*J. Plant Production, Mansoura Univ., Vol. 3 (6): 957 - 970, 2012*

# GARLIC PRODUCTION IN CALCAREOUS SOIL AS AFFECTED BY GENOTYPES AND POPULATION DENSITY

**Ahmed, S.I.**
**Vegetable Res. Dept. Hort. Res. Inst., Agric. Res. Center,Giza, Egypt.**

## ABSTRACT

This experiment was conducted at the private farm of Mr. Mohamed El-Soony under the official supervision of Faculty of Agriculture, Minia University and Sids Horticulture Research Station, Agricultural Research Center, Giza, Egypt, during the two successive winter seasons of 2007/2008 and 2008/2009 in calcareous sandy soil of the new reclaimed area in west Beni - Suef conditions under a drip irrigation system. The objective of this study was to determine the effect of plant density on growth, yield and yield components of four garlic genotypes. Genotypes were grown in the field at two plant densities (60 and 90 plants / $m^2$). As plant density increased, total fresh and cured yield increased from 7.99 to 10.37ton per Fed., and from 4.52 to 5.66 ton per Fed., respectively. Fresh weight of individual plants, bulb fresh weight, bulb dry matter percentage, and cured bulb weight and bulb diameter characteristics was decreased significantly as population density increased. No significant differences among the tested treatments for number of cloves per bulb. Eggaseed 1 had the highest total yield, whereas the Egyptian cultivar had the lowest. In addition, there were significant interactions between plant density and genotypes for the total fresh and cured yield. Based on the obtained results it could be concluded that for maximizing garlic yield, clone St 133 should be grown at 90 plants $m^2$ under fertigation system in the calcareous soil in the west of Beni Suef and similar conditions.

**Keywords:** Garlic(*Allium sativum* L.), genotypes, plant density, yield, sandy soil, drip irrigation.

## INTRODUCTION

Garlic is one of the most cash generating crops for Egyptian farmers. The overall production and the garlic area in the valley land are not great enough; consequently, the Egyptian government is pressing hard to increase the area and production through reclaimed land and applying new culture technology. However, one of the major production problems is improper agronomic practice used by farmers. Appropriate agronomic management has an undoubted contribution in increasing garlic yield. The optimum level of any agronomic practice such as plant population varies with environment, purpose of production and cultivar. Thus it is very difficult to give general recommendations that can be applied to the different soil characteristics of the new reclaimed area where major growing area of vegetables are existing. So that, to optimize garlic productivity in specific conditions, full package of information is required (England, 1991).

Plant density is one of this packages that need to be optimized. It is a vulnerable way of controlling bulb size, shape and yield in garlic. Higher yield and better control over bulb size could be obtained of cloves planted at optimum density (El-Beheidi *et al.*, 1983; Abd El – Hameid *et al.*, 1991; and Kilgori *et al.,* 2007). The demand for high quality fresh market garlic continues to increase as foreign market and local consumers seek to purchase the Egyptian garlic (Gad El Hak and Abd El- Mageed, 2000).

The identification of the right population density that improves garlic yield quantity and quality may help garlic producer's extent their cultivars area in the new reclaimed land. Choosing cultivars and management technique will help growers to maximize garlic production under the fertigation systems as reported by Nassar *et al.* (1972); Maksoud *et al*.(1983); El-Sawah (1990); Hussein *et al.*(1995). However, Aly (2010) showed that garlic yield under Assiut conditions of 12 garlic ecotypes ranged from 4.26 to 12.03 ton /fed. Also, Tantawy (2010) reported that the six genotypes varied significantly and then fresh yield across three growing seasons ranged from 5.923 for Egyptian to 10.083 ton/ fed., for Egaseed 1.

In Egypt, effect of genotypes on garlic productivity was studied in most of the Egyptian governorates under furrow irrigation systems.

The present study aimed to find out the optimum plantation density of different garlic genotypes to achieve maximum yield under new reclaimed calcareous soil conditions using the fertigation system.

## MATERIALS AND METHODS

The present experiment was conducted at the private farm of Mr. Mohamed El-Soony under the official supervision of Faculty of Agriculture, Minia University and Sids Research Station, Agricultural Research Center, Giza, Egypt, during the two successive winter seasons of 2007/2008 and 2008/2009 in calcareous sandy soil. The source and bulb visual color of the used genotypes are shown in Table 1.

The physical and chemical properties of this soil are presented in Table 2.

**Table 1: Source and bulb visual color of the used genotypes.**

| Genotypes | Source | Bulb skin Color |
|---|---|---|
| Eggaseed 1 | Egyptian Agriculture Company for seed Production (EGAS) | Purple |
| Clone St 133 | Egyptian Agriculture Company for seed Production (EGAS) | White |
| Egyptian | Egyptian landrace from Sids Research Station | White |
| Sids 40 | Sids Research Station, Agric.Res. Center, Giza, Egypt. | Purple |

**Table 2:Physical and chemical properties of the soil used for growing garlic varieties before using any fertilizers.**

| Component | Sand % | Silt% | Clay% | Soil Texture | PH | E.C. ds/m | Total CaCo3 % |
|---|---|---|---|---|---|---|---|
| First season | 92.3 | 3.1 | 4.6 | Sandy | 8.2 | 1.2 | 9.5 |
| Second season | 90.5 | 2.9 | 6.6 | Sandy | 8.0 | 1.4 | 10.4 |

The experimental field was ploughed and pulverized. Twenty $m^3$ farmyard manure, ammonium sulphate (20.5% N) at the rate of 100 kg/fed., super phosphate (15.5%) at the rate of 300 kg/feddan, sulpher at the rate of 100 kg/fed., respectively, were added during the soil preparation. Then the soil was formed into beds (50 meters long and one meter wide). The bed surface was carefully leveled as possible. Irrigation pipes were hand–laid on beds to the end of the experiment. The experiment was conducted in split plots using a Randomized Complete Block Design (RCBD) with four replications. Plant density was assigned as the main plots and cultivars in the sub-plots. Area occupied by a subplot was 10x1m. Two plant densities viz 60 and 90 plants per square meter were tried on four garlic cultivars namely Eggaseed-1, Sids-40, clone St133 and Egyptian. Drip irrigation and fertigation were adopted uniformly as recommended by the Egyptian Ministry of Agriculture for garlic production year book, 1999).

Pregerminated cloves of the four cultivars were planted on the 10$^{th}$ and 16$^{th}$ of October in the first and second seasons, respectively. The total amount of irrigation water which were added to the experimental plots along the growing season is shown in the following table by the Egyptian Ministry of Agriculture for garlic production year book, 1999).

| Months | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. |
|---|---|---|---|---|---|---|
| Amount of water $m^3$/fed. /day | 9.45 | 8.40 | 5.04 | 6.30 | 10.50 | 12.60 |

Also, the following amounts of fertilizers g /$m^3$ were added .

| Fertilizers \ Months | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. |
|---|---|---|---|---|---|---|
| Ammonium nitrate | 400 | 400 | 350 | 300 | 300 | 250 |
| Phosphoric acid | 100 | 100 | 100 | 120 | 120 | 120 |
| Potassium sulphate | 700 | 700 | 700 | 700 | 650 | 650 |
| Magnesium sulphate | 250 | 250 | 250 | 250 | 250 | 250 |
| Nitric acid | 100 | 100 | 75 | 75 | 75 | 75 |

Other Horticulture practices recommended for garlic production were followed. Data were recorded at harvesting for plant height, leaves number, fresh weight of whole plant, bulb fresh weight, 70 C° – oven dry weight of the plant vegetative growth without bulb, 70 C° - oven dry weight of bulbs and bulbing ratio. After curing for 21 days from harvesting, bulb diameter, bulb weight, clove number/bulb and single clove weight, were determined. Also, fresh yield and total cured yield for grade A (> 4.0 cm diameter) of bulbs were estimated according to the European standards.

**Statistical analyses.**

Analysis of variance and Duncan means separation tests using MSTST C Ver. 4 software were used to compare the collected data (MSTATC, 1985*).*

## RESULTS AND DISCUSSION

**1- Plant height.**

Cultivars varied significantly from each other with respect to plant height in both seasons. The highest values were recorded in clone St133 followed by cv. Egyptian without significant differences. The shortest plants were recorded in cv. Sids-40 and Eggaseed-1, respectively. Both cultivars attained statistically similar plant height but differed significantly from the other two cultivars. Significant variations were observed in plant height as reported by Tantawy (2010).

Significant values in plant height were observed with increased plant population. High plant density (90 plants $m^2$) had significantly taller plants during both years plants than that of wider plant densities (60 plants/m2). Cumulative effect of cultivars and plant densities was significant in both years, plants of maximum height values were recorded in clone St133 followed by Balady without significant differences when grown in plots with higher population.

**Table 3: Plant height (cm) of four garlic cultivars as affected by plant density and their interactions under new reclaimed soil in two successive winter seasons.**

| Main effect | Plant height (cm.) | |
|---|---|---|
| | **First season** | **Second season** |
| **Cultivars** | | |
| **1-Eggaseed-1** | 83.96C | 86. 80C |
| **2-Sids- 40** | 77.80D | 81.57D |
| **3-St 133** | 95.14A | 102. 56A |
| **4-Egyptian** | 92.45AB | 100. 51AB |
| **Plant density** | | |
| **1-60 plants/m$^2$** | 88.25B | 86.43B |
| **2-90 plants/m$^2$** | 93.12A | 92.61A |
| **Interaction** | | |
| **1x1** | 84.85f | 87.30e |
| **1x2** | 86.80e | 86.80f |
| **2x1** | 78.37h | 77.22g |
| **2x2** | 81.30g | 81.86h |
| **3x1** | 96.04c | 94.22c |
| **3x2** | 102.67a | 102.45a |
| **4x1** | 93.73d | 91.17d |
| **4x2** | 101.69ab | 99.32ab |

**Means within each column followed by the same letter are not statistically different at 0.05 level (Duncan's range test).**

**2- Number of leaves per plant.**

No significant differences in this trait were noticed among cultivars during both years. Plant densities insignificantly influenced leaves number in both seasons. The interaction among the studded factor was insignificant. Variation in number of leaves is due to genetic variations. But slight increase in number of leaves was observed in wider spacing in the first season (10.84 vs 10.59 leaves) and in narrower spacing in the second season (10.82 vs. 10.77 leaves).

**Table 4: Leaves number/plant of four garlic cultivars as affected by plant density and their interactions under new reclaimed soil in two winter successive seasons.**

| Main effect | Number of leaves per plant | |
|---|---|---|
| | First season | Second season |
| **Cultivars** | | |
| **1-Eggaseed-1** | 10.87 A | 10.97 A |
| **2-Sids- 40** | 10.86 A | 10.96 A |
| **3-St 133** | 10.76 A | 10.52 A |
| **4-Egyptian** | 10.71 A | 10.36 A |
| **Plant density** | | |
| **1-60 plants/m$^2$** | 10.84 A | 10.77 A |
| **2-90 plants/m$^2$** | 10.59 A | 10.82 A |
| **Interaction** | | |
| **1x1** | 10.87 a | 10.87 a |
| **1x2** | 10.85 a | 11.10 a |
| **2x1** | 10.92 a | 10.79 a |
| **2x2** | 10.80 a | 11.12 a |
| **3x1** | 10.75 a | 10.77 a |
| **3x2** | 10.50 a | 10.55 a |
| **4x1** | 10.80 a | 10.62 a |
| **4x2** | 10.22 a | 10.50 a |

**Means within each column followed by the same letter are not statistically different at 0.05 levels (Duncan's range test).**

### 3-Fresh weight of whole plant (g).

Growing temperature, day length and solar reaction differ from year to year. Thus some traits remain consistent and others may change when garlic is replanted in similar conditions (Waterer and Schmitz, 1994). The effects of growing cultivars were significant. The highest value of fresh weight was obtained from growing the purple cv. Eggaseed - 1 in both years followed by the white clone St133. Heavier plants were produced from lower population plots when compared with that of higher population. The impact of plant density on the plant growth should be considered in the degree of competition under which evaluation for performance of entries should be applied. Low planting density (60 plants/m$^2$) produced high values of plant weight (154.00 g) against the lighter weight (137.87g) from high density planted plots (90 plants/m$^2$). Plants size variability is directly related to neighbor-hood competition in which the growth of an individual depends on the number, size and proximity of neighbors. Generally, there is a negative relationship between plant density and plant–to–plant uniformity (Kilgori *et al*. 2007). Concerning effect of cultivars and plant densities in both years, plants of maximum height fresh weight of whole plant (g) values were recorded in cv. Eggaseed -1 followed by clone St133 when grown in plots with lower population.

**Table 5: Fresh weight of whole plant (g) of four garlic cultivars as affected by plant density and their interactions under new reclaimed soil in two winter successive seasons**

| Main effect | Fresh weight of whole plant g / plant | |
|---|---|---|
| | First season | Second season |
| **Cultivars** | | |
| **1-Eggaseed-1** | 154.37 A | 151.75A |
| **2-Sids- 40** | 138.37C | 141.00C |
| **3- St 133** | 150.37B | 144.87B |
| **4-Egyptian** | 140.63D | 134.37D |
| **Plant density** | | |
| **1-60 plants/m$^2$** | 154.00A | 149.12A |
| **2-90 plants/m$^2$** | 137.87B | 136.87B |
| **Interaction** | | |
| **1x1** | 164.00a | 160.75a |
| **1x2** | 144.75d | 142.75de |
| **2x1** | 141.50e | 143.00cd |
| **2x2** | 135.25f | 139.00ef |
| **3x1** | 157.00b | 148.75b |
| **3x2** | 143.75de | 141.00de |
| **4x1** | 153.50c | 144.00c |
| **4x2** | 127.75g | 124.75g |

**Means within each column followed by the same letter are not statistically different at 0.05 levels (Duncan's range test).**

### 4- Bulb cured weight percentage (g).

Bulb dry weight percentage was significantly affected by cultivars and population density (Table 6). The interaction cultivars x plant density showed significant effects. This may reflects the good adaptability of the tested genotypes. Also these results indicated that differences in bulb dry weight percentage were consistent from cultivar to cultivar.

Waterer and Schmite, (1994) and Gvozdenovic- Varga *et al*. (2002) stated that bulb mass is highly correlated with environmental factors.

In conclusion, bulb dry weight percentage differences among genotypes changed by plants density. The genotypes produced relatively above – average weight in low – population enviroments. The order of their bulb dry weight was Eggaseed –1> Sids- 40> clone St133> Egyptian. Therefore, Eggaseed–1produced relatively bulb dry weight heavier percentage and was not sensitive to environments These results disagreed with those of Aly (2010) who reported that bulb dry weight was increased with increasing plant density.

**Table 6: Bulb dry weight percentage of four garlic cultivars as affected by plant density and their interactions under new reclaimed soil in two successive winter seasons.**

| Main effect | Bulb dry weight percentage | |
|---|---|---|
| | First season | Second season |
| **Cultivars** | | |
| **1-Eggaseed1** | 26.62 A | 27.49A |
| **2-Sids 40** | 25.20B | 25.97B |
| **3- St 133** | 22.69C | 22.41C |
| **4-Egyptian** | 21.30D | 21.22D |
| **Plant density** | | |
| **1-60 plants/m$^2$** | 24.92A | 25.37A |
| **2-90 plants/m$^2$** | 22.99B | 23.18B |
| **Interaction** | | |
| **1x1** | 27.75a | 29.17a |
| **1x2** | 25.50c | 25.80c |
| **2x1** | 26.32b | 27.65b |
| **2x2** | 24.07d | 24.30d |
| **3x1** | 23.47e | 23.17e |
| **3x2** | 21.90g | 21.65f |
| **4x1** | 22.12f | 21.47 fg |
| **4x2** | 20.47h | 20.97h |

**Means within each column followed by the same letter are not statistically different at 0.05 level (Duncan's range test).**

### 5- Bulbing ratio.

The photoperiods, temperature and light of low red - ratio are the factors which control bulbing in garlic (Brewester, 2008). Data presented in Table 7 indicated significant differences among cultivars in bulbing ratio. The Egyptian cv. gave the lower bulbing ratio than those of clone St133, Sids-40 and Egseed-1 in both seasons respectively. This indicated that Egaseed-1 cv. was more earlier in maturity then the other cultivars in both seasons.

With regard to the effect of the studied plant density on bulbing ratio, there are significant differences in both seasons. (90 plants / m$^2$) gave the earlier plants, with insignificant differences (60 plants / m$^2$) in the second season only.

In addition, there are insignificant differences between the mean values of the interactions of cultivars and plant density in both seasons.

### 6- Cured bulb diameter.

One challenge of garlic production in the Upper Egypt especially for exporting to foreign markets is to mature the crop within a relatively short season. In this region, garlic producers seek the shifting from vegetative to bulbing stage in the right time to assure adequate time for developing larger bulbs. However, the genetics background of the cultivated genotypes shifts nutrients resources to developing larger bulbs. Growing season influenced bulb – diameter significantly. Also the effects of genotypes and plant density were significant in this study. Increasing bulb diameter is observed in the genotype Eggaseed- 1 with planting density of 60 plants per square meter in both seasons Table 8.

**Table 7: Bulbing ratio of four garlic cultivars as affected by plant density and their interactions under new reclaimed soil in two successive winter seasons**

| Main effect | Bulbing ratio | |
|---|---|---|
| | First season | Second season |
| **Cultivars** | | |
| **1-Eggaseed-1** | 0.29 A | 0.29 A |
| **2-Sids -40** | 0.28B | 0.25 B |
| **3- St 133** | 0.25C | 0.24BC |
| **4-Egyptian** | 0.24C | 0.23 C |
| **Plant density** | | |
| **1-60 plants/m$^2$** | 0.24B | 0.25 A |
| **2-90 plants/m$^2$** | 0.28A | 0.25 A |
| **Interaction** | | |
| **1x1** | 0.26 a | 0.29 a |
| **1x2** | 0.33 a | 0.30 a |
| **2x1** | 0.25 a | 0.26 a |
| **2x2** | 0.30 a | 0.24 a |
| **3x1** | 0.24 a | 0.24 a |
| **3x2** | 0.25 a | 0.24 a |
| **4x1** | 0.22 a | 0.22 a |
| **4x2** | 0.25 a | 0.23 a |

**Means within each column followed by the same letter are not statistically different at 0.05 level (Duncan's range test).**

**Table 8: Cured bulb diameter of four garlic cultivars as affected by plant density and their interactions under new reclaimed soil in two successive winter seasons**

| Main effect | Cured bulb diameter(cm) | |
|---|---|---|
| | First season | Second season |
| **Cultivars** | | |
| **1-Eggaseed-1** | 6.09 A | 5.80A |
| **2-Sids- 40** | 5.02B | 4.90B |
| **3- St 133** | 4.61C | 4.35C |
| **4-Egyptian** | 4.20CD | 3.85D |
| **Plant density** | | |
| **1-60 plants/m$^2$** | 5.47A | 4.99A |
| **2-90 plants/m$^2$** | 4.49B | 4.46B |
| **Interaction** | | |
| **1x1** | 6.65a | 6.20a |
| **1x2** | 5.52b | 5.40b |
| **2x1** | 5.62b | 5.12bc |
| **2x2** | 4.42c | 4.67d |
| **3x1** | 5.07b | 4.62de |
| **3x2** | 4.15c | 4.07def |
| **4x1** | 4.52bcd | 4.00def |
| **4x2** | 3.87e | 3.70g |

**Means within each column followed by the same letter are not statistically different at 0.05 level (Duncan's range test).**

**7- Cured bulb weight.**

Data presented in Table 9 indicated that the cured bulb weight (g) of cultivar Egaseed -1 significantly surpassed those of cultivars Sids-40, clone St133 and Egyptian in both seasons respectively. Further more there were significant differences among the studied plant density. The highest values were obtained from (60 plants /m$^2$) density in both seasons.

Concerning effect of cultivars and plant densities interaction, the effect was significant in both seasons; plants of maximum highest values were recorded in cv. Eggaseed -1 when grown in plots with lower population.

**Table 9: Cured bulb weight (g) of four garlic cultivars as affected by plant density and their interactions under new reclaimed soil in two successive winter seasons.**

| Main effect | Cured bulb weight g / plant | |
|---|---|---|
| | First season | Second season |
| **Cultivars** | | |
| **1-Eggaseed-1** | 75.92 A | 73.47A |
| **2-Sids- 40** | 66.35B | 61.96B |
| **3- St 133** | 50.01C | 46.36C |
| **4-Egyptian** | 41.17D | 38.32D |
| **Plant density** | | |
| **1-60 plants/m$^2$** | 65.75A | 61.77A |
| **2-90 plants/m$^2$** | 50.08B | 48.29B |
| **Interaction** | | |
| **1x1** | 82.97a | 79.90a |
| **1x2** | 68.87c | 67.05c |
| **2x1** | 76.67b | 71.10b |
| **2x2** | 56.02d | 52.82d |
| **3x1** | 57.25de | 52.69d |
| **3x2** | 42.77efg | 40.02ef |
| **4x1** | 46.10defg | 43.40fg |
| **4x2** | 36.25h | 33.25efgh |

**Means within each column followed by the same letter are not statistically different at 0.05 level (Duncan's range test).**

**8-Clove number per bulb.**

The analysis of the main effect of this characteristic indicated that the cultivars, plant density and all types of interactions were different insignificantly. Insignificant interactions indicate a high degree of adaptation of garlic genotypes (Yan and Hunt, 1998 and Gvozdanovic *et al*. 2002). The average number of cloves per bulb ranged from 15.05(Eggaseed-1 at 90 plants/m$^2$) to 42.00(Egyptian at 60 plants/m$^2$). Clove number shows significant differences among cultivars. From the results of both years, Egyptian gave the highest number (41.40 cloves/bulb) followed by clone St133 (37.57 cloves/bulb). Eggaseed-1 gave the lowest number (15.19 cloves/bulb) followed by Sids-40 (16.64 cloves/bulb)as shown in Table (10). Garlic market are focusing on low number and big size cloves in the bulb (Gad El Hak and Abd El- Mageed, 2000).

**Table 10: Clove number/bulb of four garlic cultivars as affected by plant density and their interactions under new reclaimed soil in two successive winter seasons.**

| Main effect | Clove number per bulb | |
|---|---|---|
| | First season | Second season |
| **Cultivars** | | |
| **1-Eggaseed-1** | 15.09B | 15.30B |
| **2-Sids- 40** | 16.36B | 16.92B |
| **3- St 133** | 37.05A | 38.10A |
| **4-Egyptian** | 40.90A | 41.90A |
| **Plant density** | | |
| **1-60 plants/m$^2$** | 27.47A | 28.37A |
| **2-90 plants/m$^2$** | 27.22A | 27.74A |
| **Interaction** | | |
| **1x1** | 15.12b | 15.45b |
| **1x2** | 15.05b | 15.15b |
| **2x1** | 16.37b | 16.92b |
| **2x2** | 16.35b | 16.92b |
| **3x1** | 37.20a | 38.62a |
| **3x2** | 36.90a | 37.57a |
| **4x1** | 41.20a | 42.50a |
| **4x2** | 40.60a | 41.30a |

**Means within each column followed by the same letter are not statistically different at 0.05 levels (Duncan's range test).**

### 9- Clove weight.

Genotypes and population density had significant effects on this quality character. Clove weight ranged from 0.90 g (Egytian at 90 plants/m2 in the first season) to 5.67 g for Eggaseed -1 at 60 plants/m2 in the first season). Cultivar Eggaseed-1 with (5.50 g) in average, was superior to the other tested genotypes followed by cultivar Sids-40 (4.39g) Table 11. However, the maximum clove weight for both cultivars was obtained at density of 60 plants/m2. Genotype x plant density interactions had significant effect on clove weight. The genotypes responded to increasing planting densities. However, the increases in some cultivars were superior to increases in others which explain why the interactions effects occurred. Eggaseed-1 had heavier cloves in both years at lower planting density and this cultivar gave an average of 5.67 g in the first season and 5.12 g in the second. Increasing plant population decreased the clove weight (Abd El-Hameid *et al*., 1991). The high stability of this character among the tested genotypes indicated that the environmental fluctuations as well as plant density did not play a key role in clove number per bulb.

**Table 11: Clove weight (g) of four garlic cultivars as affected by plant density and their interactions under new reclaimed soil in two successive winter seasons.**

| Main effect | Clove weight (g) | |
|---|---|---|
| | First season | Second season |
| **Cultivars** | | |
| **1-Eggaseed-1** | 5.50A | 4.86A |
| **2-Sids- 40** | 4.39A | 4.05A |
| **3- St 133** | 1.31B | 1.09B |
| **4-Egyptian** | 0.94B | 0.81B |
| **Plant density** | | |
| **1-60 plants/m$^2$** | 3.16A | 2.82A |
| **2-90 plants/m$^2$** | 2.90B | 2.58B |
| **Interaction** | | |
| **1x1** | 5.67a | 5.12a |
| **1x2** | 5.32a | 4.60a |
| **2x1** | 4.62a | 4.15a |
| **2x2** | 4.15a | 3.95a |
| **3x1** | 1.37b | 1.17b |
| **3x2** | 1.25b | 1.00b |
| **4x1** | 0.97b | 1.17b |
| **4x2** | 0.90b | 1.00b |

**Means within each column followed by the same letter are not statistically different at 0.05 level (Duncan's range test).**

## 10-Fresh yield (ton/fed).

Total fresh yield per fed. increased significantly by increasing population density of different growing cultivars. The effect of cultivars x population density interactions also verified for fresh yield (Table 12) .In this case, all cultivars were responded significantly to increased population densities. However, the research on managing garlic in row spacing has focused on modeling the response of crop yield and bulb size in response to crop density (Aliudin, 1980; Cardenas Valdovinos: 1986:Abdel-Hameid *et al*.1991; Ismail *et al*, 1996 and Kilgori *et al*. 2007). The total yield per unit area depends not only on the performance of individual plants but also on the growing cultivars and the total number of plants per unit area. Ismail *et al*.(1996) reported that fresh yield ranged from 10.96 to 12.12 Ton/fed. with Egyptian and from 8.37 to 9.92 ton/fed with the Chinese cultivars in alluvial soil conditions at Sids Horticulture Research Station, Beni Sweif governorate. However, the fresh yield of Egyptian cultivar in this sandy soil conditions ranged from 6.82 ton/fed (low population density) to 9.20 ton/fed.(high population density). Eggaseed-1 cultivar gave the highest yield which ranged from 9.47 to 11.57 ton/ fed. The highest values were given by the growing cultivar Eggaseed-1 at 90 plants per square meter in the first season. Similar observations with different garlic genotypes were reported by Kilgori *et al*. (2007).

## 11- Cured yield.

Selecting the suitable genotypes for specific area and understanding the climatic and other environmental factors that affect the genotype performance is extremely important for garlic growers. Cured bulb yield increased significantly with increased plant density in both seasons. However, the bulb size decreased with increasing plant density (Table 13). Garlic bulbs were smaller in high density cultivation (90 plants / m$^2$).

**Table 12: Fresh yield (Ton/fed) of four garlic cultivars as affected by plant density and their interactions under new reclaimed soil in two successive winter seasons**

| Main effect | Fresh yield (Ton/ fed.) | |
|---|---|---|
| | First season | Second season |
| **Cultivars** | | |
| **1-Eggaseed-1** | 10.80A | 10.52A |
| **2-Sids- 40** | 8.82B | 8.77B |
| **3- St 133** | 9.09C | 9.37C |
| **4-Egyptian** | 7.84D | 8.21D |
| **Plant density** | | |
| **1-60 plants/m$^2$** | 7.84B | 7.99B |
| **2-90 plants/m$^2$** | 10.34A | 10.37A |
| **Interaction** | | |
| **1x1** | 9.7abc | 9.47abc |
| **1x2** | 11.85a | 11.57a |
| **2x1** | 7.60cdef | 7.52cdefg |
| **2x2** | 10.05ab | 10.02ab |
| **3x1** | 7.57abcde | 7.95cdef |
| **3x2** | 10.6ab | 10.80ab |
| **4x1** | 6.82cdefg | 7.22cdefgh |
| **4x2** | 8.85bcd | 9.20abcde |

**Means within each column followed by the same letter are not statistically different at 0.05 levels (Duncan's range test).**

Garlic is commonly priced according to bulb sizes. The results of this study may help choose the best genotypes most important for maximizing the profitability of garlic production under the new reclaimed soil conditions in the west desert of middle Egypt.

**Table 13 : Cured yield (Ton/fed) of four garlic cultivars as affected by plant density and their interactions under new reclaimed soil in two successive winter seasons**

| Main effect | Cured yield (ton/ fed) | |
|---|---|---|
| | First season | Second season |
| **Cultivars** | | |
| **1-Eggaseed-1** | 6.49A | 6.24A |
| **2-Sids- 40** | 5.27B | 5.20B |
| **3- St 133** | 4.54C | 4.74C |
| **4-Egyptian** | 3.91D | 4.19D |
| **Plant density** | | |
| **1-60 plants/m2** | 4.41B | 4.52B |
| **2-90 plants/m2** | 5.70A | 5.66A |
| **Interdiction** | | |
| **1x1** | 5.85b | 5.70b |
| **1x2** | 7.12a | 6.77a |
| **2x1** | 4.57c | 4.50d |
| **2x2** | 5.97ab | 5.90bc |
| **3x1** | 3.72ef | 4.07f |
| **3x2** | 5.35fg | 5.40de |
| **4x1** | 3.47fgh | 3.82g |
| **4x2** | 4.35d | 4.55de |

**Means within each column followed by the same letter are not statistically different at 0.05 level (Duncan's range test).**

**Conclusion**

Based on the results obtained, it could be concluded that, for maximizing garlic yield , clone St133 should be grown at 90 plants / $m^2$ under fertigation system in calcareous soil.

## REFERENCES

Abdel-Hameid, A. M.; M. Z. Abdel- Hak and A.Z. Osman (1991): Effect of plant density and nitrogen level on growth and yield of garlic plant. Egypt. J.Appl.Sci.,6(1):69-81.

Agriculture Research Center Giza, Egypt. Year Book (1999): Production and plantation of garlic in you reclaimed desert land. P.P 7 :10

Aliudin (1980): The effect of seed size and plant spacing on garlic production. Bulletin Penelition Hortikultura, Vol. 8: 3-11 (c.f. Hort. Abst., 52: 736).

Aly, Shreen, H. (2010): Growth and yield of some garlic (Allium sativum L.) ecotype as affected by different culture practices under Assiut condition. Ph.D .Thesis, Fac. Agric. Assiut Univ. Egypt.

Cardenas Valdoinos, J.H. (1986): Nitrogen fertilization planting layout in garlic. Proceedings of the Tropical Region, American Society for Horticultural Science 23, 182-186.

Brewester, J.L.(2008):Crop production science in horticulture onions and other vegetable Alliums. CABI is a trading name of CAB international CABI North American office 875 massachusetts avenue 7th floor.

El-Beheidi, M.A.; N.H. Kamel and M. M. Abou EL-Magd (1983): Effect of water regime and nitrogen fertilizers on some mineral contents, yield and amino acid contents of garlic plants. Ann. Agric. Sci., Moshtohor, 19(1):149-169. Egypt.

El - Sawah, M. H.(1990): Study of the effect of ether on growth and yield of two garlic cultivars. Zagazig J. Agric. Res. Vol. 17 (2): 403-410.

England, R. L. (1991): Growing great garlic: The definitive guide for organic gardeners and small farmers. Filaree Farms, Okanogan, WA.226 p. ISBN# 0- 9630850 -1-8.

Gad El – Hak, S.H. and Y.T. Abd El – Mageed (2000): Effect of nitrogen source on growth, yield, nitrate content and storage ability of two garlic cultivars. Minia J. .Res. & Dev. Vol. 20 (1) :115 – 139.

Gvozdanovic- Varga. J., J.M.Vasic, and J. Cervenski(2002): Variability of characteristics of garlic (Allium sativum L.) ecotype ISHS Acta Horticulture 579: 171-175.

Hussein, M. S.; H. M. E l- Saeid and E.A. Omer (1995): Development of growth and yield of some lines of Chinese garlic. Egypt J. Hort 22(1): 19-30.

Ismail, S.A.; A.Z.Osman; A.M. Abd El-Hameid and D.S.Darwish (1996):Effect of ammonia gas in alluvial soil with different rates, population and their interaction on garlic plants (Allium sativum L.) Egyptian J. Appl. Sci.; 11(1) 151-160.

Kilgori, M.J., M.D. Magaji and A.I. Yakubu (2007): Effect of plant spacing and date of planting on yield of two garlic (Allium sativum L.) cultivars in Sokoto, Nigeria. Am. Euras. J. Agric.&Environ. Sci. 2: 143-157.

Maksoud, M.A.; Sherifa Foda; A. El-Gizawi and M.T. El-Sayed (1983): Response of garlic plants to fertilization treatments. Egypt. J. Hort., 10(2): 159-165.

MSTAT-C (1985) A software program for the design management, and analysis of agronomic research experiments (Version 4)Michigan State University, USA.

Nassar, S. H.; S. Moustapha; Sh. Foda; M. Gheta and S. Ghebrial (1972): A better garlic variety for export. Agric. Res. 50(4) 47-58.

Tantawy, I.A.A. (2010): Studied on improving quantitative and qualitative garlic productivity. M. Sc, Dept. Hort., Fac. Agric., Minia University , El-Minia , Egypt.

Waterer, D. and D. Schmitz (1994): Influence of variety and cultural practices on garlic yields in Saktchewan. Canadian J.P. Scineca. Vol.74: 611-614.

Yan,W. and L.A. Hunt (1998):Genotype by environment interaction and crop yield. Plant Breeding Reviews 16: 135-178.

## إنتاج الثوم فى الأراضى الجيرية تحت تأثير الأصناف وكثافة الزراعة

**سعيد إبراهيم احمد**
**مركز البحوث الزراعية - معهد بحوث البساتين- بحوث الخضر.**

أجريت التجربة فى مزرعة خاصة ملك المزارع محمد السنى بإشراف من كلية الزراعة – جامعة المنيا و محطة بحوث البساتين بسدس –مركز البحوث الزراعية – الجيزة –مصر خلال موسمين متتاليين ٢٠٠٧ /٢٠٠٨ و ٢٠٠٨/٢٠٠٩ فى الاراضى الجيرية الرملية فى مناطق الاستصلاح الجديدة تحت ظروف غرب بنى سويف تحت نظام الرى بالتنقيط .الغرض من الدراسة تحديد تأثير كثافة الزراعة على النمو والمحصول ومكونات المحصول على أربع تراكيب وراثية من الثوم وهى ( الصنف البلدى-والسلالة ST133 -ايجاسيد-١ وسدس-٤٠) . كل التراكيب الوراثية زرعت فى الحقل المستديم على كثافتين من الزراعة (٦٠ و٩٠ نبات لكل متر مربع) فوجد الاتى : أنة كلما زادت كثافة الزراعة زاد المحصول الكلى الطازج والجاف فزاد المحصول الطازج من ٧,٩٩ حتى ١٠,٣٣ طن للفدان بينما زاد المحصول الكلى الجاف من ٤,٥٢ حتى ٥,٦٦ طن للفدان. صفات وزن النبات الكلى ووزن البصلة الطازج والنسبة المؤية للمادة الجافة ووزن البصلة الجاف وقطر البصلة هدة الصفات كانت منخفضة المعنوية بزيادة كثافة الزراعة. ووجد أنه لا توجد فروق معنوية بين المعاملات المختبرة فى عدد الفصوص. ووجد ان الصنف أيجا سيد -١ كان أعلى محصولا بينما الصنف البلدى كان اقل محصولا . بالإضافة الى ذلك وجدت فروقاً معنوية فى التداخل بين كثافة الزراعة والأصناف لصفات المحصول الطازج والجاف. ومن النتائج المتحصل عليها يمكن نوصى بزراعة الصنف ايجاسيد-١ والصنف سدس -٤٠على كثافة زراعية ٩٠ نبات لكل متر مربع تحت نظام الرى بالتنقيط فى الاراضى الجيرية تحت ظروف غرب بنى سويف.

**قام بتحكيم البحث**

| | |
|---|---|
| **أ.د / حسام السعيد عبد النبى** | **كلية الزراعة – جامعة المنصورة** |
| **أ.د / أحمد مختار شرارة** | **معهد بحوث البساتين** |