

**INFLUENCE OF COMMERCIAL BIOFERTILIZERS, ORGANIC  
MANURE, NITROGEN AND PHOSPHORUS MINERALS FERTILIZER  
ON GROWTH AND YIELD OF POTATO (*Solanum tuberosum*, L.)  
BY**

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**ABSTRACT**

This study was carried out at the Experimental Farm of the South Tahrir Station of Horticulture during the two successive seasons of 2003/3004 and 2004/2005 to investigate the influence of commercial biofertilizers, organic manure, nitrogen and phosphorus minerals fertilizer on the growth and yield of potato cv. Mondial. Results show that all used commercial biofertilizers treatments combination with 50% nitrogen, phosphorus plus 50% chicken manure of added dose increased all parameters of vegetable growth and produced yield i.e., plant height, number of main stems, fresh and dry weight of plant foliage and tuber yield with significant differences in most cases. In addition, the different tested biofertilizers significantly increased both total carbohydrates and nitrogen contents while phosphorus was not affected during both seasons of study in leaves and tubers. In this respect, the best results of all studies vegetative growth, yield and chemical traits in the two seasons were obtained from the treatments of 50% N, P + 50% chicken manure + (EM) + (BV) followed by 100% chicken manure + (BV) and 50% N, P + 50% chicken manure + (EM) + (BM).

**INTRODUCTION**

Potato (*Solanum tuberosum*, L.) is considered one of the most important and popular vegetable crop in Egypt. Growing vegetables in sandy soil are faced by various problems; the most important one is the low fertility also poor physical and biological properties of such soil. Improvement of such conditions could be accomplished by the addition of chemical nitrogen and phosphorus fertilizer which can play significant role in increasing agricultural production. Applying biofertilizers to potato plant increase microorganisms living in the soil. The microorganisms working on the organic matter in the soil to convert organic forms of nutrients such as N to mineral N. This increase the up take of nutrients from soil by root of plant and promote plant growth Lampkin (1990). Abdel-Ati *et al.* (1996) reported that the values of plant height and dry matter content per plant were significantly higher in plants inoculated with either *Azotobacter sp.* or *Azospirillum sp.* and/or their mixture with phosphate dissolving bacteria in the presence of recommended dose of mineral fertilizers than those only treated with mineral fertilizers. Similarly, in newly reclaimed areas, El-Gamal (1996 b) found

that using Halex-2 (a mixture of *Azotobacter*, *Azospirillum* and *Klebsiella*) in the presence of 0, 40, 80, 120 or 160 Kg N/fed. increased plant height, as compared with control plants only fertilized with mineral nitrogen fertilizer. Ashour *et al.* (1997) indicated that inoculation of potato plants with either *Azotobacter*, *Azospirillum* or their mixture, significantly increased the foliage fresh and dry weight, as well as plant height. In the seam line, Ashour (1998) when used phosphorien at 10 Kg/ton and phosphorus at 0, 45, 60 and 75 Kg P<sub>2</sub>O<sub>5</sub>/fed. He found that treating seed potato tubers with phosphorein plus increasing P<sub>2</sub>O<sub>5</sub> up to 60 Kg/fed., increased fresh and dry weights of foliage/plant. Besides, Hammad and Abdel-Ati (1998) showed that the highest values of plant height of potato, cv. Diamant were recorded in the plants inoculated with dual inoculation (*Azospirillum* and *Mycorhiza*) plus 60 Kg N/fed. These values were higher than those of the un-inoculated plants, which received 80 Kg N/fed. (100% of the recommended dose).

Abdulla (1999) noted that vegetative growth characteristics represented as plant height, number of stems, number of tubers, fresh and dry weights of whole plants were increased a result of applying the poultry manure (40 m<sup>3</sup>/fed.) combined with biofertilizers (Rhizobacterein 4 Kg + phosphorein 4 Kg/fed.). Additionally, El-Banna and Tolba (2000) found that treating seed potato tubers with Microbein at rate of 10.67 Kg/t, before planting in addition to 135 Kg N + 56.25 Kg P<sub>2</sub>O<sub>5</sub>/fed., increased vegetative growth, i.e., plant height, number of main stems per plant, and both foliage fresh and dry weight per plant. Also, El-Banna *et al.* (2001) reported that application of bioorganic fertilizers (10.67 Kg Biogen/t of seeds + 10.67 Kg phosphorein/t of seeds) (together with phosphate rock 75 Kg P<sub>2</sub>O<sub>5</sub>/fed. + potassium sulphate 96 Kg K<sub>2</sub>SO<sub>4</sub>/fed. + 15t. FYM/fed.) led to significant increases in the plant height, foliage fresh weight/plant and number of main stems/plant of potato cv. Diamant.

Sud *et al.* (1992); Schulz and Kopke (1996); Waddell *et al.* (1999) and Danilchenko *et al.* (2005). concluded that increasing fertilizer in pot increased total yield and average tuber weight. Whereas, the comparison between organic manure and mineral fertilizer showed that using mineral fertilizer increased total yield and average tuber weight than organic fertilizer.

Ivanyuk and Alexandrov (1996) and Ashour *et al.* (1997) found that increasing rates of applying N, P and organic fertilizers to potatoes reduced the development of *Rhizoctonia solani* on all underground organs and increased the yield and quality of seed tubers. Mahendran *et al.* (1996) mentioned that the biofertilizer in combination with different levels of N, PK significantly influenced the N, P and dry matter contents and uptake of N, P by different plant parts. Kushwah and Banafar (2003) indicated that dry matter content of potato tubers was increased by application of 150 Kg N + 80 Kg P<sub>2</sub>O<sub>5</sub>/ha. and application of *Azotobacter* and PSB culture.

In sandy soil, El-Gamal (1996a) found that using of phosphorein biofertilizer significantly increased total tuber yield. Also, Ashour (1998) found that treating seed potato tubers with phosphorien at the rate of 10kg/ton in

addition to 60 kg P<sub>2</sub>O<sub>5</sub>/fed. gave the maximum tuber yield/fed. In the seam line, Abdulla (1999) found that applying the biofertilizer (Rhizobacterin 4 Kg + Phosphorein 4 Kg/fed.) combined with cattle manure (40 m<sup>3</sup>/fed.) and poultry manure (20 m<sup>3</sup>/fed.) reflected the highest total and marketable yield, specific gravity and significantly decreased nitrate and nitrite in potato tubers. El-Banna *et al.* (2001) reported that application of bioorganic fertilizers (10.67 Kg Biogen/t of seeds + 10.67 Kg phosphorein/t of seeds) together with phosphate rock 75 Kg P<sub>2</sub>O<sub>5</sub>/fed. + potassium sulphate 96 Kg K<sub>2</sub>SO<sub>4</sub>/fed. + 15t. FYM/fed. led to significant increases in the weight and number of tuber per plant of potato cv., Diamant. Abou-Hussen *et al.* (2002c) indicated that the potato yield was increased by using chicken manure compost and biofertilizers. In addition, Indires *et al.* (2003) showed that inoculation of potato seeds with *Azotobacter chroococum* and *Pseudomons striate* gave significant effect on total yield and marketable tubers yield of potato. Furthermore, dual inoculation and 50% NPK fertility was the best in obtaining economically higher potato yield. Kushwah and Banafar (2003) showed that application of potato with 150 Kg N + 80 Kg P<sub>2</sub>O<sub>5</sub>/ha and inoculation with Phosphate solubilizing bacteria (PSB) increased tubers yield. Also, Hakoomat and Anjum (2004) reported that plant height and foliage fresh weight significantly increased with increasing phosphorus level. Ciecko *et al.* (2004) and Maiti *et al.* (2004) stated that yield of the large tuber was increased by increasing phosphorus rates.

This investigation aimed to evaluate the influence of commercial biofertilizers, organic manure, nitrogen and phosphorus minerals fertilizer on growth and yield of potato vegetative growth, yield and its components as well as chemical measurements of potato variety Mondial.

**MATERIAL AND METHODS**

Two field experiments were carried out at the Experimental Farm of the South Tahrir Station of Horticulture during the two successive seasons of 2003/2004 and 2004/2005 to investigate the influence of commercial biofertilizers, organic manure, nitrogen and phosphorus minerals fertilizers on the growth and yield of potato cv. Mondial under sandy soil conditions. The soil of the experimental field was sandy in texture with PH 7.8, the chemical analysis of soil samples and used organic manure (chicken manure) was carried out at laboratories of soil and water Research. Inst. Agric. Res. Center according to the methods described by Jakson (1973) and the results of those analyses were presented in Tables (1 and 2).

**Table (1): Some chemical properties of the used soil.**

Year	pH	EC (dS/m)	Anions mg/L			Cations mg/L				Mineral nutrients mg/kg soil		
			HCO <sub>3</sub> <sup>-</sup>	Cl <sup>-</sup>	SO <sub>4</sub> <sup>2-</sup>	Mg	Na	Ca	K	N	P	K
2003/2004	7.83	1.49	1.67	3.84	4.38	0.84	5.0	4.64	0.41	5	4.5	25
2004/2005	7.75	2.00	1.39	5.76	8.57	2.38	8.5	4.12	0.72	4	5.4	30

**Table (2): Chemical analysis of the used chicken manure.**

Analysis	Value
C %	26.62
Total N %	2.20
C/N	12.10
Organic matter %	45.90
Total P %	1.60
Total K %	2.00
Available N (mg kg <sup>-1</sup> )	1140
Available P (mg kg <sup>-1</sup> )	1680
Available K (mg kg <sup>-1</sup> )	20000
Humidity	16.90
Weight of 1 m <sup>3</sup>	650

Potato seeds (tubers) cv. Mondial were obtained from Vegetable Res. Dept., Hort. Res. Inst., Agric. Res. Center, Dokki, Giza, Egypt were planted on 15<sup>th</sup> of October in the first season and 5<sup>th</sup> of October in the second season. Potato tubers were planted at distance of 25 cm between plants and 75 cm between rows.

A complete randomized block design with three replicates was adopted. Each experimental plot included four rows each 3.5m length and 75cm in width with an area 10.5m<sup>2</sup>.

The amount of chicken manure at the rates of 100%N and 50%N was added before planting in the furrow and raked lightly with soil. Total Nitrogen at 0, 90 and 180 kg/fed. added in the forms of ammonium sulphate (20.5% N) and ammonium nitrate (33.5% N). The amounts of N fertilizer as ammonium sulphate two thirds of the total nitrogen as ammonium sulphate were equally divided and applied before planting and at complete plant emergence. The rest of N fertilizer was soil dressed in the form of ammonium nitrate at two weeks after complete plant emergence stage.

Total phosphorus (P<sub>2</sub>O<sub>5</sub>) with 0, 36 and 72 kg/fed. applied during soil preparation in the form of calcium super phosphate (15.5% P<sub>2</sub>O<sub>5</sub>) while potassium fertilizer was applied in the form of potassium sulphate (48% K<sub>2</sub>O) at the rate of 96 kg K<sub>2</sub>O/fed. as a soil application twice at 45 and 60 days after planting (DAP).

All the experimental plots received the same amount of water from planting till harvest, using drip irrigation system. Irrigation was stopped at 10 days before harvesting. Other culture practices were applied according to the recommendation of the Egyptian Ministry of Agriculture.

BioMagic (BM) and BioVit (BV) were used in this experiment as biostimulants. Plants were sprayed 5 times with BioMagic periodically every 15 days starting from 45 days after planting until 15 days before date of harvest. Biomagic has pH 5.5 and consists of the different constituents as follows:

I- **Amino acids (1.907%)**

- |                  |                   |                |
|------------------|-------------------|----------------|
| 1. Thiamin .     | 2. Cystine.       | 3. Glycine.    |
| 4. Histidine.    | 5. Isoleucine.    | 6. Leucine.    |
| 7. Lysine.       | 8. Phenylalanine. | 9. Therionine. |
| 10. Tryptophane. | 11. Tyrosine.     | 12. Valine.    |

II- **Vitamins (0.038%)**

- |                |                |                 |
|----------------|----------------|-----------------|
| 1. Arginine.   | 2. Biotin.     | 3. Choline.     |
| 4. Folic acid. | 5. Niacin.     | 6. Pantothenic. |
| 7. Pyrodixine. | 8. Riboflavin. |                 |

III- **Macro elements (g/1)**

- |             |                                       |                          |
|-------------|---------------------------------------|--------------------------|
| 1. N 11.25. | 2. P <sub>2</sub> O <sub>5</sub> 5.50 | 3. K <sub>2</sub> O 6.25 |
|-------------|---------------------------------------|--------------------------|

IV- **Microelements (mg/1)**

- |            |           |           |
|------------|-----------|-----------|
| 1. Fe 160. | 2. Zn 124 | 3. Mn 100 |
| 4. Mg 45   | 5. Cu 45  | 6. B 14   |
| 7. Mo 12   | 8. Cd 7   | 9. Ni 4   |

Also, BioVit (BV) is the mixture of bacteria strain which contained *Azospirillum sp* and *Bacillus megatherium* was applied after 45 and 75 day after planting (DAP) around plants.

The Effective microorganisms (EM) stock solution that used in the study has been produced and available at Ministry of Agriculture, Egypt. EM content different of beneficial microorganisms about 80 species as reported by Higa and Parr (1994) the main species included in EM are as follows:-

(Lactic acid bacteria, Photosynthetic bacteria, Yeasts, Fungi). Plants were treated 5 times with (EM) starting after planting until 15 days before date of harvest around plants.

The fertilization treatments of organic, inorganic and bio-fertilization either in a single form or in combination were conducted as follows:

1. 100% of recommended N, P. (180 kg N + 72 kg P<sub>2</sub>O<sub>5</sub>)
2. 50% of recommended N, P + 50% of recommended chicken manure.
3. 100% of recommended chicken manure (control).
4. 100% of recommended chicken manure + BioMagic (BM).
5. 50% N, P + 50% chicken manure + BioMagic (BM).
6. 100% of recommended chicken manure + BioVit (BV).
7. 50% N, P + 50% chicken manure + BioVit (BV).
8. 100% chicken manure + BioMagic (BM). + BioVit (BV).
9. 50% N, P + 50% of recommended chicken manure + BioMagic (BM) + BioVit (BV).
10. 100% chicken manure + Effective Microorganisms (EM).
11. 50% N, P + 50% chicken manure + Effective Microorganisms (EM).
12. 100% chicken manure + Effective Microorganisms (EM) + BioMagic (BM).
13. 50% N, P + 50% chicken manure + Effective Microorganisms (EM) + BioMagic (BM).
14. 100% chicken manure + Effective Microorganisms (EM) + BioVit (BV).

15. 50% N, P + 50% chicken manure + Effective Microorganisms (EM) + BioVit (BV).
16. 100% chicken manure + Effective Microorganisms (EM) + BioMagic (BM) + BioVit (BV).
17. 50% N, P + 50% chicken manure + Effective Microorganisms (EM) + BioMagic (BM) + BioVit (BV).

#### **Data recorded**

A random sample of three plants at 90 day after planting (DAP) from each plot was used for the determination of growth and yield characters of the plant.

#### **Growth characters:**

- 1) Plant height (cm.).
- 2) Number of main stems/plant.
- 3) Tubers weight/plant (g.).
- 4) Number of tubers/plant.
- 5) Foliage fresh weight (g.).
- 6) Foliage dry weight (g.).

#### **Yield and its components:**

The experiment was harvested after 120 day after planting (DAP) and the following yield data were recorded:

- 1) Number of tubers/plant.
- 2) Tubers weight/plant (g.).
- 3) Average tubers weight (g.).
- 4) Total yield (ton/fed.).

#### **Tuber quality:**

- 1) Specific gravity (SG) was estimated by the following formula according to Nissen (1955):

$$SG = \frac{\text{Weight in the air}}{\text{Weight in the air} - \text{weight in the water}}$$

- 2) Dry matter (%) was determined at 65°C for 72 hr. using the standard methods as illustrated by AOAC (1990).

#### **Chemical constituents:**

- Determination of N, P of tuber and foliage at 75 day after planting (DAP) and tubers at the harvest time 120 day after planting (DAP). Total nitrogen was determined by Neslar method described in A. O. A. C. (1990).

Phosphorus content was determined calorimetrically as described by Jakson (1973),

- Determination of Total carbohydrates% in tuber at harvest were determined calorimetrically as gm. Glucose/100gm. Dry weight of tubers according to James (1995) samples of potato were oven dried at 70°C till constant weight

then the dry weight was calculated. Chemical determinations were calculated on dry weight basis. Tuber potato content of nitrogen was determined according to Kock and Mc Meekin (1924).

- Determination of Nitrates in tuber at harvest 120 day after planting (DAP) was estimated according to Salicylic acid method Cafado *et al.* (1975).

#### **Statistical analysis:**

The data were subjected to proper Statistical analysis of variance of randomized complete block design by Snedecor and Cochran (1980).

## **RESULTS AND DISCUSSION**

### **Vegetative growth**

Data in the Tables (3 and 4) show the effect of commercial biofertilizers, chicken manure and mineral N, P fertilizer on the plant height, number of stems and tubers of plant, as well as fresh and dry weight of plant during the two seasons of study.

### **Plant height**

The tallest plants were observed for the treatments of chicken manure + BM and chicken manure + (BM) + (BV) followed by 50% N, P + 50% chicken manure + (BM) + (BV), chicken manure + (EM) and 50% N, P + 50% chicken manure + (EM) + (BV) which gave 27.3, 27.3, 26.7, 26.7 and 26.7 cm in the first season, while in the second one the highest plants were noticed for the treatments of 50% N, P + 50% chicken manure + (EM) and chicken manure + (BM) which recorded 28.3 and 28.2 cm respectively. On the other hand, the control plants (100% chicken manure) were the shortest, which registered 21.4 and 21.5 cm in the first and second season, respectively. However the treatments of the chicken manure + (BV), 50% N, P + 50% chicken manure + (BV), and chicken manure + (EM) + (BV) recorded 26.0, 25.7 and 25.3 cm for plant height with a non significant differences as compared to the control treatment in the first season only. Meanwhile in the second season all used kinds of biofertilizers increased the plant height over the control plants with a significant difference in the most cases. However, the treatments of chicken manure + (EM) + (BM) + (BV) and 50% N, P + 50% chicken manure + (EM) + (BM) + (BV) gave 23.0 and 22.6 cm for plant height with non-significant differences as compared to the control treatment.

### **Number of main stems/plant**

It was clear from Tables (3 and 4), that all treatments caused an increase in the number of stems/plant with non-significant differences in most cases during the two seasons compared with the chick treatment.

### **Foliage fresh weight/plant**

It was obvious from Tables (3 and 4) that used biofertilizers significantly increased the foliage fresh weight of potato plant in the two seasons. In this respect, the heaviest values of foliage fresh weight per plant were obtained from the treatments of chicken manure + (EM) + (BV) followed by chicken manure + (EM) + (BM) as gave 142.3 and 123.7 g/plant against 108.8 g/plant for the control treatment

in the first season, while in the second one the heaviest values of foliage fresh weight/plant were recorded from the treatments of 50% N, P + 50% chicken manure + (EM) + (BM) followed by 50% N, P + 50% chicken manure + (EM) + (BV), chicken manure + (BV) and chicken manure + (BM) + (BV) as gave 160.9, 157.5, 156.4 and 155.3 g/plant compared to 116.2 g/plant for the control treatment.

Table (3): Effect of commercial biofertilizers, organic manure and nitrogen, phosphorus minerals fertilizer on vegetative growth during the season of 2003-2004.

Treatment	Characters Plant height (cm.)	Season 2003-2004				
		Number/plant		Weight/plant (g.)		
		Main stems	Tubers	Tuber	Foliage Fresh	Foliage Dry
100% Recom. N, P.	21.9	2.00	5.89	345.2	114.6	14.15
50% Recom. N, P.+ 50% Recom. ch.	23.0	2.23	6.00	361.5	116.7	14.78
100% Recom. ch.	21.4	1.67	5.45	330.5	108.8	13.42
100% Recom. ch. + BioMagic (BM).	27.3	2.13	5.33	391.9	99.4	13.88
50% Recom N, P. +50% Recom. ch. + BM	23.2	2.00	5.33	394.0	119.5	16.08
100% Recom. ch. + BioVit (BV)	26.0	1.87	5.67	384.0	112.1	14.11
50% Recom N, P. + 50% Recom. ch. + BV	25.7	1.77	6.11	406.6	109.5	15.94
100% Recom. ch. + BM + BV	27.3	1.90	6.22	418.3	108.9	15.76
50% Recom N, P. + 50% Recom. ch. + BM + BV	26.7	2.23	6.56	402.1	117.6	15.58
100% Recom. ch. + Effective Microorganisms (EM)	26.7	2.00	5.89	344.3	109.8	16.47
50% Recom N, P. +50% Recom. ch. + (EM)	24.7	2.43	6.33	402.1	121.8	16.55
100% Recom. ch. + (EM) + BM	24.3	1.67	6.45	362.1	123.7	18.09
50% Recom N, P. + 50% Recom. Ch + EM + BM	24.9	1.90	6.11	422.7	115.9	17.15
100% Recom. ch. + EM + BV	25.3	2.00	6.11	416.1	112.5	15.29
50% Recom N, P. +50% Recom. ch. + EM + BV	26.7	2.33	5.66	464.3	142.3	21.93
100% Recom. ch. + EM + BM + BV	24.4	2.10	5.88	342.8	118.2	14.03
50% Recom N, P. +50% Recom. ch. + EM + BM + BV	24.1	1.80	5.77	339.6	114.7	13.71
L.S.D at 5%	4.6	NS	NS	41.2	15.0	2.46

#### Foliage dry weight/plant

Data in the Tables (3 and 4) show that all treatments increased foliage dry weight/plant as compared to control treatment in both seasons.

In the first season, the heaviest values of dry weight was resulted from the treatments of chicken manure + (EM) + (BV) followed by chicken manure +



(EM) + (BM) as gave 21.93 and 18.09 g/plant compared to 13.42 g/plant for the control treatment in the first season, while in the second the heaviest values of dry weight/plant obtained from the treatments of 50% N, P + 50% chicken manure + (EM) + (BV) were followed by chicken manure + (BV) and 50% N, P + 50% chicken manure + (EM) + (BM) as gave 19.02, 18.46 and 17.87 g/plant compared to 12.79 g/plant for the control treatment.

Increasing the morphological characters of potato plants, after organic manure application may be due to increasing the soil organic matter content, cation exchange capacity and mineral nutrients, which in turn encouraged the plant growth to go for ward Danilchenko *et al.* (2005).

**Table (4): Effect of commercial biofertilizers, organic manure, nitrogen and phosphorus minerals fertilizer on vegetative growth during the season of 2004-2005.**

Characters Treatment	Season 2004-2005					
	Plant height (cm.)	Number/plant		Weight/plant (g.)		
		Main stems	Tubers	Tuber	Foliage Fresh	Foliage Dry
100% Recom. N, P.	22.8	1.43	5.44	329.3	123.7	12.83
50% Recom. N, P. + 50% Recom. ch.	23.8	1.70	5.44	339.4	129.8	14.86
100% Recom. ch.	21.5	1.23	5.44	300.3	116.2	12.79
100% Recom. ch. + BioMagic (BM).	28.2	1.67	6.11	367.4	136.7	13.94
50% Recom N, P. +50% Recom. ch. + BM	27.7	1.87	5.56	344.6	138.4	14.40
100% Recom. ch. + BioVit (BV)	26.9	2.00	6.57	406.2	156.4	18.46
50% Recom N, P. + 50% Recom. ch. + BV	25.4	1.80	6.00	346.9	129.7	14.39
100% Recom. ch. + BM + BV	27.8	1.70	6.00	364.1	155.3	17.27
50% Recom N, P. + 50% Recom. ch. + BM + BV	26.5	1.67	5.78	364.8	140.6	14.26
100% Recom. ch. + Effective Microorganisms (EM)	23.9	1.70	7.22	368.8	143.8	16.93
50% Recom N, P. +50% Recom. ch. + (EM)	28.3	1.80	5.11	358.3	131.1	13.20
100% Recom. ch. + (EM) + BM	25.7	1.43	5.33	365.0	122.1	14.47
50% Recom N, P. + 50% Recom. Ch + EM + BM	24.7	1.43	5.78	401.9	160.9	17.87
100% Recom. ch. + EM + BV	25.2	1.43	6.22	374.5	132.5	14.58
50% Recom N, P. +50% Recom. ch. + EM + BV	27.0	1.57	6.67	405.4	157.5	19.02
100% Recom. ch. + EM + BM + BV	22.6	1.57	6.78	356.1	128.7	15.42
50% Recom N, P. +50% Recom. ch. + EM + BM + BV	23.0	1.47	6.00	331.0	117.4	13.02
L.S.D at 5%	4.5	NS	NS	45.5	26.0	3.89

Adding chemical fertilizers particularly nitrogen and phosphorus to the organic manure may enhance chemical activities within organic manure and promote N and P releasing there by increase these elements in roots zone Mengel and Kirkby (1987), Ashour (1998), El Banna and Tolba (2000) and Kushwah and Banafar (2003)

The applying biofertilizers to potato plant increased microorganisms living in the soil. The microorganisms working on the organic matter in the soil to convert organic forms of nutrients such as N to mineral N. This increase in the up take of nutrients from soil by root of plant promotes plant growth Lampkin (1990).

These results agree with Abedl-Ati *et al.* (1996), Ashore *et al.* (1997), El-Ginbihi, Ali (2001) and Indires, *et al.*, (2003) reported that inoculation of potato plants with biofertilizer significantly increased plant height, foliage plant fresh and dry weight.

#### **Yield characters**

##### **Average tuber weight**

It was evident from data in Table (5) that most treatments of commercial biofertilizer significantly increased the tuber weight of potato in the two seasons.

In the first season the highest values of tuber weight were obtained from the treatments of chicken manure + (EM), 50% N, P + 50% chicken manure and chicken manure + (BV) which recorded 103.80, 99.49 and 96.70 g/tuber followed by 100% N, P, 50% chicken manure + (BM) + (BV) + 50% N, P and chicken manure + (EM) + (BV) which 96.65, 94.60 and 94.55 g/tuber compared to 73.32 g/tuber for the control treatment (chicken manure), while in the second one the heaviest values of tuber weight were obtained from the treatments of chicken manure + (EM) and chicken manure + (BM) + (BV) it gave 111.7 and 111.4 g/tuber followed by 50% N, P + 50% chicken manure + (EM) + (BV), chicken manure + (BM) and 100%N, P as gave 109.50, 108.40 and 105.30 g/tuber against 91.42 g/tuber for the control treatment (chicken manure).

##### **The number of tubers per plant**

It was clear from data in Table (5) that most treatments of biofertilizers increased the number of tubers/plant than control treatment (chicken manure) in the two seasons. The highest augmentation of the number of tuber/plant was resulted from the treatment of 50% N, P + 50% chicken manure + (EM) + (BV) and 50% N, P + 50% chicken manure + (EM) which recorded 6.34 and 6.30 in the first season, while in the second one was observed for 50% N, P + 50% chicken manure + (EM) + (BV) and chicken manure + (BV) which gave 4.89 and 3.83. Moreover, the values of the number of tubers/plant had no significant difference between all used biofertilizers treatment. The values of tubers number range from 4.10 to 6.34 while the control treatment (chicken manure) had 4.10 in the first seasons.

##### **Weight of tubers per plant**

Data in Table (5) show clearly that the tubers weight/plant was significantly increased by using all biofertilizers treatments as comparing with the untreated plants.

**Table (5): Effect of commercial biofertilizers, organic manure and nitrogen, phosphorus minerals fertilizer on yield characters of potato plant cv. Mondial at harvest.**

Season Characters Treatment	2003-2004				2004-2005			
	Average tuber weight (g.)	Plant tubers		Yield (ton/fed.)	Average tuber weight (g.)	Plant tubers		Yield (ton/fed.)
		Number	Weight (g.)			Number	Weight (g.)	
100% Recom. N, P.	77.00	4.50	360.9	7.500	92.46	3.69	368.0	7.600
50% Recom. N, P. + 50% Recom. ch.	83.22	4.80	374.7	8.100	95.54	3.87	379.7	8.000
100% Recom. ch.	73.32	4.10	356.5	7.400	91.42	3.29	345.4	7.300
100% Recom. ch. + BioMagic (BM).	87.33	4.30	426.7	8.500	98.82	3.82	401.3	8.000
50% Recom N, P. +50% Recom. ch. + BM	87.34	4.90	472.7	9.600	108.40	4.35	440.2	8.800
100% Recom. ch. + BioVit (BV)	94.15	4.80	441.1	9.200	99.79	3.83	440.8	8.100
50% Recom N, P. + 50% Recom. ch. + BV	96.70	5.47	501.7	10.000	105.30	4.40	404.6	9.100
100% Recom. ch. + BM + BV	92.09	4.67	441.1	8.800	96.60	4.12	413.4	8.200
50% Recom N, P. + 50% Recom. ch. + BM + BV	94.60	5.33	475.2	10.200	103.00	4.27	449.4	9.200
100% Recom. ch. + Effective Microorganisms (EM)	96.65	4.84	424.4	10.400	103.00	4.14	411.8	8.500
50% Recom N, P. +50% Recom. ch. + (EM)	103.80	6.30	528.7	11.100	109.50	4.89	413.1	9.200
100% Recom. ch. + (EM) + BM	94.55	4.82	442.4	8.900	103.70	4.21	429.4	8.500
50% Recom N, P. + 50% Recom. Ch + EM + BM	99.48	5.21	503.5	10.500	106.20	4.86	443.0	9.300
100% Recom. ch. + EM + BV	91.31	5.16	463.5	9.700	103.90	4.16	440.2	8.800
50% Recom N, P. +50% Recom. ch. + EM + BV	84.99	6.34	578.7	11.700	111.70	4.89	532.6	10.500
100% Recom. ch. + EM + BM + BV	73.63	4.30	399.8	7.800	92.62	3.82	401.5	8.500
50% Recom N, P. +50% Recom. ch. + EM + BM + BV	73.93	4.40	410.2	8.200	96.60	3.91	406.3	8.700
L.S.D at 5%	17.41	1.25	101.5	2.616	17.57	0.69	48.8	1.428

In the first season the heaviest weight of tubers/plant was obtained from the treatments of 50% N, P + 50% chicken manure + (EM) + (BV) followed by 50% N, P + 50% chicken manure + (EM), 50% N, P + 50% chicken manure + (EM) + (BM) and 50% N, P + 50% chicken manure + (BV) as gave (578.7, 528.7, 503.5 and 501.7 g/plant) compared to 356.5 g/plant for the control treatment. In the second seasons the highest values of tuber weight/plant was recorded from the treatments of 50% N, P + 50% chicken manure + (EM) + (BV) as gave 532.6 g/plant compared to 345.4 g/plant for the control treatment(100% chicken manure).

#### **Total yield**

Data in Table (5) show that, all used biofertilizers treatments increased tubers yield/feddan over the untreated ones, with significant differences in most cases during the two seasons. In the first season the highest values of tubers yield were recorded for the treatment 50% N, P + 50% chicken manure + EM + BV followed by 50% N, P + 50% chicken manure + (EM) and 50% N, P + 50% chicken manure + (EM) + (BM) which gave 11.700, 11.100 and 10.500 ton/fed., compared to 7.400 ton/fed., for the control treatment (100% chicken manure) while in the second one the heaviest values of tubers yield were obtained from the treatments of 50% N, P + 50% chicken manure + (EM) + (BV) followed by 50% N, P + 50% chicken manure + (EM) + (BM), 50% N, P + 50% chicken manure + (EM) and 50% N, P + 50% chicken manure + (BV) as gave 10.500, 9.300, 9.200 and 9.100 ton/fed., compared to 7.300 ton/fed., for the control treatment (100% chicken manure).

#### **Chemical constituents:**

Data of the effect of organic manure, mineral nitrogen, phosphorus and commercial biofertilizers (EM, BM and BV) on nitrogen and phosphorus percentage of potato plant foliage and tuber at harvest in the two experimental seasons are presented in Table (6).

#### **1-a Nitrogen percentage in plant foliage at 75 days**

Data in Table (6) show clearly that all treatments of biofertilizers increased the N contents in the leaves of potato plant during both seasons of growth.

In the first season the highest values of nitrogen percentage in the foliage were observed for the treatments of 100% N, P followed by 50% N, P +50% chicken manure, 50% N, P + 50% chicken manure + (EM) + (BM) and 50% N, P + 50% chicken manure. + (EM) + (BM) + (BV) witch registered foliage (2.62, 2.48, 2.48 and 2.46 N %) corresponding 1.53 N% for the control treatment (100% chicken manure). While in the second one the highest values of nitrogen percentage resulted from the treatments of 100% N, P followed by 50% N, P + 50% chicken manure, 50% N, P + 50% chicken manure + (EM) and 50% N, P + 50% chicken manure + (BM) witch registered foliage (3.12, 3.09, 3.09 and 3.03 N%) compared to 2.23 N% for the control treatment (100% chicken manure).

**Table (6): Effect of commercial biofertilizers, organic manure and nitrogen, phosphorus minerals on nitrogen and phosphorus in foliage and tuber contents.**

Characters Treatment	Foliage at 75 days				Tuber at 75 days				Tuber at harvest AT 120 days			
	season 1		season2		season 1		season2		season 1		season2	
	N%	P%	N%	P%	N%	P%	N%	P%	N%	P%	N%	P%
100% Recom. N, P.	2.62	0.44	3.12	0.76	1.70	0.35	1.76	0.33	2.23	0.39	2.45	0.38
50% Recom. N, P. + 50% Recom. ch	2.48	0.39	3.09	0.68	1.58	0.16	1.71	0.31	2.10	0.31	2.27	0.33
100% Recom. ch.	1.53	0.37	2.23	0.76	0.98	0.25	0.96	0.35	1.30	0.42	1.67	0.36
100% Recom. ch. + BioMagic (BM).	1.62	0.33	2.42	0.70	1.15	0.35	1.14	0.28	1.44	0.35	1.71	0.38
50% Recom N, P. +50%Recom. ch. + BM	2.13	0.34	3.03	0.45	1.44	0.48	1.62	0.32	2.04	0.48	2.16	0.40
100% Recom. ch. + BioVit (BV)	1.72	0.30	2.54	0.68	1.12	0.52	1.11	0.36	1.56	0.52	1.68	0.35
50% Recom N, P. 50%Recom. ch. + BV	2.30	0.28	3.03	0.53	1.43	0.37	1.52	0.29	2.04	0.37	1.71	0.40
100% Recom. ch. + BM + BV	1.95	0.32	2.59	0.70	1.28	0.45	1.41	0.29	1.44	0.45	1.78	0.39
50% Recom N, P. + 50%Recom. ch. + BM + BV	2.14	0.34	2.89	0.59	1.57	0.37	1.50	0.28	1.95	0.37	2.07	0.37
100% Recom. ch. + Effective Microorganisms(EM)	1.94	0.38	2.61	0.69	1.25	0.41	1.29	0.36	1.66	0.41	1.70	0.36
50% Recom N, P. +50%Recom. ch. + (EM)	2.35	0.38	3.09	0.43	1.52	0.60	1.49	0.26	1.92	0.60	2.11	0.42
100% Recom. ch. + (EM) + BM	1.97	0.37	2.61	0.65	1.38	0.31	1.41	0.27	1.68	0.31	1.91	0.38
50% Recom N, P. + 50% Recom. ch. + EM + BM	2.48	0.31	2.89	0.38	1.49	0.30	1.52	0.26	1.89	0.30	2.03	0.35
100% Recom. ch. + EM + BV	2.07	0.43	2.55	0.48	1.31	0.49	1.41	0.34	1.73	0.49	1.96	0.38
50% Recom N, P. +50% Recom. ch. + EM + BV	2.35	0.29	2.84	0.54	1.45	0.37	1.46	0.25	1.95	0.37	2.04	0.38
100% Recom. ch. + EM + BM + BV	2.08	0.30	2.68	0.52	1.38	0.35	1.42	0.23	1.76	0.35	2.00	0.32
50% Recom N, P. +50% Recom. ch. + EM + BM + BV	2.46	0.32	2.86	0.58	1.46	0.54	1.50	0.30	1.89	0.54	2.08	0.40
L.S.D at 5%	0.46	NS	0.51	NS	0.23	NS	0.27	NS	0.35	NS	0.40	NS

**1-b Nitrogen percentage in tuber at 75 days :**

Data in Table (6) show that all used of commercial biofertilizers increased nitrogen percentage with significant differences, in most cases during both seasons. In the first season the highest values of nitrogen percentage were recorded from the treatments 100% N, P followed by 50% N, P +50% chicken manure then 50 % N, P +50% chicken manure + (BM) + (BV) and 50% N, P +50% chicken manure + (EM) + (BM) as gave (1.70, 1.58, 1.57 and 1.49 N%) compared to 0.98 N% for the control treatment (100% chicken manure). While in the second one the highest values of nitrogen percentage resulted from the treatments of 100% N, P followed by 50% N, P +50% chicken manure, 50% N, P +50% chicken manure + (BM) and 50% N, P +50% chicken manure + (BV) witch registered foliage (1.76, 1.71, 1.62 and 1.52 N%) compared to 0.96N% for the control treatment (100% chicken manure).

**1-c Nitrogen percentage in tuber after 120 days at harvest**

It was obvious from data in Table (6) that all treatment of biofertilizers increased the nitrogen percentage with significant differences in most cases when compared to the control. In the first season the highest values of nitrogen percentage in the tubers were observed for the treatments of 100% N, P followed by 50% N, P +50% chicken manure, 50% N, P +50% chicken manure + BV and 50% N, P +50% chicken manure + (BM) witch registered foliage (2.23, 2.10, 2.04 and 2.04 N%) corresponding to 1.30N% for the control treatment (100% chicken manure).

While in the second one the highest values of nitrogen percentage resulted from the treatments of 100% N, P followed by 50% N, P +50% chicken manure, 50% N, P +50% chicken manure + BM and 50% N, P +50% chicken manure + (EM) witch registered (2.45, 2.27, 2.16 and 2.11 N%) compared to 1.67 N% for the control treatment (100% chicken manure).

These results may be attributed to the increase of nitrogen percentage in plant foliage. These results agree with those obtained by Ashour *et al.* (1997).

**2- Phosphorus percentage:**

Data in Table (6) show that, the phosphorus percentage either in plant foliage or tuber at 75 and 120 day from sowing was not significantly affected by using all different studied treatments when compared to the control treatment during the two seasons of growth.

**3- Total carbohydrates percentage:**

Data in the Table (7) show that, the total carbohydrates percentage in the tubers at harvest in the two experimental seasons was increased by using all different commercial biofertilizers combined with organic and mineral fertilizers when compared to the control treatment with significant differences in the most cases during the two seasons.

**Table (7): Effect of commercial biofertilizers, organic manure and nitrogen, phosphorus minerals on tubers characters of potato plant cv. Mondial.**

Characters Treatment	Total carbohydrates (%)		Nitrates (ppm)		DM (%)		Specific Gravity (g./cm <sup>3</sup> )	
	Season 1	Season 2	Season 1	Season 2	Season 1	Season 2	Season 1	Season 2
100% Recom. N, P.	40.12	40.96	720	786	16.20	19.04	1.062	1.073
50% Recom. N, P. + 50% Recom. ch.	40.02	38.15	665	763	16.48	19.18	1.066	1.079
100% Recom. ch.	37.94	33.44	491	651	14.20	18.90	1.061	1.065
100% Recom. ch. + BioMagic (BM).	41.28	33.54	490	493	15.97	19.01	1.063	1.078
50% Recom N, P. +50% Recom. ch. + BM	41.41	36.82	548	633	16.70	19.48	1.065	1.075
100% Recom. ch. + BioVit (BV)	39.84	35.84	367	471	16.52	19.08	1.065	1.078
50% Recom N, P. + 50% Recom. ch. + BV	41.35	39.47	573	609	17.07	19.62	1.063	1.077
100% Recom. ch. + BM + BV	39.60	33.34	348	460	16.30	19.02	1.063	1.077
50% Recom N, P. + 50% Recom. ch. + BM + BV	40.11	38.62	523	599	17.04	19.62	1.063	1.074
100% Recom. ch. + Effective Microorganisms (EM)	38.45	35.28	307	324	16.59	19.08	1.062	1.079
50% Recom N, P. +50% Recom. ch. + (EM)	43.17	37.30	490	555	17.28	19.59	1.062	1.081
100% Recom. ch. + (EM) + BM	39.01	33.94	344	309	16.76	19.16	1.061	1.078
50% Recom N, P. + 50% Recom. Ch + EM + BM	43.52	41.40	443	520	17.13	19.71	1.064	1.075
100% Recom. ch. + EM + BV	39.50	34.06	282	294	16.86	19.25	1.060	1.077
50% Recom N, P. +50% Recom. ch. + EM + BV	44.59	40.33	491	493	17.57	19.72	1.063	1.077
100% Recom. ch. + EM + BM + BV	40.94	36.81	487	478	16.59	19.28	1.063	1.078
50% Recom N, P. +50% Recom. ch. + EM + BM + BV	42.45	38.28	544	509	17.11	19.43	1.064	1.080
L.S.D at 5%	5.61	5.75	166	139	0.686	0.690	N.S	N.S

The highest values of total carbohydrates percentage in the tubers were resulted from the treatments of 50% N, P +50% chicken manure + (EM) + (BV) followed by 50% N, P + 50% chicken manure + (EM) + (BM) then 50% N, P + chicken manure + (EM) and 50% N, P +50% chicken manure + (EM) + (BM) + BV which recorded 44.59, 43.52, 43.17 and 42.45% compared to 37.94% for the control treatment (100% chicken manure) in the first season.

On the other hand in the second season the highest values were observed from the treatments 50% N, P + 50% chicken manure + (EM) + (BM) followed by 50% N, P +50% chicken manure + (EM) + (BV) then 50% N, P + chicken manure + (BV) and 50% N, P +50% chicken manure + (BM) + (BV) which recorded 41.40, 40.33, 39.47 and 38.62% compared with 33.54% for the control treatment. These results are in harmony with those obtained by Abo-Hussein *et al.* (2002c) indicated that total carbohydrates increased due to the application of chicken manure compost and biofertilizers.

#### 4- Nitrate content

Data in Table (7) show that, the nitrate-N concentration found in the tubers were significantly lowered with commercial biofertilizer and organic fertilizer compared with mineral fertilizer.

In the first season the lowest values of nitrate-N concentration were recorded from the treatments of 100% chicken manure + EM +BV followed by 100% chicken manure + (EM), 100% chicken manure + (EM) + (BM) and 100% chicken manure + (BV) while in the second one the lowest values were observed for the treatments 100% chicken manure + (EM) +(BV) followed by 100% chicken manure + (EM) + (BM) and 100% chicken manure + (EM). These results are in accordance with those obtained by Abdulla (1999) who found that applying the biofertilizer (Rhizobacterin 4 Kg + Phosphorein 4 Kg/fed.) combined with cattle manure (40 m<sup>3</sup>/fed.) and poultry manure (20 m<sup>3</sup>/fed.) significantly decreased nitrate and nitrite in potato tubers.

Additionally, El-Banna *et al.* (2001) found that the lower concentration of nitrate (ppm) by using the biofertilizer and FYM together, in comparison with mineral fertilizers application, while,

#### 5- Dry matter

Data in Table (7) show that all treatments significantly increased dry matter % for potato plant as compared to the control treatment in both seasons. In the first season, the heaviest values of dry matter resulted from the treatment of 50% N, P + 50% chicken manure + (EM) + (BV), 50% N, P + 50% chicken manure + (EM) followed by 50% N, P + 50% chicken manure + (EM) + (BM) and 50% N, P + 50% chicken manure + (BV) as gave 17.75, 17.28, 17.13 and 17.07% compared to 14.20 % for the control treatment, while in the second season the heaviest values of dry matter obtained from the treatments of 50% N, P + 50% chicken manure + (EM) +(BV), 50% N, P + 50% chicken manure + (EM) + (BM) followed by 50% N, P + 50% chicken manure + (BV) + (BM) and 50% N, P + 50% chicken manure + (BV) as gave 19.72, 19.71, 19.62 and 19.52% compared with 18.90 %for the control.



#### 6- Specific gravity

Data in Table (7) clearly show the specific gravity was not significantly affected by using all different tested treatments when compared to the control treatment during the two seasons.

The effect of biofertilizer, organic and mineral, N, P were observed and discussed by many workers on potato yield Abdel-Ati *et al.*, (1996), Schulz and Kopke (1996), Ashour *et al.* (1997), Awad (1997), Abdulla (1999), El-Ghinbihi and Ali (2001), Cieccko *et al.* (2004) and Maiti *et al.* (2004).

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تأثير الأسمدة الحيوية التجارية والعضوية والمعدنية النيتروجينية والفوسفاتية على النمو ومحصول البطاطس

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جيزة - مصر

نفذت هذه الدراسة بالمزرعة التجريبية بجنوب التحرير التابعة لمعهد البساتين خلال موسمي ٢٠٠٣/٢٠٠٤ و ٢٠٠٤/٢٠٠٥ لدراسة تأثير استخدام الأسمدة الحيوية التجارية، والعضوية وكذلك الأسمدة المعدنية النيتروجينية والفوسفاتية علي النمو والمحصول الصنف 'مونديال' وقد أدت كل الأسمدة التجارية الحيوية مع إضافة ٥٠% نيتروجين وفسفور + ٥٠% سماد دواجن إلي زيادة في كل الصفات للنمو الخضري ممثلة في ارتفاع النبات، عدد السيقان الرئيسية، الوزن الطازج والجاف لأوراق النبات ومحصول الدرنة حيث كانت الاختلافات معنوية في معظم الحالات. وكانت أحسن النتائج في حالة استخدام ٥٠% نيتروجين وفسفور + ٥٠% سماد دواجن + (EM) + (BV)، سماد دواجن + (BV) و ٥٠% نيتروجين وفسفور + ٥٠% سماد دواجن + (EM) + (BM) في كلا الموسمين. زاد المحتوى من الكربوهيدرات الكلية والنيتروجين في الأوراق والدرنات زيادة معنوية في معظم الحالات باستخدام معاملات الأسمدة التجارية الحيوية المختلفة. وكانت أفضل النتائج المشاهدة في كلا الموسمين للمعاملة ٥٠% نيتروجين وفسفور + ٥٠% سماد دواجن + (EM) + (BV)، ١٠٠% سماد دواجن + (BV) و ٥٠% نيتروجين وفسفور + ٥٠% سماد دواجن + (EM) + (BM). بينما كانت الزيادة غير معنوية في محتوى الفوسفور خلال موسمي الدراسة.