease of this trait may be due to the role of Vit. C to the increment of plant growth and translocation photosynthesis production in into grains. Thereby decreased weak grain / mean spike.

9- Spike fertility/ plant:-

Data in Table (31) show that different antioxidants treatments (i.e. Vit.C , Vit.E and mixture of Vit.C+E) affected spike fertility in 2006 and 2007 seasons. It could be noticed that different applied antioxidants increased this trait in both seasons. The highest value was existed with Vit.C that reached to the high significantly level in first season but in second season did not reach the level of significance.

It is of interest to note that the obtained increase of this trait at the harvest time was a direct response to the effect of Vit.C on spike fertility of wheat plant and increased spike number/ plant. Other studies nearly got similar results by Anton *et al*, (1999).

10- Number of grains per gram:-

Data in Table (32) show that number of grain /g was decreased with application of each antioxidant during 2006 and 2007 seasons. The highest reduction value was existed with Vit.C during both seasons.

In this respect, the obtained decrease of this trait could be attributed to that increase of fully grains / main spike (Table, 30) and also may be due to reduction in number of grains per gram.

11- Weight of 1000 grains:-

Data in Table (32) indicated that weight of 1000 grains was increased with application of each antioxidant in 2006 and 2007 seasons. The highest value was existed with Vit.C compared with the control.

The obtained increase of this trait could be attributed to that increase of fully grains (Table, 30) and increase grains weight thereby could increase the weight of 1000 grains.

12- Number of grains /main spike :-

As shown in Table (33) different applied antioxidants increased number of grains/ main spike in 2006 and 2007 seasons. The highest value was existed with Vit.C in both seasons.

In this respect, the obtained increase of this trait may be due to that role of Vit.C on grain fertility and increased number of spikelets/ main spike (Table, 26) may be due to that increase of grain number/ main spike.

13-Grain weight/ main spike :-

As shown in Table (33) Vit.C increased grain weight / main spike in 2006 and 2007 seasons. Also, other separately application of all antioxidants increased this trait but by less extent. Although, existed increase of grain weight either with Vit.C or separately treatments did not reach the significant level.

The obtained increase of this trait may be due to that role of Vit.C on fullfillity of grains and increased fully grains number/main spike, number of grain/ main spike and 1000 grain weight (Table,30,32 and 33) thereby increased grains weight / main spike

14-Grain and straw yields:-

a- Grain yield :

As shown in Table (32) and (33) grain yield/ plant and grain yield / fed significantly were increased with application of each antioxidant in 2006 and 2007 seasons. The highest value was existed with Vit.C that reached 16.28 and 18.84 g/ plant in 2006 and 2007 seasons, respectively and that means 2265 and 3255 kg / fed in first and second seasons, respectively. Meanwhile control value was reached 11.269 and 11.362 g / plant and gave 1710 and 2445 kg / fed in first and second seasons, respectively.

In this respect, the obtained increased of this trait it could be attributed to increment of plant growth. That gave more photosynthesis products which translocated to the grains and increased fully grains and number and weight of grains (Table, 30,33) due to increase of grain yield/ plant and / fedan thereby increased total grain yield .

b- Straw yield :-

Data in Table (32) and (33) show that straw yield / plant and / fed were increased with application of each antioxidant (i.e. Vit.C ,Vit.E and mixture of Vit. C+E) during 2006 and 2007 seasons The highest value was existed with Vit.C+E. This value was reached 31.13 and 27.43 g/plant and 3987.39 and 4644.4 Kg / fed in first and second seasons, respectively. Meanwhile control value was only 23.29 and 22.92 g/ plant and 3080.1 and 4142 Kg/ fed in first and second seasons, respectively.

15- Biological yield :-

Data in Table (34) indicate that different applied antioxidants increased Biological yield / plant during 2006 and 2007 seasons, The highest value was existed with Vit. C+E in both seasons. The above mentioned results are also being more clear when calculated as a percentage of control (Tables of yield characteres).

The obtained increase of this trait may be due to that increment of grain and straw yields thereby increment of biological yield.

III -Chemical analysis of wheat plants :

1- Photosynthetic pigments:-

Data in Table (35) and (36) indicate that different photosynthetic pigments as chlorophyll a, b and carotenoids were positively responded to the different applied antioxidants treatment in first and second samples of measurements at 2006 and 2007 seasons. Also, Vit.C gave the highest value comparing with the control.

The stimulative of photosynthetic pigments formation, could be attributed to the obtained vigorous growth that stimulate chlorophylls and carotenoids formation hence enhanced photosynthesis efficiency and increased total leaf area/ plant (Table,25) all of that could be consider as indicator for expectable high total grain yield. Other studies nearly got similar results by **Inskbashi and Iwaya (2006)** and **Irfan *et al.* (2006)**

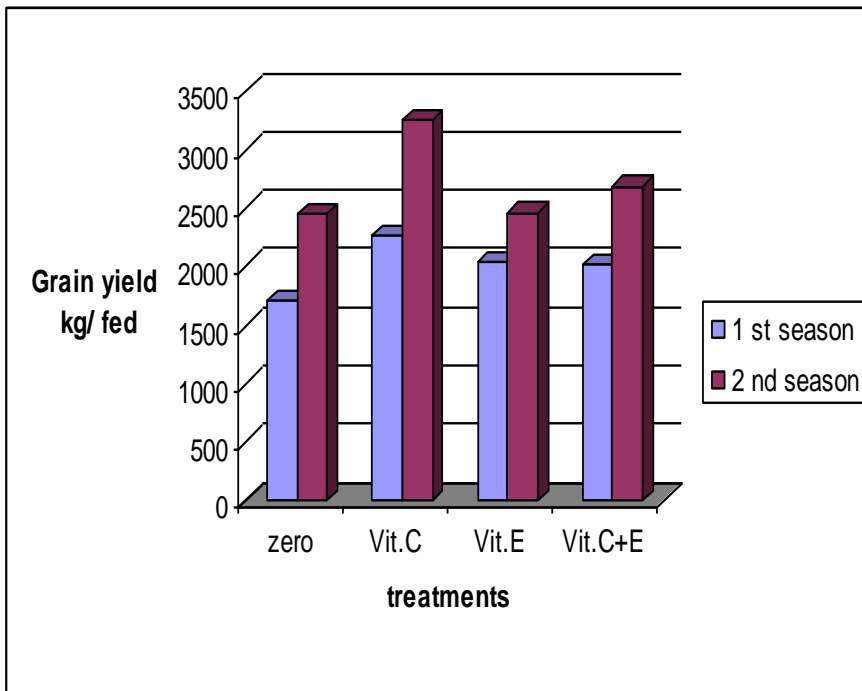


Fig (3) Show the effect of antioxidants treatments on grain yield (kg/fed)

Zero:- Control Vit.:-Vitamin C Vit.E:- Vitamin E

Vit C+E :-Vitamin C+E

2- NPK content:-

As shown in Table (37) different applied antioxidants (i.e. Vit. C, Vit. E and mixture of Vit.C+E) increased NPK concentration in shoots of wheat at 70 days and flage leaf at 110 days of plant age during 2007 season. The highest value of this trait was existed with Vit.C in first and second samples of measurements that reached 34.80 , 1.80 and 43.45 mg /g dry weigh (for N, P and K) at 70 days of plant age, respectively. Also, it was for 33.46 , 1.35 and 22.27 mg/g dry weigh (for N,P and K) in flag leaf at 110 days of plant age in 2007 season, respectively. Meanwhile control value was reached 31.5 , 1.32 and 36.91 mg/g dry weight (for N, P and K) in shoots at 70 days of plant age during 2007 season, respectively and 29.49 , 74 and 18.76 mg/g dry weight (for N, P and K) in flage leaf at 110 days of plant age in 2007 season, respectively.

In this respect the obtained increase of this trait could be attributed to that increase of N,P and K uptake by plants and increased elements accumulation in wheat organs. Other studies nearly got similar results by **Mitsui and Oi (1984)** ,**Bardisi, (2004)** and **Irfan, et al (2006)**.

3- NPK uptake:-

As shown in Table (38) NPK uptake increased with application of antioxidants (i.e. Vit.C , Vit.E and mixture of Vit.C+E) in shoots at 70 days and in flag leaf at 110 days of plant age in 2007 season. The highest value was existed with Vit.C, in shoots at 70 days and flag leaf at 110 days of plant age in 2007 season.

The obtained increase may be due to highest elements uptake by plant and increased NPK concentration in root surface in soil and uptake. Other studies nearly got similar results by Anton, *et al* (1999) and Arisha, (2000).

4- Total carbohydrate contents :-

Data in Table (39) indicate that total carbohydrates was increased with application of each antioxidant (i.e. Vit.C , Vit.E and mixture Vit.C+E) in shoots at 70 days and flag leaf at 110 days of plant age in 2007 season. The highest value was existed with Vit.C in first and second samples of measurements in 2007 season. The highest value was reached 236.90 and 519.90 mg/g dry weight in shoots at 70 days and flag leaf at 110 days of plant age in 2007 season, respectively. Meanwhile control value was reached 153.0 and 378.4 mg/g dry weight in shoots at 70 days and flag leaf at 110 days of plant age in 2007 season, respectively.

In this respect the obtained increase of this trait could be attributed to that increase in total leaf area/ plant and increased photosynthetic pigments concentration in leaves (Table, 25, 35 and 36) as well as to the active translocation of photosynthetic production (i.e. carbohydrates) from source organs (i.e. leaves) to the sink organs (grains) at last stage of plant age.

5- crude protein :-

As shown in Table (39) crude protein content significantly increased with application of antioxidants in shoots at 70 days and flag leaf at 110 days of plant age in 2007 seasons. The highest value was existed with Vit.C in first and second samples of measurements in 2007 season. The highest value was

reached 202.04 and 198.39 mg/g dry weight in shoots at 70 days and in flag leaf at 110 days of plant age in 2007 season, respectively. Meanwhile control value was reached 166.18 and 169.59 mg/g weight in shoots at 70 days and flag leaf at 110 day pf plant age in 2007 season, respectively.

The obtained increased of this trait could be attributed to that increase of protein biosynthesis and increase of plant growth a

IV- Chemical composition of wheat grains :

1- NPK content :-

Data in Table (40) indicated that different applied antioxidants increased NPK concentration in grain wheat in 2007 season. The highest value was existed with Vit.C in 2007 season. Other studies nearly got similar results by **Anton and Bassiem, (1998), Arisha,(2000) and Irfan *et al.* (2006).**

2- Total carbohydrate and crude protein :-

Data in Table (40) show that total carbohydrate and crude protein were increased with application of each antioxidant in 2007 season. The highest value was existed with Vit.C for each of total carbohydrate and crude protein contents. The above mentioned results are also being more clear when calculated as a percentage of control (Tables of chemical composition of wheat plant and grains). The obtained increase of this trait could be attributed to that increase in total leaf area/ plant and photosynthetic pigments concentration in wheat leaves (Table, 25, 35 and 36) and increased photosynthetic production and translocation from source organs (i.e. leaves) to the sink organs (i.e. grains at last stage of plant age thereby increased total carbohydrate and crude protein in wheat grains.

V- Endogenous Phytohormones content:

Data in Table (41) showed that Phytohormones content (Auxin, gibberellins and cytokinins i.e. promoters) were increased with application of Vit. C at 70 days of plant age at second season and abscisic (ABA) acid (inhibitor) was decreased in wheat leaves at the same time. Also, the ratio of promo to inhibitors was affected in favor of promoters.

The obtained increase of this trait could be attributed to beneficial effects of Vit.C on that increase of Phytohormones content. (i.e. Auxin, gibberellins, cytokinine) and the reduction of Absisic acid concentration in wheat leaves. Simillar results nearly got, by **Bardisi, (2004) and El-Bassiouany *et al*, (2005).**

C– Interactions of bio and mineral NPK fertilizer with antioxidants:

I – Growth behavior :

1 – plant height :-

Data in Table (42) indicate that different applied bio and mineral fertilizers with antioxidants (i.e. combination of biofertilizers and mineral fertilizers with Vit.C and mixture of Vit.C+E) increased plant height during 70 , 110 and 155 (at harvest) days of plant age during 2006 and 2007 Seasons. This increment of plant height was parally with the advancing of plant age. Since. It was reached to the maximum at 155 days of plant age (at harvest). Also, the highest value of plant height existed with bio and complete strength CS of mineral NPK fertilizers with Vit.C. This value significantly increased in first and second samples of measurements in both seasons, but at harvest no significant obtained during both seasons.

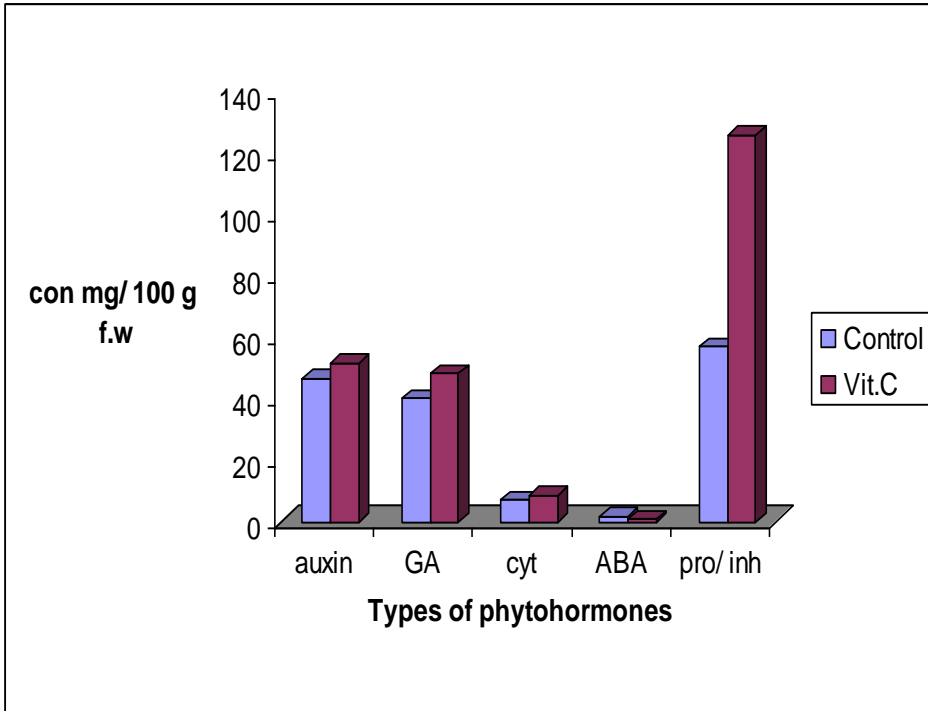


Fig (4) Show the effect of antioxidants treatments on Phytohormones contents (mg/100 f.w).

C:- Zéro Vit. C:- Vitamin C

The enhancement of bio and CS mineral NPK fertilizers on plant height, might due to the well established physiological roles on the increase of meristematic activity in wheat plant as well as cell elongation. Its effect on Auxin formation and other endogenous Phytohormones thereby, enhancement of plant growth including plant height. This interpretation will be confirmed after words in the part of hormones determinations (Table,61). Other studies, nearly got similar results by **Wang and Below, (1995)**, **Abdel- Hamed, (1999)**, **Anton, et al, (1999)**, **Ghallab and Salem, (2001)** and **Inskbashi and Iwaya (2006)**.

2- Number of tillers / plant:-

As shown in Table (43) number of tillers / plant was increased with combination of bio and CS of mineral NPK fertilizers with Vit.C during 70, 110 and 155 days of plant age during 2006 and 2007 seasons. In addition, the application of bio and NPK levels with Vit.C and mixture of Vit C+E increased this trait compared with the control both Seasons.

In this respect, the obtained increase of this trait could be attributed to those beneficial effects of bio and mineral fertilizer with Vit.C on tillers number and effect of cytokinins production by applied microorganisms to increased formation of endogenous Phytohormones. This interpretation will be confirmed after words in the part of hormone determination (Table, 21). Also, in this respect **Abdel-Hamed, (2005)** reported that number of tillers increased with application of bio combined with CS mineral NPK fertilizers. Similar results were obtained by **Arisha, (2000)**, **Ghallab and Salem, (2001)** and **Abdel- Hamed, (2005)**.

3- Number of leaves / plant:-

Data in Table (44) show that, number of leaves increased with the advancing of plant age. Also , it Could be noticed that combination of bio with mineral NPK fertilizer with Vit.C gave maximum increase in number of leaves / plant during 70 and 110 days of plant age in 2006 and 2007 seasons. In addition combination of bio and mineral NPK fertilizers levels with Vit.C and mixture of Vit. C+E increased this number but by less extent. Increment of this trait compared with the control was obtained during first and second samples of measurements in both seasons.

The obtained increase of this trait may be due to the encouragement of different aspects of wheat growth thereby increased leaves number/ plant and increased plant height and tillers number/plant (Table, 42 and 43)

4- Fresh weight of Shoots :-

Data in Table (44) show that different applied combination of bio and mineral NPK fertilizers with Vit.C and mixture of Vit.C+E increased fresh weight of shoots during 70 and 110 days of plant age in 2006 and 2007 seasons. The highest Value of this trait existed with combination of bio and CS mineral NPK fertilizers with Vit.C during first and second samples of measurement in both seasons.

The increment of this trait may be due to the beneficial effects of bio and mineral NPK fertilizers with Vit.C to increased vegetative growth (Table 42, 43 and 44) due to stimulation of plant growth including fresh weight of shoots in wheat plants. Other studies nearly got similar results by **Anton and Bassiem (1998) and Irfan et al. (2006)**.

5- Dry weight of Shoots:-

Data in Table (45) indicate that dry weight of Shoots increased with application of combination of bio and CS mineral NPK fertilizer with Vit.C during first and second samples of measurement during 2006 and 2007 Seasons .In addition, different applied combination of bio and mineral NPK fertilizers with Vit.C increased this trait during both seasons.

In this respect, the obtained increase of this trait could be attributed to that beneficial effects of these combinations to increased nutrient availability, uptake and accumulation of dry matter and increased plant height, number of tillers/ plant, number of leaves and fresh weight of shoots (Table, 42,43 and 44). Similar results nearly got by **Abdel- Hamed, (2005 and Inskbashi and Iwaya (2006).**

6- Total leaf area / plant :-

As Shown in Table (45) combination of bio and CS mineral NPK fertilizers with Vit.C increased total leaf area / plant at 70 and 110 days of plant age during 2006 and 2007 Seasons. The above mentioned results are also being more clear when calculated as a percentage of control (Tables of growth characteres).

This might due to the superiority of using combination of bio and CS mineral NPK with Vit.C to increase plant growth and formation of different metabolites to

increase total leaf area/ plant and increased plant height, number of tillers/ plant and number of leaves/ plant due to that increase in total leaf area/ plant.

This increment of leaf area by using such combination was previously recommended by **Mengal and Kirkby, (1979)**. Since, that could be reflected on the final expanded of formed leaves and vigorous vegetative growth as well **Banzigor, et al, (1994)** and many others.

II – Yield Characteristics :-

1- Number of Spikelets / main Spike :

Data in Table (46) Show the effect of combination of bio and mineral NPK with Vit.C and mixture of Vit.C+E on number of Spiklets. It could be noticed that combination of bio and CS mineral NPK fertilizers with Vit.C increased this trait at 110 and 155 (at harvest) days of plant age .

In this respect the obtained increase of this trait it could be attributed to beneficial effects of bio and mineral NPK fertilizer with Vit.C on fertility and spike formation thereby increased this trait.

2 – Spike length :-

Data in Table (46) indicated that Spike length was increased with combination of bio and CS mineral NPK fertilizers with Vit.C at 110 and 155 days of plant age (at harvest) during 2006 and 2007 seasons. This Value reached to the high level of significant at 155 days of plant age in 2006 Seasons. Inaddition Separately application of combination of bio and mineral NPK fertilizers levels with Vit.C increased this trait compared with the control in both Seasons.

In this respect the obtained increase of this trait may be due to the increment of plant height (Table, 42) and that could increase spike length.

3 – Number and weight of second and third basic spikelets / main spike :-

As shown in Table (47) different applied combination of bio and mineral NPK fertilizers with Vit.C and mixture of Vit.C+E increased number and weight of second and third basic spikelets during 2006 and 2007 seasons. The highest value existed with combination of bio and CS mineral NPK fertilizers with Vit.C in both seasons. This increment reached to the high level of significance in first seasons but second seasons no significant.

In this respect, the obtained increased of this trait may be due to increased parameters of vegetative growth (Table, 42, 43,44 and 45) that increased photosynthetic rate and translocation of photosynthates into grains. Other studies nearly got similar results by **Ghallab and Salem, (2001) and Abdel- Hamed, (2005)** and many others.

4- Number and Weight of Second and third middle spikelets / main Spike:-

Data in Table (48) show the effect of combination of bio and mineral NPK fertilizers with Vit.C and mixture of Vit.C+E on number and weight of Second and third middle spikelets. It could be noticed that combination of bio and CS mineral NPK with Vit.C increased this trait during 2006 and 2007 Seasons. In addition, different treatments increased this trait compared with the control but by less extent in both seasons.

In this respect, the obtained increase of this trait could be attributed to increment of total leaf area /plant (Table, 45), due to increased photosynthates production and translocation into grains thereby increased this trait. Similar results nearly got, by **Ali, et al, (2004), Bardisi, (2004) and Abdel- Hamed, (2005).**

5– Number and weight of second and third terminal spikelets / main spike :-

Data in Table (49) showed that number and weight of second and third terminal spikelet was increased with combination of bio and CS mineral NPK fertilizers with Vit.C during 2006 and 2007 seasons. Although, Separately application of combination of bio and mineral NPK with Vit.C increased this trait but by less extent.

The obtained increase of this trait may be due to increased photo synthetic rate and translocation of photosynthates into grains and beneficial effects of combined them. **Abdel-Hamed, (2005).**

6 – Number and weight of fully grains / main Spike :-

Data in Table (50) indicated that combination of bio and complete strength CS mineral NPK fertilizers with Vit.C increased number of fully grains and their weight during 2006 and 2007 seasons. In addition, different combination of bio and mineral NPK levels with Vit.C increased of this trait with increasing mineral NPK levels in both seasons but by less extent.

In this respect, the obtained increase of this trait could be attributed to that increase in total leaf area and increased number of spikelet/ main spike (Table, 45 and 46) due to increased

photosynthetic rate and translocation of photosynthates into grains and increased number of grains per main spike thereby increased fully grains per main spike. Other studies nearly got similar results by **Abdel- Hamed, (2005) and Inskbashi and Iwaya (2006)**.

7- Number and weight of semi fully grains / main Spike:-

As Shown in Table (50) different applied combinations of bio and mineral NPK chemical fertilizers with Vit.C and mixture of Vit.C+E increased number and weight of semi fully grains / main spike during 2006 and 2007 seasons. The highest value was existed with combinations of bio and complete strength CS NPK fertilizer with Vit.C during 2006 and 2007 Seasons.

In this respect the obtained increase of this trait could be attributed to increased photosynthate production and their translocation into grains.

Simillar results nearly got by **Ali, et al, (2004) and Abdel- Hamed, (2005)**.

8- Number and weight of lowest fully grains / main Spike :-

Data in Table (51) indicate that different applied combinations of bio and mineral NPK with Vit.C and mixture of Vit.C+E decreased lowest fully grains / main spike during 2006 and 2007 seasons. The highest decrease was obtained with the combination of bio and CS NPK with Vit.C in both seasons.

In this respect, the obtained decrease of this trait could be attributed to increased translocation of photosynthates produced into grains and decreased fully grains per main spike thereby decreased number of lowest fully grains / main spike.

9 – Spike Fertility / plant :-

Data in Table (51) show that combination of bio and CS mineral NPK with Vit.C increased spike fertility/ plant during 2006 and 2007 seasons. Although, application of bio and mineral NPK with Vit.C and mixture of Vit.C+E increased this trait but by less extent in both seasons.

Increase of spike fertility with this value is related to the know/ physiological effects of there treatments on increasing of the endogenous Cytokinins **Wang and Below, (1995)** and beneficial effect of this value on increment of number of spike / plant and increased this trait.

Similar results nearly got by **Abdel- Hamed, (1999), Ghallab and Salem, (2001), Abdel- Hamed, (2005) and Irfan et al. (2006).**

10 – Number of grains per gram :-

Data in Table (52) indicated that number of grains was decreased with combination of bio and CS mineral NPK fertilizers with Vit.C during 2006 and 2007 Season . Although, separately application of bio and mineral NPK levels with Vit.C and mixture of Vit.C+E decreased this trait but by less extent in both Seasons.

In this respect, the obtained decrease of this trait could be attributed to the increase of translocation of produced photosynthates into grains and increased grains fullney (Table,50) thereby increased fullney of grains and decreased number of grains.

Similar results nearly, got by **Abdel- Hamed, (1999) Abdel- Hamed, (2005) and Inskbashi and Iwaya (2006).**

11- Weight of 1000 grains :-

Data in Table (52) indicate that Thousand grains weight was increased with combination of bio and CS mineral NPK fertilizers with Vit.C during 2006 and 2007 Seasons . Although, Separattely application of bio and mineral NPK levels with Vit.C and mixture of Vit.C+E increased this trait but by less extent in both seasons.

In this respect the obtained increase of this trait could be attributed to that increase of fully grains and number of grains per one gram (Table, 50 and 52) due to increased weight of 1000 grains.

Simillar results nearly got, by **Ali, *et al*, (2004) and Abdel- Hamed, (2005).**

12- Grain weight / main Spike:

Data in Table (53) showed that combination of bio and CS mineral NPK fertilizers with Vit .C increased grain weight per main spike during 2006 and 2007 seasons. Although , separately application of bio and mineral NPK levels with Vit.C and mixture of Vit .C+E increased this trait but by less extent in both seasons.

This increase may be due to that increment of total leaf area (Table, 46) and photosynthetic (Tables, 55 and 56) increased photosynthates production and translocation of produce photosynthates into grains thereby increased fully grains, grains weight and number of spikelets and fully grains

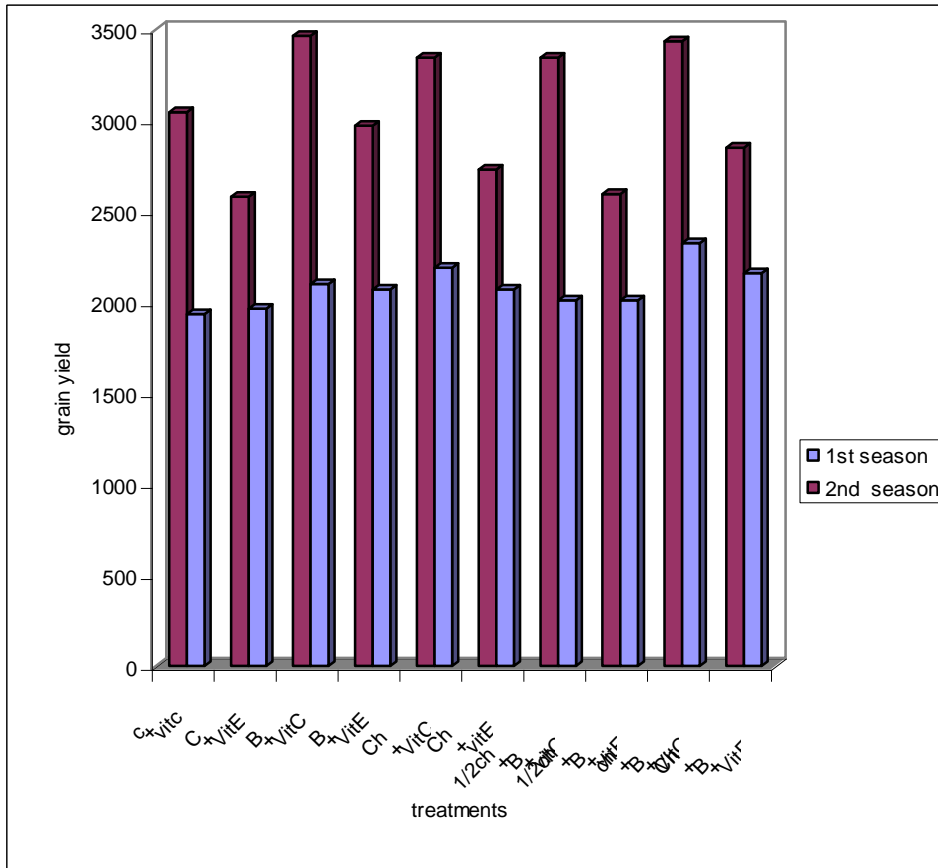


Fig (5) Show the effect of the combination of bio and mineral NPK fertilizers with antioxidants on grain yield (kg/fed).

(Tables, 47 and 50). Other studies nearly got similar results by **Abdel- Hamed, (1999), Ali *et al.*, (2004), and Abdel- Hamed, (2005)**

13 – Number of grains / main Spike :-

Data in Table (53) indicate that different applied combination of bio and mineral NPK levels with Vit.C and mixture of Vit.C+E increased number of grains / main spike during 2006 and 2007 seasons. The highest value was existed with combination of bio and CS mineral NPK with Vit.C during 2006 and 2007 seasons.

In this respect the obtained increase of this trait could be attributed to the increment of spikelets number per main spike (Table, 47) and beneficial effect of this value on improving this trait.

Other studies, nearly got Simillar results by **Mohamed, (1994), Abdel- Hamed, (1999) and Abdel- Hamed, (2005)** on wheat plants.

14- Grain and Straw Yields:-

a - Grain yield :-

As Shown in Table (52) and (53) combination of bio and CS mineral NPK with Vit .C increased grain yield per plant and per fed during 2006 and 2007 seasons . Although , separately application of bio and mineral NPK levels with Vit C and mixture of Vit. C+E increased this Trait but by less extent in both seasons. The above mentioned results are also being more clear when calculated as a percentage of control (Table,52 and 53).

This increase of this trait could be attributed to the increase of total leaf area/ plant (Table,46) and increased photosynthetic pigments formation (Tables 55 and 56), increased photosynthates production and their translocation into grains and increased grains fullness, number and weight of grain/ main spike(Tables, 51 and 53), thereby increased grain yield per plant and per fedan. Other studies nearly got similar results by **Abdel- Hamed, (1999), Ali , *et al.* (2004) , Bardisi, (2004) and Abdel- Hamed, (2005)**.

b- Straw yield :-

Data in Table (52) and (53) show the effect of combination of bio and mineral NPK levels with Vit.C and the mixture of Vit.C+E on straw weight/ plant and / fed during 2006 and 2007 seasons.Clearly indicate that straw was similarly responded as well as grains. The above mentioned results are also being more clear when calculated as a percentage of control (Table, 53).

15- Biological yield :-

Data in Table (54) indicated that biological yield increased with combination of bio and CS mineral NPK fertilizers with Vit. C during 2006 and 2007 seasons . Although, separately, application of bio and mineral NPK levels with vit C and mixture of Vit.C+E increased this trait but by less extent in both seasons. The above mentioned results are also being more clear when calculated as a percentage of control (Table,54).

The obtained increase of this trait may be reversed upon increase grain and straw yields per plant and per fedan (Table,52 and 53).

16- Harvest index:-

Data in Table (54) indicated that harvest index was increased with bio and CS mineral NPK with Vit .C during 2006 and 2007 seasons. Although, separately application of bio and mineral NPK levels with Vit. C and mixture of Vit.C+E increased this trait but by less extent in both seasons. The above mentioned results are also being more clear when calculated as a percentage of control (Tables of yield characters).

Increased of harvest index could be attributed to increment of grain yield/ feddan.

III- Chemical analysis of wheat plants:

1- Photosynthetic pigments :

Data in Table (55) and (56) indicated that different photosynthetic pigments as (chlorophyll a,b and carotenoides) were positively responded to the different applied combination of bio and mineral NPK fertilizer with Vit C and mixture of Vit.C+E at 70 , 110 days of plant age during 2006 and 2007 seasons. Also, combined bio and CS mineral NPK with Vit.C gave the highest value in this trait comparing with the control.

In addition, the simulation of photosynthetic pigments formation could be attributed to the vigorous growth that could increase chlorophylls and carotenoides formation were enhanced photosynthetic efficiency, and increased total leaf area/ plant (Table,45). Other studies nearly got similar results by **Abdel- Hamed, (2005) and Inskbashi and Iwaya (2006)**.

2- NPK Content :-

As shown in Table (57) NPK concentration in two stages of wheat growth (i.e. 70 and 110 days of plant age) obviously was increased in shoots at 70 days and flage leaf at 110 days with combination of bio and CS mineral NPK with Vit.C in 2007 season. Although, separatley application of bio and mineral NPK with Vit.C and mixture of Vit.C+E increased this trait but by less extent.

As for phosphorus and potassium concentrations, also clearly was similarly responded as well as in caseof nitrogen concentration.

In general, as previously mentioned vegeitive growth was obviously affected with each the combination bio and mineral NPK levels with Vit.C and mixture of Vit.C+E. Here, it could be noticed that there is an intimate relationship between the growth aspects and the accumulation of different determined elements in shoots and flage leaf in wheat plants.

Other studies nearly got similar results, by **Ali *et al*, (2004), Abdel- Hamed, (2005) and Irfan, *et al* (2006).**

3- NPK uptake :-

Data in Table (58) indicated that different applied combination of bio and mineral NPK levels with Vit.C and mixture of Vit.C+E increased NPK uptake by shoots at 70 days and flage leaf at 110 days of plant age in 2007 season. The highest value was existed with combination of bio and CS mineral NPK with Vit.C in first and second samples of measurements in 2007 season.

In this respect, the obtained increase of this trait may be due to beneficial effects of bio and mineral NPK with Vit.C on increase nutrient availability and uptake by plants.

Other studies nearly got similar results by **Sonbol *et al*, (2000)**, **Ali , *et al*, (2004)** and **Abdel- Hamed , (2005)**.

4 Total carbohydrates :-

As shown in Table (59) total carbohydrates was increased with combination of bio and CS mineral NPK with Vit.C at 70 and 110 days of plant age during 2007 season. Although, separately application of combination of bio and mineral NPK level with Vit.C and mixture of Vit .C+E increased this trait but by less extent.

In this respect, the obtained increase of this trait could be attributed to that increase of total leaf area (Table.45), photosynthetic pigment, (Tables 55 and 56) and photosynthetic rate and photosynthates production (carbohydrates) thereby increased carbohydrates content.

Similar results nearly got , by **Abdel- Hamed, (1999)** , **Ali, *et al*, (2004)**, **Abdel- Hamed, (2005)** and **Inskbashi and Iwaya (2006)**.

5- Crude protein :-

With regard to the content of crude protein in shoots at 70 days and flag leaf at 110 days of plant age in 2007 season as indicated in Table (59), a strict increase of this content existed with combination of bio and CS mineral NPK fertilizer with Vit.C at first and second samples of measurements. Although, separately application of combination of bio and mineral NPK level with Vit. C and mixture of Vit .C+E increased this trait but by less extent.

The above mentioned results could consider as a direct effect of bio , mineral NPK and Vit C on protein content and increased photosynthetas production and formation of protein.

Other studies nearly got similar results by **Abdel- Hamed, (2005)**.

IV- Chemical composition of wheat grains :

1- NPK content:-

As shown in Table (60) different applied combination of bio and mineral NPK levels with Vit.C and Vit.C+E increased mineral NPK content in wheat grains in 2007 seasons. The highest value was existed with combination of bio and CS mineral NPK fertilizers with Vit.C in grains during 2007 season.

The obtained increase of this trait may be due to that beneficial effect of bio , mineral NPK and Vit. C on nutrient availability, uptake and translocation into grains. **Abdel-Hamed, (2005)**.

2- Total carbohydrates and crude protein :-

Data in Table (60) show that combination of bio and CS mineral NPK with Vit. C increased total carbohydrates and crude protein in wheat grains. Although, separatley application of combination of bio and mineral NPK levels with Vit.C and Vit C+E increased this trait but by less extent. The above mentioned results are also being more clear when calculated as a percentage of control (Tables of chemical composition of wheat plants and wheat grains).

In this respect , the obtained increase of total leaf area (Table 45) photosynthetic pigments (Table, 55 and 56) and increased photosynthetic production and translocation of

photosynthates produced from source organs (leaves) to sink organs(grains) thereby increased total carbohydrates and crude protein in wheat grains.

Simillar results nearly got, by **Abdel- Hamed, (2005)**.

V- Endogenous Phytohormones contents:

Data in Table (61) show that Phytohormones content (i .e. Auxins, Gibberellins and Cytokinins) was increase with application of bio and mineral NPK level with Vit.C in wheat leaves at 70 days of plant age. The highest value was existed with combination of bio and CS mineral NPK with Vit.C. Meanwhile, growth inhibitors was reduced in roots and increased in leaves at 70 days of plant agein 2007 season. The above mentioned results are also being more clear when calculated as a percentage of control (Table, 61).

The obtained increase of endogenous phytohormones content may be due to beneficial effects of bio and mineral NPK with Vit.C on growth behaviour.

This results are in agreement with **Ghallab and Salem, (2001)**.

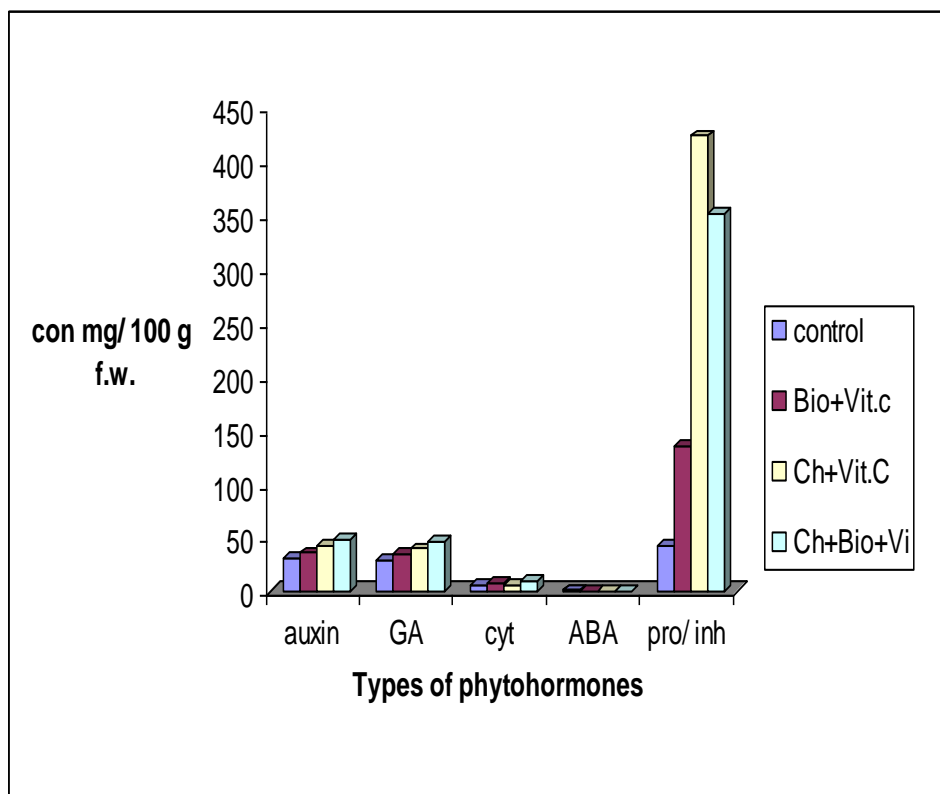


Fig (6) Show the effect of the combination of bio and mineral NPK with antioxidants on Phytohormones contents

Bio+Vit.C: Biofertilizers +Vit C

Ch+Vit C:- Chemical fertilizers +Vit C

Ch+B+Vit C:-Chemical fertilizer + Biofertilizer +Vitamine C

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