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EFFECT OF SOME ORGANIC, CHEMICAL AND BIO-FERTLIZERS ON GARLIC (*Allium sativum* L.): 2. CHICKEN MANURE.

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ABSTRACT

Two experiments were carried out on garlic clone Sids 40, in the vegetable private farm at Tawila village Dakahila Governorate during two successive seasons 2003/2004 and 2004/2005 to study the effect of chicken manure (10 and 20 m^3/fed), three phosphorus levels (25, 50 and 75 kg P_2O_5/fed), phosphorien (with 3 kg/fed and without) and potassium fertilization (soil fertilization 72 kg K_2O/fed and 60 kg K_2O/fed + 1% K_2O/fed as foliar fertilization) on growth, yield and its components, chemical composition and storability of garlic.

The results indicated that treatment of 20 m^3 chicken manure/fed + 50 kg P_2O_5/fed + with phosphorien (3 kg/fed) + 60 kg K_2O/fed + 1% K_2O/fed foliar fertilization gave the best results for (fresh weight/plant, dry weight /plant, leaf area/plant, bulb diameter at 160 days after planting, weight of bulb/plant, bulb yield/fed, N, P and K percentage and total chlorophyll content) during the two seasons. But, it had the lowest values of bulbing ratio at 120 and 160 days after planting at the two seasons, the same treatment had the lowest value of total weight of loss percentage of bulbs in the second season. While the treatment of 20 m^3 chicken manure/fed + 75 kg P_2O_5/fed + without phosphorien + 60 kg K_2O/fed + 1% K_2O/fed foliar fertilization gave lowest value of total weight of loss percentage of bulbs in the first season.

Therefore, the treatment of 20 m^3 chicken manure/ fed + 50 kg P_2O_5/fed + with phosphorien (3 kg/fed) + 60 kg K_2O/fed + 1% K_2O/fed foliar fertilization could be recommended for raising garlic yield with good quality bulbs.

INTRODUCTION

Garlic (*Allium sativum* L.), is one of the most important bulb vegetable crops and is next to onion in importance. It is commonly used as a spice or in the medicinal purposes. In Egypt, it has been generally cultivated for both local consumption and export.

The use of chicken manure as organic fertilizer is increasing in Egypt due to its reputation as a quick-acting fertilizer, and it contribute to plant and soil relationship through its effects on physical and chemical and biological properties of the soil, its effect as a source of essential elements, its ability to increase the availability of certain nutrients as well as its effect in reducing the leaching out of mineral nutrients (Maynard 1989, Sharply and Smith 1995 and Nahm 2003).

However, chicken manure can degrade water quality through the leaching of nitrate into drainage and ground water (Liebhardt *et al.* 1979, Sallade and Sims 1994). El-Sheekh and Hegazy (1998) on onion, found that all organic manure fertilizers with all rate increased plant height and dry weight of all plants. Also, increased yield and average weight of bulbs. Farrag and Hussien (2000) on onion, found that the highest value of fresh weight of bulbs was obtained by application of 30 tons/fed of poultry manure but quality was moderate. As for the effect of using chicken manure on the vegetative growth, yield and its components N, P and K contents and storability. Ali *et al* (2001), Khalil *et al.* (2002), Radwan (2003), El-Bassoyunie *et al.* (2005) and Patil *et al*. (2005) showed that garlic or onion growth parameters gradually increased with increasing chicken manure rate. Mahmoud (2006) showed that the increases in the nutrient concentration and up take by onion due to the application on of these sources of nitrogen fertilizer followed the trend of ammonium sulfate + chicken manure > Ammonium sulfate alone > chicken manure alone. Yassen and Khalid (2009) on onion, found that all organic fertilizer treatments is mixture of farmyard manure treatment (recommended NPK) and improved the vegetative growth, essential oil and NPK content.

Phosphorus is considered the second essential nutrient element for plant growth and development, it plays an important role in certain prevalent steps in plant growth, such as accumulation and release of energy celluar metabolism, in addition, it is main constituent of many organic compounds in plant (Russell, 1950). Several researchers reported that P nutrient is very important for garlic plant growth. Panchal *et al.* (1992) on garlic found that application of phosphorus at (25, 50 and 75 kg/ha) gave the highest values of plant height, number of leaves, leaf area/plant, diameter of bulb, average weight of bulbs and bulb yield. In general, the results indicated that application of phosphorus fertilizer exerted apparent increases in plant growth of garlic and onion viz, number of leaves, foliage fresh and dry weight, bulbing ratio, bulb yield/fed its components, NPK content and storability. (El-Sheekh and Hegazy (1998), El-Kalla *et al.* 1999, Abd El-Rehim (2000), Jakse and Mihelic (2001), Turk and Tawaha (2001), Muthuramalingam *et al.*(2002), Lee-Jong Tae *et al.* (2003), Santhie *et al* (2005) and Ahmed *et al.* (2006).

Phosphorien content *Bacillus megatherium* a phosphate dissolving bacteria. Many investigators reported that application of phosphobacterium are involved in the availability of phosphorus and other elements in soils, through the decomposition of organic compounds, which may lead to a change in the soil reaction (Mahmoud and Abdel-Hafez 1982, Forster and Freter, 1988 and El-Dahtory *et al.* (1989). El-Sheekh (1997) found that the highest values of dry weight/plant, total yield/fed, diameter of bulb and weight bulb of onion plant were obtained by adding phosphorien at 400 gm/ fed

Several investigators reported that the application of phosphorus dissolving organisms increase the vegetative growth, yield and its components, N, P and K contents and storability on garlic or onion plants. Al-Karaki (2002) on garlic, Alok-Singh *et al.* (2002) on onion, Sari *et al.* (2002) on garlic, El-Shaikh (2005) on onion and Jha *et al.* (2006) on onion.

Potassium element is very important in over all metabolism of plant enzymes activity, it was found to serve a vital role in a photosynthesis by direct increasing in growth, leaf area and hence CO_2 assimilation. Potassium also has a beneficial effect of water consumption. (Mengel and Kirkby, 1982, Gardener *et al.*, 1985, Abd El-Aal, 1990 and Said, 1997).

Foliar fertilization of potassium is more economical than root application due to the higher degree of applied nutrients utilization and the continuous increases in the costs of using chemical fertilizers (Franke 1986). Ciecko *et al.* (2000) showed that increasing of the K rate significantly increased total chlorophyll biosynthesis in potato leaves. El-Morsy *et al.* (2004) on garlic, found that plant height, shoot dry weight/plant, bulbing ratio, total yield, bulb weight, bulb diameter, number of clove and clove weight were significantly increased with suppling 50% K fertilizer as a soil application and foliar application 2% K_2O solution and increased concentration of N, P, K and increasing of the storability of garlic plants.

MATERIALS AND METHODS

Two field experiments were carried out at Tawila village Dakahlia Governorate during two successive seasons (2003/2004 and 2004/2005) on garlic cultivar sids-40 to study the effect of two chicken manure levels, three phosphorus levels, phosphorien and potassium fertilization on growth, yield and its components, chemical composition and storability of garlic. The soil of the experimental field was clay loam in texture with organic matter% (1.95, 1.88), EC 3.7 ds/cm, PH 7.7. Available N, P and K contents were 50-70, 10-12 and 330-390 ppm during the first and second seasons.

Chicken manure was added at levels of 10 and 20 m^3 / fed it was broad coated during soil preparation and phosphorus fertilizer with three rates at 25, 50 and 75 kg P_2O_5 / fed in two equal doses (30 and 60 days after planting). Phosphorus was used in the form of super-phosphate (15.5% P_2O_5). Phosphorien was mixed with wet cloves at rate of 3 kg/fed before planting. Nitrogen fertilizer was used as Ammonium- Sulfate (20.5% N) at rate of 120 kg/fed in two equal doses (30 and 60 days after planting). Potassium fertilizer Potassium Sulfate (48% K_2O), it was used in two forms of soil fertilization 72 kg K_2O/fed and soil fertilization 60 kg K_2O/fed + 1% K_2O/fed foliar spray fertilization. Soil application was applied for two equal times 30 and 60 days later after planting while, foliar application was spared at 50, 70 and 90 days after planting. The experimental design was randomized complete block design with three replicates in this experiment.

Treatments of experiment

1- 10 m^3 /fed chicken manure + 25 kg P_2O_5/fed + without phosphorien + 72 kg K_2O/fed

2- 10 m^3 /fed chicken manure + 25 kg P_2O_5/fed + without phosphorien + (60 kg K_2O/fed + 1% K_2O foliar application).

3- 10 m^3 /fed chicken manure + 25 kg P_2O_5/fed + with phosphorien + 72 kg K_2O /fed

4- 10 m^3 /fed chicken manure + 25 kg P_2O_5/fed + with phosphorien + (60 kg K_2O /fed + 1% K_2O foliar application).

5- 10 m^3 /fed chicken manure + 50 kg P_2O_5/fed + without phosphorien + 72 kg K_2O /fed

6- 10 m^3 /fed chicken manure + 50 kg P_2O_5/fed + without phosphorien + (60 kg K_2O /fed + 1% K_2O foliar application).
7- 10 m^3 /fed chicken manure + 50 kg P_2O_5/fed + with phosphorien + 72 kg K_2O /fed
8- 10 m^3 /fed chicken manure + 50 kg P_2O_5/fed + with phosphorien + (60 kg K_2O /fed + 1% K_2O foliar application).
9- 10 m^3 /fed chicken manure + 75 kg P_2O_5/fed + without phosphorien + 72 kg K_2O /fed
10- 10 m^3 /fed chicken manure + 75 kg P_2O_5/fed + without phosphorien + (60 kg K_2O /fed + 1% K_2O foliar application).
11- 10 m^3 /fed chicken manure + 75 kg P_2O_5/fed + with phosphorien + 72 kg K_2O /fed
12- 10 m^3 /fed chicken manure + 75 kg P_2O_5/fed + with phosphorien + (60 kg K_2O /fed + 1% K_2O foliar application).
13- 20 m^3 /fed chicken manure + 25 kg P_2O_5/fed + without phosphorien + 72 kg K_2O /fed
14- 20 m^3 /fed chicken manure + 25 kg P_2O_5/fed + without phosphorien + (60 kg K_2O /fed + 1% K_2O foliar application).
15- 20 m^3 /fed chicken manure + 25 kg P_2O_5/fed + with phosphorien + 72 kg K_2O /fed
16- 20 m^3 /fed chicken manure + 25 kg P_2O_5/fed + with phosphorien + (60 kg K_2O /fed + 1% K_2O foliar application).
17- 20 m^3 /fed chicken manure + 50 kg P_2O_5/fed + without phosphorien + 72 kg K_2O /fed
18- 20 m^3 /fed chicken manure + 50 kg P_2O_5/fed + without phosphorien + (60 kg K_2O /fed + 1% K_2O foliar application).
19- 20 m^3 /fed chicken manure + 50 kg P_2O_5/fed + with phosphorien + 72 kg K_2O /fed
20- 20 m^3 /fed chicken manure + 50 kg P_2O_5/fed + with phosphorien + (60 kg K_2O /fed + 1% K_2O foliar application).
21- 20 m^3 /fed chicken manure + 75 kg P_2O_5/fed + without phosphorien + 72 kg K_2O /fed
22- 20 m^3 /fed chicken manure + 75 kg P_2O_5/fed + without phosphorien + (60 kg K_2O /fed + 1% K_2O foliar application).
23- 20 m^3 /fed chicken manure + 75 kg P_2O_5/fed + with phosphorien + 72 kg K_2O/fed
24- 20 m^3 /fed chicken manure + 75 kg P_2O_5/fed + with phosphorien + (60 kg K_2O /fed + 1% K_2O foliar application).

NPK percentages of chicken manure used were 1.97% N, 0.23% P and 1.50% K. (AOAC, 1990 and Ranganna, 1979).

Garlic cloves were selected uniformly in shape and size. The cloves were planted on the 12th and 9th of October in the first and second seasons, respectively. The cloves were planted on both sides of each ridge at 10 cm apart. The plot area was 11.2 m^3, which contained 4 rides, with 4 m length and 0.7 m width.

The harvest was done 180 days after planting for both seasons. The following characters were determined:-

A. Vegetative growth characters

Five plants from each plot were chosen randomly in both seasons after 120 days from planting date to study the following characteristics:-

1. Fresh weight/plant (g).
2. Dry weight/plant (g).
3. Leaf area (cm^2)/plant.
4. Bulbing ratio = $\frac{\text{Neck diameter (cm)}}{\text{Bulb diameter (cm)}}$ Mann (1952) after 120 and 160 days from planting.
5. Bulb diameter (cm) after 160 days from planting.

B. Yield and its components

1- Total yield ton/ feddan before curing treatment.
2- Average bulb weight.

C. Chemical composition:-

1- Total chlorophyll (was estimated by spectrophotometrically by using the method of Macking (1941)
2- Nitrogen, phosphorus and potassium percentage in the dry matter of cured clover were determined according to methods described by AOAC (1990) for nitrogen, phosphorus and potassium (Ranganna, 1979).

D. Storability:-

After curing, random samples (each 10 kg) were taken from every treatment and stored at the normal room conditions. (Average temperature was 26°C and 24°C at the first and second seasons , respectively. Average relative humidity was 66% at both seasons)

The samples were weight after one, three and six months later and percentage of loss weight were calculated.

The obtained data were subjected to statistical analysis using technique of the randomized complete block design according to Snedecor and Cochran (1982) using MSTAT-C, computer. The treatment means were compared using Duncan's Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

A. Vegetative growth characters

Date on vegetative growth characters i.e., Fresh weight/plant, dry weight/plant, Leaf area (cm^2)/plant and bulbing ratio at 120 days after planting are present in Table 1. The highest values (Fresh weight/plant, dry weight/plant and leaf area (cm^2/plant) were recorded with 20 m^3 chicken manure/fed + 50 kg P_2O_5/fed + with phosphorien (3 kg/fed) + 60 kg K_2O/fed + 1% K_2O/fed foliar fertilization.

1

The superiority of chicken manure and phosphorien on vegetative growth often due to improving the structure of soil and increase total count of botany as well as, improving soil biological and chemical properties. Also, its effect in reducing the leaching out of mineral nutrients (cook 1972 and 1982, Maynard 1989 and Nahm 2003). However, chicken manure can degrade water quality through the leaching of nitrate into drainage and ground water (Liebhardt *et al.* 1979 and Sallade and Sims 1994).

On the other hand, the favorable effect of potassium fertilizer on the plant growth may be due to that potassium element is very important in the overall metabolism of plant (Mengel and Kirkby, 1982). Moreover, foliar fertilization of potassium is more economical than root application due to the higher degree of applied nutrient utilization and the continuous increases in the costs of using chemical fertilizers (Franke (1986). Similar results were obtained by, El-Kalla (1999), Farrage and Hussein (2000), Muthuramalingam *et al.* (2001), Al-Kaff *et al.* (2002), Abo El-Magd *et al.* (2003), Prabu *et al.* (2003), El-Morsy (2004), El-Shaikh (2005), Jha *et al.* (2006) and Yassen and Khalid (2009).

B. Yield and its components

Data presented in Table 2 indicated that application 20 m^3 chicken manure/fed + 50 kg P_2O_5/fed + with phosphorien (3 kg/fed) + 60 kg K_2O + 1% K_2O/fed foliar fertilization results in the highest value (diameter of bulb at 160 days after planting, weight of bulb and bulb yield/fed) but, the lowest bulbing ratio was resulted from the plants fertilized by the same treatment during two seasons. On the other hand, the highest value (bulbing ratio at 160 days after planting) was resulted by fertilizing the plants with 20 m^3 chicken manure/fed + 25 kg P_2O_5/fed + without phosphorien + 72 kg K_2O or 20 m^3 chicken manure/fed + 25 kg P_2O_5/fed + 60 kg/fed K_2O + 1% K_2O /fed foliar fertilization during two seasons. Similar results obtained by Muthuramalingam *et al.* (2001), Al-Kaff *et al.* (2002), Prabu *et al.* (2003), El-Mansi *et al.* (2004), El-Morsy *et al.* (2004), and Yassen and Khalid (2009).

The enhancing effect of such treatments on yield and its components are mainly attributed to the ameliorative effect on vegetative growth Table (1). The increase in both weight and diameter of bulb with supply of chicken manure, phosphorus levels, phosphorien and potassium soil fertilization with foliar fertilization could be due to more luxuriant growth, more foliage and leaf area and higher supply of photosynthates which helped producing bigger bulbs resulting in higher yield.

C. Chemical composition

Results recorded in Table 3 reveal that nitrogen, phosphorus and potassium percentage in garlic cloves and total chlorophyll contents in leaves had the highest values at the treatment of 20 m^3 chicken manure/fed. + 50 kg P_2O_5/fed + with phosphorien (3 kg/fed.) + 60 kg K_2O + 1% K_2O/fed. foliar fertilization during both seasons of study. Such increments are connected with the increasing in vegetative growth parameter also it may be attributed to the highest content and more as well easily decomposition of chicken manure, phosphorien and availability of such macro elements N, P, K and total chlorophyll for absorption by plant roots compared with other treatments.

2

3

Obtained results as in agreement with those reported by Muthuramalingam *et al.* (2002), Prabu *et al.* (2003), El-Shaikh (2005) and Jha *et al.* (2006).

In addition, the increment up take of N, P and K by different plants parts may be due to higher availability of the nutrients with increase the fertilizer application NPK which ultimately resulted in better root growth and increased physiological activity of roots to absorb the nutrients and thereby nutrient up take was found closely linked with productivity (Veeranna *et al.* 1997, Komor *et al.* 1980 and Mengel and Kirkby 1982). Similar results were obtained by Cieko *et al.* (2000), El-Morsy *et al.* (2004) and Yassen and Khalid (2009).

D. Storability

Data presented in Table 4 showed that the response of total weight loss percentage of bulbs to the different treatments. The data indicated that 20 m^3 chicken manure/fed. + 75 kg P_2O_5/fed + without phosphorien + 60 kg K_2O + 1% K_2O/fed. foliar fertilization gave the lowest total weight loss percentage during storage period at the first season. But, the application of 20 m^3 chicken manure/fed. + 50 kg P_2O_5/fed + with phosphorien + 60 kg K_2O + 1% K_2O/fed. foliar fertilization gave the lowest values at the second season. These results may be due to increase dry weight in plant Table 1 and K element in Table 3. The reduction in percentage of weight loss during storage may be due to low moist content in bulb reflected as observed in the dry matter percentage. Also, phosphorus is required for the production of high energy phosphate molecules, produced in both photosynthesis and respiration processes, therefore higher content of ATP reduced the degradation of clove content for respiration and hence less lose from bulb during storage period. The presence of the micro-organisms found chicken manure and phosphorien may secrete antioxidant and suppressed pests and diseases which could be the major reason for reducing weight loss during storage (Mengel and Kirkby 1982 and Gardener *et al.* 1985). The results are similar to those reported by , El-Sheekh (1997), El-Morsy *et al* (2004), El-Shaikh (2005) and Jha *et al* (2006).

4

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تأثير بعض الأسمدة العضوية والأسمدة الكيماوية والحيوية على محصول الثوم: ٢- سماد الدواجن.

طه محمد الجزار*، حسام السعيد عبد النبى*، عبد المنعم محمد عبد الحميد، احمد سعد الجمل* وأحمد السيد عبد القادر****

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****قسم بحوث الخضر – معهد بحوث البساتين – مركز البحوث الزراعية**

أجريت تجربتان حقليتان على الثوم (سلالة سدس-٤٠) فى مزرعة خاصة بالطويلة بمحافظة الدقهلية خلال موسمي الزراعة ٢٠٠٣/٢٠٠٤ و٢٠٠٤/٢٠٠٥ لدراسة تأثير سماد الدواجن بمستويين (١٠ و ٢٠ م٣ / فدان) وثلاث مستويات للفوسفور (٢٥ ، ٥٠ و٧٥ كجم فو٢ ا٥/فدان) والفوسفورين (بدون ومع فوسفورين بمعدل ٣ كجم/فدان) والتسميد البوتاسى بمعدل ٧٢ كجم بو٢ا/فدان ، ٦٠ كجم بو٢ ا/فدان مع ١% بو٢ا/فدان تسميد بالرش على النمو ومحصول الأبصال ومكوناته وكذلك المحتويات الكيماوية فى الفصوص ونسبة الفقد فى وزن الأبصال خلال فترة التخزين. تم اضافة النتروجين و الفوسفور و البوتاسيوم الارضى على دفعتين متساويتين بعد ٣٠ و ٦٠ يوم من الزراعة. و تم خلط الفوسفورين بالفصوص قبل الزراعة مباشرة. استخدم البوتاسيوم رشا على النباتات بعد ٥٠ , ٧٠ و ٩٠ يوم من الزراعة.

ويمكن تلخيص النتائج المتحصل عليها فيما يلى:-

* وجد أن استخدام المعاملة ٢٠ م٣/فدان سماد دواجن + ٥٠ كجم فو٢ ا٥/فدان مع الفوسفورين (٣ كجم/فدان) + ٦٠ كجم بو٢ ا/فدان مع ١% بو٢ا/فدان سماد رش ورقى تعطى أفضل نتائج للوزن الطازج/نبات، الوزن الجاف/نبات ، المساحة الورقيه/نبات وقطر البصلة عند ١٦٠ يوم من الزراعة، وكذلك متوسط وزن البصلة، المحصول الكلى/فدان، نسبة محتوى العناصر (نتروجين ، الفوسفور والبوتاسيوم) ومحتوى الكلوروفيل الكلى أثناء موسمى الزراعة.

ولكن حدث انخفاض فى قيم نسبة التبصيل عند ١٢٠ و١٦٠ يوم من الزراعة مع نفس المعاملة فى كلا الموسمين.

* مع نفس المعاملة حدث انخفاض فى نسبة الفقد الكلية فى وزن الأبصال المخزنة فى الموسم الثانى بينما المعاملة ٢٠ م٣/فدان سماد دواجن + ٧٥ كجم فو٢ ا٥/فدان و بدون الفوسفورين + ٦٠ كجم بو٢ ا/فدان سماد أرضى + ١% بو٢ا/فدان سماد رش ورقى يعطى انخفاض فى قيم نسبة فقد الوزن الأبصال خلال فترة التخزين خلال الموسم الأول للزراعة.

* توصى هذه الدراسة باستخدام المعاملة (٢٠ م٣/فدان سماد دواجن + ٥٠ كجم فو٢ ا٥/فدان مع الفوسفورين (٣ كجم/فدان) + ٦٠ كجم بو٢ ا/فدان سماد أرضى + ١% بو٢ا/فدان سماد رش ورقى) لرفع إنتاجية الثوم وتحسين جودة الأبصال وقابليتها للتخزين تحت نفس الظروف.

قام بتحكيم البحث

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Table 1: Fresh and dry weight/plant, leaf area /plant and bulbing ratio of garlic as affected by combination among chicken manure, phosphorus levels, phosphorien and potassium fertilizers at 120 days after planting during 2003/2004 and 2004/2005 seasons.

Characters / Treatments	Fresh weight/plant (g)		Dry weight/plant (g)		Leaf area /plant (ChM^2)		Bulbing ratio	
	2003/2004	2004/2005	2003/2004	2004/2005	2003/2004	2004/2005	2003/2004	2004/2005
10 m^3 Ch+P_1+Wt.Ph+Ks	60.56 ef	82.33 l	5.95 f	7.52 a	136.79 j	221.28 g	0.401 a	0.446 a
10 m^3 Ch+P_1+Wt.Ph+K(s+f)	63.66 cdef	83.00 kl	6.42 def	7.72 a	137.13 j	223.16 g	0.397 ab	0.422 ab
10 m^3 Ch+P_1+W.Ph+Ks	61.09 def	83.66 jkl	6.25 def	7.80 a	145.44 i	221.28 efg	0.394 ab	0.419 ab
10 m^3 Ch+P_1+W.Ph+K(s+f)	65.00 c	85.33 ijkl	6.78 cdef	7.80 a	147.95 hi	225.99 defg	0.398 abc	0.397 abc
10 m^3 Ch+P_2+Wt.Ph+Ks	61.26 def	97.00 bcd	6.70 cdef	7.94 a	151.98 efgh	231.18 cdef	0.390 abc	0.392 abc
10 m^3 Ch+P_2+Wt.Ph+K(s+f)	70.30 b	88.66 hi	7.12 bcdef	8.00 a	151.78 fgh	234.01 cdef	0.382 abc	0.390 abc
10 m^3 Ch+P_2+W.Ph+Ks	56.13 g	89.33 gh	6.61 cdef	8.37 a	145.13 i	233.54 efg	0.365 abc	0.362 abc
10 m^3 Ch+P_2+W.Ph+K(s+f)	62.93 cdef	92.22 fg	6.63 cdef	8.40 a	145.26 i	234.01 efg	0.361 abc	0.353 abc
10 m^3 Ch+P_3+Wt.Ph+Ks	60.44 ef	89.33 gh	6.24 def	8.78 a	144.31 i	242.51 fg	0.351 abc	0.360 abc
10 m^3 Ch+P_3+Wt.Ph+K(s+f)	65.20 c	92.33 fg	6.89 bcdef	8.89 a	150.31 gh	244.39 cdef	0.338 abc	0.346 abc
10 m^3 Ch+P_3+W.Ph+Ks	60.26 f	93.33 ef	6.62 cdef	9.00 a	151.04 fgh	245.81 cdef	0.320 abc	0.347 abc
10 m^3 Ch+P_3+W.Ph+K(s+f)	61.06 def	94.66 def	6.58 cdef	9.08 a	151.44 fgh	248.64 cdef	0.322 abc	0.350 abc
20 m^3 Ch+P_1+Wt.Ph+Ks	63.13 cdef	86.00 hijk	7.17 bcdef	8.18 a	151.76 efgh	234.96 cdef	0.341 abc	0.373 abc
20 m^3 Ch+P_1+Wt.Ph+K(s+f)	64.53 cd	86.55 hij	6.07 ef	8.20 a	160.47 bc	234.96 abcd	0.337 abc	0.364 abc
20 m^3 Ch+P_1+W.Ph+Ks	62.46 cdef	97.00 bcd	6.92 bcdef	8.58 a	154.17 defg	237.32 cdef	0.332 abc	0.364 abc
20 m^3 Ch+P_1+W.Ph+K(s+f)	65.46 c	88.66 hi	6.99 bcdef	8.78 a	162.90 b	244.39 abc	0.321 abc	0.352 abc
20 m^3 Ch+P_2+Wt.Ph+Ks	70.78 b	94.66 def	7.96 abc	8.93 a	157.56 cd	237.79 bcde	0.334 bc	0.333 bc
20 m^3 Ch+P_2+Wt.Ph+K(s+f)	69.20 b	96.33 cde	7.23 bcdef	9.08 a	163.03 b	244.39 abc	0.325 bc	0.325 bc
20 m^3 Ch+P_2+W.Ph+Ks	71.04 b	97.33 bcd	7.95 abc	9.46 a	157.83 cd	253.83 bcde	0.310 c	0.307 c
20 m^3 Ch+P_2+W.Ph+K(s+f)	76.00 a	101.33 a	8.81 a	9.96 a	172.16 a	276.48 a	0.293 c	0.295 c
20 m^3 Ch+P_3+Wt.Ph+Ks	69.48 b	96.33 cde	6.66 cdef	9.17 a	155.40 def	250.53 cdef	0.323 bc	0.329 bc
20 m^3 Ch+P_3+Wt.Ph+K(s+f)	69.20 b	97.66 bcd	7.65 abcd	9.37 a	156.40 cde	251.00 cdef	0.329 bc	0.327 bc
20 m^3 Ch+P_3+W.Ph+Ks	61.48 def	98.66 abc	7.48 bcde	9.39 a	169.31 a	254.77 ab	0.316 c	0.307 c
20 m^3 Ch+P_3+W.Ph+K(s+f)	63.86 cde	100.27 ab	8.27 ab	9.80 a	170.44 a	268.46 a	0.315 c	0.298 c

Ch chicken manure **P_1 25 kg/fed. P_2o_5** **P_2 50kg/fed. P_2o_5** **P_3 75 kg /fed. P_2o_5**

Wt.Ph Without phosphorien **W.Ph** With phosphorien

Ks 72 kg/fed. K_2O (soil fertilization) **K(s+f)** 60 kg K_2O/fed (soil fertilization + 1% K_2O/fed. foliar fertilization)

Table 2: Bulb diameter, bulbing ratio at 160 days after planting, weight of bulb and bulb yield (ton/fed) of garlic as affected by combination among chicken manure, phosphorus levels, phosphorien and potassium fertilizers at harvest during 2003/2004 and 2004/2005 seasons.

Characters / Treatments	Bulb diameter (ChM)		Bulbing ratio		weight of bulb (g)		Bulb yield (ton/fed)	
	2003/2004	2004/2005	2003/2004	2004/2005	2003/2004	2004/2005	2003/2004	2004/2005
10 m^3 Ch+P_1+Wt.Ph+Ks	4.74 k	6.12 j	0.187 a	0.230 a	77.75 h	66.44 h	9.135 m	9.872 j
10 m^3 ChP_1+Wt.Ph+K(s+f)	4.79 jk	6.16 ij	0.183 a	0.234 a	77.82 h	70.44 h	9.174 M	10.228 ij
10 m^3 Ch+P_1+W.Ph+Ks	4.81 jk	6.12 j	0.179 ab	0.227 ab	81.54 fgh	71.00 fgh	9.476 L	10.493 hij
10 m^3 Ch+P_1+W.Ph+K(s+f)	4.86 ijk	6.17 hij	0.169 ab	0.227 ab	81.99 efgh	71.33 efgh	9.543 L	10.886 ghi
10 m^3 Ch+P_2+Wt.Ph+Ks	4.90 hij	6.17 hij	0.168 ab	0.226 ab	82.62 efgh	72.44 efgh	9.775 k	11.447 fg
10 m^3 Ch+P_2+Wt.Ph+K(s+f)	4.92 ghij	6.19 ghij	0.165 ab	0.226 ab	83.27 defgh	71.55 defgh	9.917 k	11.690 efg
10 m^3 Ch+P_2+W.Ph+Ks	4.92 ghij	6.21 ghij	0.158 ab	0.219 ab	83.45 defgh	73.44 defgh	10.152 j	11.800 def
10 m^3 Ch+P_2+W.Ph+K(s+f)	4.98 fghi	6.23 fghi	0.163 ab	0.218 ab	86.54 cdefg	74.77 cdefg	10.441 i	12.003 bcdef
10 m^3 Ch+P_3+Wt.Ph+Ks	4.99 efghi	6.26 efghi	0.152 ab	0.220 ab	87.40 abcdefg	74.11 abcdefg	10.384 i	11.865 cdef
10 m^3 Ch+P_3+Wt.Ph+K(s+f)	5.00 efghi	6.27 defgh	0.154 ab	0.224 ab	88.05 abcdef	75.33 abcdef	10.449 i	12.021 bcdef
10 m^3 Ch+P_3+W.Ph+Ks	5.01 efgh	6.36 cde	0.158 ab	0.208 ab	88.81 abcde	75.22 abcde	10.634 h	12.385 abcde
10 m^3 Ch+P_3+W.Ph+K(s+f)	5.06 defg	6.37 bcd	0.145 ab	0.210 ab	86.67 bcdefg	75.77 bcdefg	10.824 fg	12.416 abcde
20 m^3 Ch+P_1+Wt.Ph+Ks	5.11 cdef	6.32 cdef	0.153 ab	0.211 ab	86.93 abcdefg	77.89 abcdefg	10.667 gh	11.210 fgh
20 m^3 Ch+P_1+Wt.Ph+K(s+f)	5.04 efgh	6.33 cdef	0.153 ab	0.211 ab	89.74 abcd	78.44 abcd	11.249 e	11.330 fg
20 m^3 Ch+P_1+W.Ph+Ks	5.08 def	6.27 defgh	0.169 ab	0.219 ab	85.39 cdefg	78.89 cdefg	10.828 fg	11.450 fg
20 m^3 Ch+P_1+W.Ph+K(s+f)	5.07 def	6.28 defg	0.154 ab	0.213 ab	80.42 gh	80.89 gh	11.732 d	11.679 efg
20 m^3 Ch+P_2+Wt.Ph+Ks	5.14 bcde	6.32 cdef	0.150 ab	0.217 ab	82.69 efgh	77.44 efgh	10.934 f	12.401 abcde
20 m^3 Ch+P_2+Wt.Ph+K(s+f)	5.23 bc	6.35 cde	0.151 ab	0.205 ab	91.50 abc	77.33 abc	11.783 d	12.430 abcde
20 m^3 Ch+P_2+W.Ph+Ks	5.09 cdef	6.40 bc	0.161 ab	0.204 ab	90.56 abc	79.33 abc	11.679 d	12.715 abc
20 m^3 Ch+P_2+W.Ph+K(s+f)	5.54 a	6.59 a	0.119 b	0.194 b	93.87 a	87.78 a	12.846 a	13.184 a
20 m^3 Ch+P_3+Wt.Ph+Ks	5.20 bcd	6.37 cd	0.154 ab	0.206 ab	90.48 abc	81.55 abc	11.686 d	12.599 abcd
20 m^3 Ch+P_3+Wt.Ph+K(s+f)	5.13 bcdef	6.40 bc	0.160 ab	0.203 ab	91.11 abc	82.11 abc	11.708 d	12.850 ab
20 m^3 Ch+P_3+W.Ph+Ks	5.23 bc	6.40 bc	0.138 ab	0.203 ab	91.77 abc	82.22 abc	12.458 c	13.079 a
20 m^3 Ch+P_3+W.Ph+K(s+f)	5.27 b	6.47 b	0.133 ab	0.198 ab	93.62 ab	83.00 ab	12.657 b	13.108 a

Ch chicken manure **P_1** 25 kg/fed. P_2o_5 **P_2** 50kg/fed. P_2o_5 **P_3** 75 kg /fed. P_2o_5
Wt.Ph Without phosphorien **W.Ph** With phosphorien
Ks 72 kg/fed. K_2O (soil fertilization) **K(s+f)** 60 kg K_2O/fed (soil fertilization + 1% K_2O/fed. foliar fertilization)

Table 3: Total chlorophyll at 120 days after planting, the percentage of N, P and K in cloves of garlic as affected by combination among chicken manure, phosphorus levels, phosphorien and potassium fertilizers at harvest during 2003/2004 and 2004/2005 seasons.

Characters / Treatments	Total chlorophyll mg/g.fw		N%		P%		K%	
	2003/2004	2004/2005	2003/2004	2004/2005	2003/2004	2004/2005	2003/2004	2004/2005
10 m^3 Ch+P_1+Wt.Ph+Ks	0.408 ef	0.252 a	2.96 j	3.56 ab	0.39 b	0.35 de	1.32 j	2.20 hij
10 m^3 Ch+P_1+Wt.Ph+K(s+f)	0.620 cde	0.252 a	3.05 j	3.55 ab	0.40 b	0.43 abcde	1.42 ij	2.30 fghi
10 m^3 Ch+P_1+W.Ph+Ks	0.543 cdef	0.316 a	3.37 ghi	3.60 ab	0.42 b	0.45 abcd	1.62 fgh	2.32 efghi
10 m^3 Ch+P_1+W.Ph+K(s+f)	0.473 def	0.322 a	3.31 hi	3.80 ab	0.43 ab	0.42 abcde	1.55 hi	2.20 hij
10 m^3 Ch+P_2+Wt.Ph+Ks	0.567 cdef	0.297 a	3.41 fghi	3.79 ab	0.42 b	0.34 e	1.65 defgh	2.12 ij
10 m^3 Ch+P_2+Wt.Ph+K(s+f)	0.545 cdef	0.215 a	3.50 efghi	3.81 ab	0.39 b	0.35 de	1.57 gh	2.10 ij
10 m^3 Ch+P_2+W.Ph+Ks	0.727 abc	0.248 a	3.73 bcd	3.69 ab	0.43 ab	0.36 cde	1.71 cdefg	2.32 efghi
10 m^3 Ch+P_2+W.Ph+K(s+f)	0.542 cdef	0.256 a	3.68 cde	3.78 ab	0.40 b	0.34 e	1.55 hi	2.57 bcdef
10 m^3 Ch+P_3+Wt.Ph+Ks	0.592 cdef	0.247 a	3.54 defg	3.87 ab	0.40 b	0.38 bcde	1.67 defgh	2.37 defghi
10 m^3 Ch+P_3+Wt.Ph+K(s+f)	0.359 f	0.223 a	3.91 ab	4.00 b	0.40 b	0.41 bcde	1.65 efgh	2.65 bcd
10 m^3 Ch+P_3+W.Ph+Ks	0.785 abc	0.318 a	3.57 defg	3.86 ab	0.40 b	0.44 abcde	1.55 hi	2.42 defgh
10 m^3 Ch+P_3+W.Ph+K(s+f)	0.655 bcd	0.262 a	3.61 cdef	3.98 a	0.46 ab	0.44 abcde	1.72 bcdef	2.55 bcdefj
20 m^3 Ch+P_1+Wt.Ph+Ks	0.614 cde	0.261 a	3.51 efgh	3.73 ab	0.41 b	0.46 abc	1.76 bcdef	2.60 bcde
20 m^3 Ch+P_1+Wt.Ph+K(s+f)	0.695 abcd	0.280 a	3.56 defg	3.77 ab	0.41 b	0.38 bcde	1.75 bcdef	2.62 bcd
20 m^3 Ch+P_1+W.Ph+Ks	0.563 cdef	0.260 a	3.28 i	3.80 ab	0.49 ab	0.39 bcde	1.79 bcde	2.60 bcde
20 m^3 Ch+P_1+W.Ph+K(s+f)	0.599 cde	0.234 a	3.26 i	3.92 ab	0.39 b	0.38 bcde	1.55 hi	2.42 defgh
20 m^3 Ch+P_2+Wt.Ph+Ks	0.734 abc	0.256 a	3.24 i	3.95 a	0.44 ab	0.48 ab	1.75 bcdef	2.55 bcdefg
20 m^3 Ch+P_2+Wt.Ph+K(s+f)	0.653 bcd	0.283 a	3.49 efgh	3.99 a	0.47 ab	0.39 bcde	1.57 gh	2.27 ghij
20 m^3 Ch+P_2+W.Ph+Ks	0.565 cdef	0.271 a	3.72 bcd	3.95 a	0.49 ab	0.42 abcde	1.86 ab	2.52 bcdefg
20 m^3 Ch+P_2+W.Ph+K(s+f)	0.919 a	0.414 a	4.06 a	4.10 a	0.53 a	0.52 a	1.67 defgh	2.95 a
20 m^3 Ch+P_3+Wt.Ph+Ks	0.470 def	0.288 a	3.92 ab	4.01 a	0.43 ab	0.48 ab	1.80 bcd	2.47 cdefgh
20 m^3 Ch+P_3+Wt.Ph+K(s+f)	0.610 cde	0.320 a	3.91 ab	4.05 a	0.44 ab	0.48 ab	1.95 a	2.72 bc
20 m^3 Ch+P_3+W.Ph+Ks	0.674 bcd	0.328 a	3.78 bc	4.02 a	0.45 ab	0.45 abcd	1.85 abc	2.75 abc
20 m^3 Ch+P_3+W.Ph+K(s+f)	0.861 ab	0.394 a	3.70 cde	3.98 a	0.50 ab	0.43 abcde	1.95 a	2.80 ab

Ch Chicken manure P_1 25 kg/fed. P_2o_5 P_2 50kg/fed. P_2o_5 P_3 75 kg /fed. P_2o_5
Wt.Ph Without phosphorien W.Ph With phosphorien
Ks 72 kg/fed. K_2O (soil fertilization) K(s+f) 60 kg K_2O/fed (soil fertilization + 1% K_2O/fed. foliar fertilization)

Table 4: Weight loss percentage after one, three and six months of garlic as affected by combination among chicken manure, phosphorus levels, phosphorien and potassium fertilizers during 2003/2004 and 2004/2005 seasons.

Characters / Treatments	Weight loss percentage after one month				Weight loss percentage after three months				Weight loss percentage after six months			
	2003/2004		2004/2005		2003/2004		2004/2005		2003/2004		2004/2005	
10 m^3 Ch+P_1+Wt.Ph+Ks	1.90	h	3.78	f	6.76	j	7.73	g	16.53	h	17.40	d
10 m^3 Ch+P_1+Wt.Ph+K(s+f)	1.43	j	0.98	n	6.25	k	5.90	k	15.42	k	15.06	g
10 m^3 Ch+P_1+W.Ph+Ks	1.62	i	2.38	g	6.76	j	7.16	h	17.06	g	17.41	d
10 m^3 Ch+P_1+W.Ph+K(s+f)	2.00	g	1.88	j	6.75	j	7.13	h	14.25	m	14.60	gh
10 m^3 Ch+P_2+Wt.Ph+Ks	0.96	l	0.98	n	9.75	E	6.10	jk	19.00	c	15.70	f
10 m^3 Ch+P_2+Wt.Ph+K(s+f)	2.25	e	0.78	p	7.25	h	5.81	k	16.00	j	14.70	g
10 m^3 Ch+P_2+W.Ph+Ks	3.00	b	2.28	h	5.75	l	4.80	m	13.25	p	13.00	i
10 m^3 Ch+P_2+W.Ph+K(s+f)	2.75	c	1.98	i	10.00	d	8.10	f	20.00	a	18.30	c
10 m^3 Ch+P_3+Wt.Ph+Ks	1.04	l	1.48	k	5.62	m	6.30	g	13.91	n	14.50	gh
10 m^3 Ch+P_3+Wt.Ph+K(s+f)	1.90	h	5.09	bc	7.34	h	11.88	b	14.20	m	18.40	c
10 m^3 Ch+P_3+W.Ph+Ks	2.32	e	5.18	b	10.46	c	14.70	a	13.40	o	17.50	d
10 m^3 Ch+P_3+W.Ph+K(s+f)	1.60	i	0.88	o	8.00	g	8.40	f	17.60	f	17.94	cd
20 m^3 Ch+P_1+Wt.Ph+Ks	1.50	j	5.08	c	5.75	i	10.90	c	14.75	l	19.40	b
20 m^3 Ch+P_1+Wt.Ph+K(s+f)	3.50	a	5.28	a	7.00	i	11.20	c	17.00	g	20.75	a
20 m^3 Ch+P_1+W.Ph+Ks	1.25	k	3.98	e	5.00	n	5.30	l	16.25	i	16.50	e
20 m^3 Ch+P_1+W.Ph+K(s+f)	1.43	j	1.23	i	6.76	j	5.20	l	14.75	l	12.40	j
20 m^3 Ch+P_2+Wt.Ph+Ks	2.50	d	0.98	n	11.50	b	6.80	i	20.00	a	15.75	f
20 m^3 Ch+P_2+Wt.Ph+K(s+f)	2.13	f	1.08	m	10.01	d	9.80	d	19.40	b	19.14	b
20 m^3 Ch+P_2+W.Ph+Ks	1.00	l	0.73	p	8.00	g	7.30	h	18.00	d	17.37	d
20 m^3 Ch+P_2+W.Ph+K(s+f)	2.00	g	0.58	q	8.00	g	4.70	m	16.00	j	12.08	j
20 m^3 Ch+P_3+Wt.Ph+Ks	2.75	c	1.08	m	12.50	a	11.75	b	14.75	l	14.00	h
20 m^3 Ch+P_3+Wt.Ph+K(s+f)	1.00	l	4.83	d	4.50	o	8.98	e	12.75	q	16.28	ef
20 m^3 Ch+P_3+W.Ph+Ks	3.00	b	0.88	o	10.00	d	9.56	d	18.00	d	17.60	d
20 m^3 Ch+P_3+W.Ph+K(s+f)	2.50	d	0.74	p	8.25	F	7.75	g	17.75	e	17.30	d

Ch Chicken manure **P_1** 25 kg/fed. P_2o_5 **P_2** 50 kg/fed. P_2o_5 **P_3** 75 kg /fed. P_2o_5

Wt.Ph Without phosphorien **W.Ph** With phosphorien

Ks 72 kg/fed. K_2O (soil fertilization) **K(s+f)** 60 kg K_2O/fed (soil fertilization + 1% K_2O/fed foliar fertilization)