# TRAITS UNDER LABORATORY CONDITIONS TO IDENTIFY GARLIC GENOTYPES SUITABLE FOR ORGANIC AGRICULTURE

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***Abstract***

Twenty one colored- and white-skin garlic genotypes from different places of the Middle Egypt were evaluated in this study for their performance in laboratory and organic farm in newly reclaimed sandy soil. Cloves of all the evaluated genotypes were planted in foam trays filled with beat moss and vermiculite soil 3:1 v/v (without chemical fertilizers). Data of the described characters were recorded after 45 days from plantation in the trays however, yield data were recorded after 180 days from the direct plantation of garlic cloves in the open field (mature stage). Results showed that these genotypes performed well under the organic agriculture in this virgin sandy soil. Most of the simple correlation coefficients values among various growth, biomass after 45 days under laboratory conditions and yield per plant under field conditions for the ten colored and eleven white genotypes for the studied characteristics were positive and significant. Yield of some of these genotypes in the open field was very acceptable and profitable. These results are very promising in which some of these genotypes can be used in organic garlic cultivations under the Middle Egypt conditions and similar environments.

**Key words**: Garlic (*Allium sativum* L.), genotypes evaluation, correlation coefficient, organic production.

## INTRODUCTION

Garlic (*Allium sativum* L.) is considered one of the most important bulb vegetable crops followed to onion (*Allium cepa*L.) in importance (Hamma*et al*., 2013). In Egypt, it has been generally cultivated for both local consumption and exportation to different countries. Egypt ranks the fourth leading country in the world in garlic production (244.626 MT) after China, India and Korea (FAO, 2011 and Abou El-Magd*et al*., 2012). Garlic is commonly used as a spice or in the medicinal purposes. Recent research indicated that fresh and processed garlic may have some benefits on human health such as anti-carcinogenic, anti-fungal and anti- bacterial properties and liquid garlic spray has been used as an insect repellent for other crops (Clemente *et al*., 2011). Moreover, it is currently used for its unique flavor as a food ingredient as well as a dietary supplement (Khanum*et al*., 2004). Among garlic cultivars and clones, the

variation is great and the great differences can be found in all or some garlic characteristics, i.e. plant height, shoot fresh weight, and yield (Osman and Moustafa, 2009).

Evaluation and documentation are important for exploitation of genetic variability for sustainable human benefits. According to Singh and Chand, (2003), evaluation may consist for nothing more than description of the place of origin and a morphological and phonological description of the places of origin or it may consist of information on physiological, biochemical, genetic, and plant pathological characteristics. Evaluation and characterization of plant genotypes provide a rapid, reliable and efficient information to augment the utilization of germplasm.Clonal selection is a major breeding method for garlic, since plant sterility precludes crop improvement by means of cross hybridization and stability and inheritance of specific traits obtained through clonal selection is hard to be monitored by normal genetic analysis (Lampasona*et al*., (2003); Osman and Moustafa, (2009). Therefore, increasing garlic yield and improving bulb quality are essential aim for both growers and consumers; however it depends on many factors especially that influence the plant growth throughout the growth period.

A wide range of adaptability to soil types, temperatures and day length, makes its farming possible from tropics to temperate region (Kumar and Prasad, 2015). Clones of garlic are variable for morphophysiologic traits (Avato*et al*., 1998), and commercial cultivars can be selected and identified on the basis of canopy structure and yield related traits (Zepeda, 1997).

Growing garlic in the newly reclaimed soils is faced by various problems, such as low amounts of available nutrients and poor organic matter content as well as poor hydrophsic, chemical and biological properties of the soil. Organic manures improve chemical, physical and physiochemical properties of soil (Abdel-Moneim*et al*, 2015). Also, excessive amounts of inorganic fertilizers are applied to vegetables in order to achieve a higher yield (Stewart *et al.,*2005 and Abdel-Moneim*et al*, 2015) and maximum value of growth, (Dauda *et al.,* 2008).However, the use of chemical fertilizers alone may cause problems for human health and the environment (Arisha and Bardisi, 1999). Organic manure can serve as alternative practice to mineral fertilizers (Naeem *et al.,* 2006) for improving soil structure and microbial biomass (Suresh *et al*., 2004).

Moreover, these changes improve soil physical structure and water holding capacity, resulting in more extensive root development and enhanced soil micro flora and fauna activity, all of which can increase the levels of micronutrients available to plants (Zeidan, 2007). Hence, the best means of maintaining soil fertility and

productivity could be through periodic addition of organic materials either alone or in addition to mineral fertilizers along with selection and cultivation of the best suitable genotypes. This study was conducted to: 1- evaluate the performance of the early growing stages of 21 local white and colored garlic genotypes for some quality characteristics under the organic system in an organic farm in the Middle Egypt and to 2- study the genotypic and phenotypic correlation coefficients for growth and yield characteristics.

## MATERIALS AND METHODS

This study was conducted at the Laboratory of Vegetables, Department of Horticulture, Faculty of Agriculture, Minia University, Minia, Egypt in co-operation with the Central Laboratory of Organic Agriculture (CLOA) during the winter season of 2012/2013. Twenty one garlic genotypes were planted (11 white-skin and 10 red-skin genotypes). The source and color of the tested garlic genotypes were listed in (Table 1 and Fig.1). The cloves of these genotypes were chosen for size homogenate and were free from all visual defects. These cloves were planted in foam trays in peat moss-vermiculite medium3:1 v/v with $CaCO_3$. After 45 days from planting, samples of 30 plants were randomly taken and their root length, cm (garlic plants were taken out from the foam trays, rinsed in tap water and root lengths were recorded using a ruler), plant height(cm), number of leaves, fresh root weight(g), fresh shoot weight (g), and biomass weight per plant. Also the average yield per plant(g) at harvest time of the two successive seasons (2012/2013 and 2013/2014) was recorded after 180 days from plantation, whereas cloves of all genotypes were planted in a virgin sandy soil at the Organic Farm Agricultural Research Center. Each experimental unit (plot) was 3 x 3.5m.

Prior to planting, garlic bulbs were split into the individual cloves. Organic matter (120 kg nitrogen plant compost) was added at the rate of 10.5ton/feddan. This compost has 1.55% N, 0.82% P and 1% K on the dry matter.

Randomized Complete Block Design (RCBD) was used to design both laboratory and field experiments (Gomez and Gomez, 1984). All obtained data were subjected to the analysis of variances.Means were compared using Duncan Range Test.The coefficient of correlation was also estimated using the MSTAT-C software version 4.0 and Microsoft Excel program version 2010.

Table 1. Source and bulb skin color of the evaluated garlic genotypes

| Colored genotypes | Source |
|---|---|
| Aiat clone 1 | Sids Horticultural Research Station, Agricultural Research Center, Giza, Egypt. |
| Bani Ghany | Sids Horticultural Research Station, Agricultural Research Center, Giza, Egypt. |
| Clone 21 | The Agricultural Egyptian Company for Seed Production, Egypt. |
| Clone 22 | The Agricultural Egyptian Company for Seed Production, Egypt. |
| Egaseed 1 | The Agricultural Egyptian Company for Seed Production, Egypt. |
| Egaseed 2 | The Agricultural Egyptian Company for Seed Production, Egypt. |
| Grower's Clone | Department of Horticulture, Faculty of Agriculture, Minia University, Minia, Egypt. |
| Salaqus-3 | Sids Horticultural Research Station, Agricultural Research Center, Giza, Egypt. |
| Sids 40 Aiat | Sids Horticultural Research Station, Agricultural Research Center, Giza, Egypt. |
| Sids 40 Station | Sids Horticultural Research Station, Agricultural Research Center, Giza, Egypt. |
| White genotypes | Source |
| Clone 5 | Sids Horticultural Research Station, Agricultural Research Center, Giza, Egypt. |
| Clone 10 | Sids Horticultural Research Station, Agricultural Research Center, Giza, Egypt. |
| Clone 18 | Sids Horticultural Research Station, Agricultural Research Center, Giza, Egypt. |
| Clone 22 | Sids Horticultural Research Station, Agricultural Research Center, Giza, Egypt. |
| Clone 24 | The Agricultural Egyptian Company for Seed Production, Egypt. |
| Clone 25 | The Agricultural Egyptian Company for Seed Production, Egypt. |
| Egaseed clone | The Agricultural Egyptian Company for Seed Production, Egypt. |
| Egyptian | Department of Horticulture, Faculty of Agriculture, Minia University, Minia, Egypt. |
| Elwady | Sids Horticultural Research Station, Agricultural Research Center, Giza, Egypt. |
| Al-Al-Owainat | Sids Horticultural Research Station, Agricultural Research Center, Giza, Egypt. |
| Salaqus-3 | Sids Horticultural Research Station, Agricultural Research Center, Giza, Egypt. |

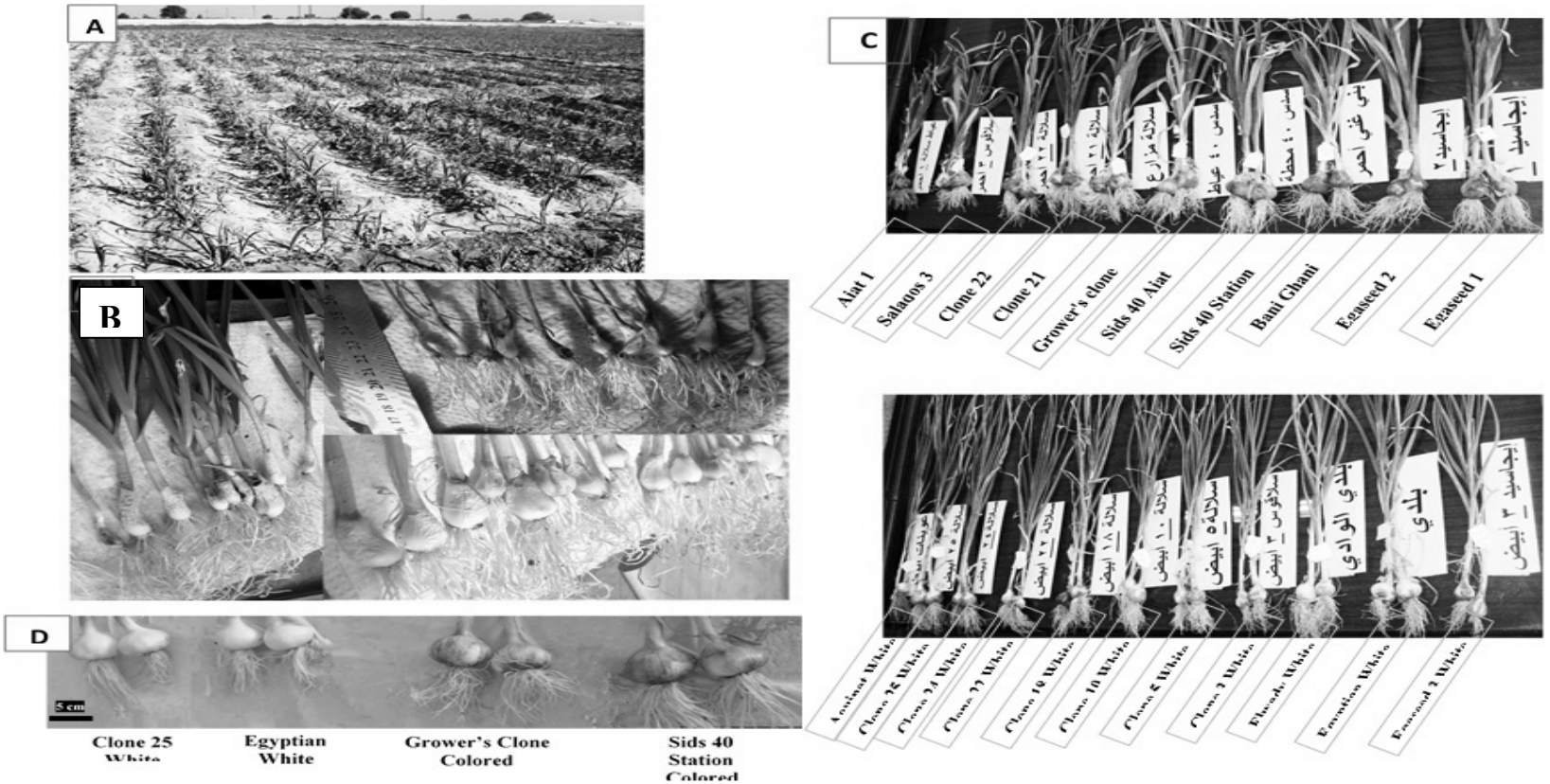


Fig1. Photos of garlic plants and bulbs.**A**: an overview of the experiment shows garlic plants grown in the open organic field in the organic farm. **B**: white and colored garlic seedlings at 45 days.**C**: whole plants of all evaluated garlic genotypes at 120 days from planting. **D**: white and colored bulbs (baby garlic) of green garlic after removing the outer skin.

## RESULTS

Results of garlic genotypes performance are described in Fig (1) and Tables (1 and 2). The simple correlation coefficient among genotypes is described in Tables (3, 4, 5, and 6). Data of the following characters are recorded after planting the cloves of all studied genotypes at 45-day old seedlings. Yield/plant mean values were recorded after harvesting the plants at 180-day old.

**Seedlings root length(cm)**

Data in Table (2) describe the root length characteristic in which, Clone 25, Sids 40 and Al-Al-Owainatclones showed the significant highest values (10.35, 10.24 and 10.17 cm, respectively). While, Bani Ghany clone showed the shortest roots (5.92 cm). Other cultivars and clones showed high values of root length, too when compared to Clone 25, Sids 40 and Al-Al-Owainatgenotypes with insignificant differences among them.

**Seedlings height (stems length) cm**

Egaseed 2 and Sids 40 showed the significant highest values of seedlings height (28.95 and 28.74 cm, respectively) and other genotypes also showed high values of seedlings height when compared to these two cultivars with insignificant differences among them. On the contrary, Clone 22 (red) and Clone 21 (red) showed the lowest values (19.67 and 19.75 cm, respectively) as described in (Table 2).

**Seedlings root weight (g)**

As shown in Table (2), Sids 40 showed the significant highest root weight value (0.90 g), while the lowest root weight value was obtained fromSalaqus 3 and Clone 22 clone (0.46 and 0.47 g, respectively). On the other hand, other cultivars and clones showed high values of the same characteristic comparing to cultivar Sids 40 with insignificant differences among those genotypes (Table 2).

**Seedlings shoot weight (g)**

Garlic seedlings vegetative shoot weight after 45 days from clove plantation were recorded and Egaseed 2 showed the highly significant vegetative shoot weight value (3.99 g), while the lowest value was obtained from Clone 10 (0.96 g). On the other hand, other genotypes showed high values of seedling shoot weight comparing to Egaseed 2 with insignificant differences among them(Table 2).

**Biomass/plant (g)**

Data in Table (2) showed that the garlic biomass weight/plant after 45 days from cloves plantation Sids 40 had the significant highest value of the biomass weight (5.16 g), while the lowest biomass weight value was obtained from both Clone 10 and Salaqus 3 clones (1.58 and 1.59 g, respectively). Other cultivars and clones showed

high values of biomass/plant comparing to Sids 40 with insignificant differences among them. It is clear from this characteristic that the colored garlic genotypes had higher values of biomass comparing to the white genotypes.

**No of leaves/plant**

As shown in Table (2) significant differences in No of leaves/seedling were noticed among the evaluated garlic genotypes after 45 days from clove plantation. Furthermore, Clone 22 (white) showed the highest mean value of leaves number (5.03), while Clone 22 (red) and Clone 21 showed the lowest values (3.79 and 3.88, respectively). On the other hand, other genotypes and clones showed high values of the same characteristic comparing to Clone 22 (white) with insignificant differences among those genotypes.

**Average plant fresh weight at harvest (yield/plant) g**

The average fresh weight (yield) of garlic plants at harvest time differed among the studied genotypes. The colored genotypes showed the highest values which was highly significant in Sids 40, Clone 22 and Egaseed 1 (64.44, 63.89 and 62.78 g, respectively) while Clone 10, Egaseed clone and Al-Al-Owainatshowed the lowest values (41.11 g). Moreover, other cultivars and clones showed values in between genotypes which gave the higher and lower values of this characteristic ( Table 2).

**Simple correlation coefficients**

The simple correlation coefficient values of the colored garlic genotypes showed high significance for all studied characteristics except for yield x No of leaves/plant which was insignificant. Also yield x root length and yield x plant height were significant (Table 3). These characteristics are correlated to each other. Regarding the white-garlic genotypes, most of the correlation coefficient values were highly significant. However, correlations between No of leaves/plant x root length, shoot weight x root length, biomass x root length and yield x root length were insignificant (Table 4). When the correlation was done for the total or average of all the studied genotypes data showed that all the correlation coefficient values were almost highly significant except for yield x root length and yield x No of leaves/plant (Table 5 and 6).

Table 2. Mean performance of different characteristics in 21 colored and white garlic genotypes organically grown in newly reclaimed sandy soil

| Genotypes | Skin color | Root[1] length (cm) | Plant height (cm) | Leaves at 45 days | Root weight (g) | Plant fresh weight (g) | Biomass/ plant (g) | Yield/plant (g) |
|---|---|---|---|---|---|---|---|---|
| Aiat" clone 1 " | C | 7.109 fg | 20.86 f-i | 4.026 g-i | 0.510 c-e | 2.439 d-f | 2.96 e-f | 52.22 a-e |
| Bani Ghany | C | 5.924 g | 20.24 g-i | 4.119 f-i | 0.520 c-e | 2.933 b-d | 3.46 c-e | 54.44 a-d |
| Clone 21 | C | 8.711 b-d | 19.75 i | 3.877 i | 0.577 c-e | 2.310 ef | 2.87 e-g | 54.44 a-d |
| Clone 22 | C | 6.702 fg | 19.67 i | 3.786 i | 0.467 e | 1.960 fg | 2.43 f-h | 63.89 a |
| Egaseed 1 | C | 9.898 ab | 25.66 bc | 4.648 a-e | 0.791 ab | 3.219 b | 4.01 bc | 62.78 a |
| Egaseed 2 | C | 8.962 a-c | 28.95 a | 4.213 e-i | 0.777 ab | 3.992 a | 4.63 ab | 60.56 ab |
| Grower's Clone | C | 7.369 d-f | 22.15 d-h | 4.349 d-g | 0.641 c | 2.930 b-d | 3.58 c-e | 55.56 a-e |
| Salaqus-3 | C | 9.413 ab | 23.18 de | 4.841 ac | 0.811 ab | 3.049 bc | 3.86 cd | 52.78 a-d |
| Sids 40 "Aiat" | C | 7.173 fg | 21.27 e-i | 4.691 a-d | 0.489 d-e | 2.659 c-e | 3.16 d-f | 49.44 b-e |
| Sids 40 "Sta+on" | C | 10.24 a | 28.74 a | 4.932 ab | 0.902 a | 3.359 b | 5.16 a | 64.44 a |
| Clone 5 | W | 7.664 c-f | 22.20 d-g | 4.433 c-g | 0.608 cd | 1.567 gh | 2.17 g-i | 47.22 c-e |
| Clone 10 | W | 8.599 b-e | 20.16 hi | 4.228 e-i | 0.481 de | 0.957 i | 1.58 i | 41.11 e |
| Clone 18 | W | 6.914 fg | 23.94 cd | 4.914 ab | 0.606 cd | 1.459 g-i | 2.08 hi | 48.89 b-e |
| Clone 22 | W | 9.898 ab | 26.46 b | 5.026 a | 0.643 c | 1.408 hi | 2.06 hi | 45.00 c-e |
| Clone 24 | W | 7.323 ef | 24.12 cd | 4.182 f-i | 0.531 c-e | 1.307 hi | 1.86 hi | 43.89 de |
| Clone 25 | W | 10.35 a | 24.16 cd | 4.840 a-c | 0.641 c | 1.389 hi | 1.97 hi | 53.89 a-e |
| Egaseed clone | W | 9.821 ab | 23.74 cd | 3.903 hi | 0.530 c-e | 1.236 hi | 1.84 hi | 41.11 e |
| Egyp+an | W | 7.174 fg | 22.36 d-f | 4.561 b-f | 0.612 cd | 1.531 g-i | 2.15 g-i | 61.11 ab |
| Elwady | W | 7.646 c-f | 22.95 de | 4.201 f-i | 0.501 de | 1.268 hi | 1.77 hi | 57.22 a-c |
| Al-Al-Owainat | W | 10.17 a | 22.15 d-h | 4.414 c-f | 0.646 c | 1.292 hi | 1.95 hi | 41.11 e |
| Salaqus-3 | W | 7.906 c-f | 20.95 f-i | 4.340 d-h | 0.464 e | 1.117 hi | 1.59 i | 45.56 c-e |

Table 3. Simple correlation coefficients values among various growth, biomass after 45 days under laboratory conditions and yield per plant under field conditions for the ten colored genotypes

| Character | Root[1] length (cm) | Plant height (cm) | Number of leaves | Root weight (g) | shoot weight (g) | Biomass weight / plant(g) | Yield/plant (g) |
|---|---|---|---|---|---|---|---|
| Root length (cm) | – | – | - | - | - | - | - |
| Plant height (cm) | 0.673** | – | - | - | - | - | - |
| Number of leaves | 0.368** | 0.476** | – | - | - | - | - |
| Root weight (g) | 0.661** | 0.759** | 0.611** | – | - | - | - |
| Shoot weight (g) | 0.314** | 0.633** | 0.510** | 0.736** | – | - | - |
| Biomass weight / plant (g) | 0.432** | 0.693** | 0.548** | 0.781** | 0.851** | - | |
| Yield/ plant (g) | 0.254* | 0.295* | 0.033$^{ns}$ | 0.332** | 0.283** | 0.297** | – |

[1]Means followed by the same letters for each trait are not significantly different at P= 0.05

Table 4. Simple correlation coefficients values among various growth, biomass after 45 days under lab conditions and yield per plantunder field conditions for the 11th white genotypes.

| Character | Root[1] length (cm) | Plant height (cm) | Number of leaves | Root weight (g) | shoot weight (g) | Biomass weight / plant(g) | Yield/plant (g) |
|---|---|---|---|---|---|---|---|
| Root length (cm) | – | – | - | - | - | - | - |
| Plant height (cm) | 0.205* | – | - | - | - | - | - |
| Number of leaves | 0.081$^{ns}$ | 0.450** | – | - | - | - | - |
| Root weight (g) | 0.300** | 0.510** | 0.567** | – | - | - | - |
| Shoot weight (g) | 0.081$^{ns}$ | 0.587** | 0.551** | 0.824** | – | - | - |
| Biomass weight / plant (g) | 0.155$^{ns}$ | 0.581* | 0.527** | 0.879** | 0.953** | - | – |
| Yield/ plant (g) | 0.026$^{ns}$ | 0.223* | 0.207* | 0.260** | 0.385** | 0.344** | – |

[1]Means followed by the same letters for each trait are not significantly different at P= 0.05

Table 5. Simple correlation coefficients values among various growth, biomass after 45 days under lab conditions and yield per plantunder field conditions for the 21th tested genotypes

| Character | Root[1] length (cm) | Plant height (cm) | Number of leaves | Root weight (g) | shoot weight (g) | Biomass weight / plant(g) | Yield/plant (g) |
|---|---|---|---|---|---|---|---|
| Root length (cm) | – | – | - | - | - | - | - |
| Plant height (cm) | 0.459** | – | - | - | - | - | - |
| Number of leaves | 0.227** | 0.455** | – | - | - | - | - |
| Root weight (g) | 0.456** | 0.660** | 0.543** | – | - | - | - |
| Shoot weight (g) | 0.068$^{ns}$ | 0.395** | 0.229** | 0.636** | – | - | - |
| Biomass weight/plant (g) | 0.168* | 0.483** | 0.293** | 0.711** | 0.927** | - | – |
| Yield/plant (g) | 0.058$^{ns}$ | 0.240** | 0.085$^{ns}$ | 0.340** | 0.422** | 0.409** | – |

[1]Means followed by the same letters for each trait are not significantly different at P= 0.05

Table 6.Simple correlation coefficients values among various growth, biomass after 45 days under laboratory conditions and yield per plant under field conditions using the average values of the 21th genotypes

| Character | Root length[1] (cm) | Plant height (cm) | Number of leaves | Root weight (g) | shoot weight (g) | Biomassweight / plant(g) | Yield/plant (g) |
|---|---|---|---|---|---|---|---|
| Root length (cm) | – | – | – | – | – | - | – |
| Plant height (cm) | 0.567** | – | – | – | – | - | – |
| Number of leaves | 0.388ns | 0.531* | – | – | – | - | – |
| Root weight (g) | 0.612** | 0.763** | 0.576** | – | – | - | – |
| Shoot weight (g) | 0.038ns | 0.378ns | 0.086ns | 0.619** | – | - | – |
| Biomass weight / plant (g) | 0.160ns | 0.485* | 0.197ns | 0.732** | 0.970** | - | – |
| Yield/ plant (g) | -0.096ns | 0.260ns | 0.087ns | 0.439* | 0.648** | 0.653** | – |

[1]Means followed by the same letters for each trait are not significantly different at P= 0.05

## DISCUSSION

The evaluated garlic genotypes performed differently in this study as some of them are colored (originally Chinese types which are adapted to the Egyptian environment) and the others (white garlic genotypes) are Egyptian clones derived from the Egyptian cultivar which is sometimes called "Balady". Kohli andPrabal, (2000) and Sengupta*et al*., (2007) found that there were insignificant differences in correlation between No of leaves/plant and almost other characteristics which is similar to our obtained results.

Our results showed that the studied garlic genotypes differed in their growth parameters at the early growth stage and in yield/plant (whole plant fresh weight). It is known that higher bulb yield may be attributed tocumulative effects of number of leaves per plant, No of cloves/bulb and other characteristics such as bulb diameters as reported by Pandey*et al*., 1996;NurzynskaWierdak, 1997; Singh *et al*.,2002;Shrivastava*et al*., (2004); Raghuwanshi*et al*., 2004 and Anonymous, 2006-2007b). Other yield component characters of these garlic genotypes are recorded and studied elsewhere. In some cases phenotypic correlation coefficients were the same or higher thangenotypic correlation coefficients suggesting that both environmental and genotypiccorrelations in these cases act in the same direction and finally maximize theirexpression at the phenotypic level (Pandey and Singh, 1987).

## CONCLUSION

In a laboratory experiment, 45 day-old seedlings of twenty one (ten colored and eleven white skin) garlic genotypes were evaluated for their performance in foam trays. Also, under organic agriculture condition the correlations among different growth characteristics e.g., root length, shoot length, No of leaves/plant, plant height, and biomass weight along with yield/plant at harvest time (180 days after cloves plantation) were studied. Results under organic system showed that the genotypes differed significantly in their yield. The colored garlic genotypes showed the highest values. Moreover, the correlation coefficient values were positive and significant or high significant meaning these charterstics are correlated to each other except for No. of leaves/plant with other characters.

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## ARABIC SUMMARY

# دراسة معملية لبعض الصفات لتحديد ملائمة بعض التراكيب الوراثية من الثوم للزراعة العضوية

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في تجربة معملية بمعمل فرع الخضر بقسم البساتين بكلية الزراعة بجامعة المنيا بالتعاون مع المعمل المركزي للزراعة العضوية تم تقييم ودراسة صفات الشتلات لعدد ٢١ سلالة وصنف من الثوم الأبيض والملون (١٠ سلالات وأصناف ملونة و١١ سلالة وصنف أبيض) المنتجة عضويا في صواني الفوم في تربة من البيتموس والفيرمكيوليت بنسبة 1:3 حجم/حجم وإضافة كربونات الكالسيوم (CaCO3) في المعمل.دون إستخدام أسمدة كيماوية وأيضا في الحقل دراسة صفات المحصول للنبات (وزن النبات وقت الحصاد) المنتج عضويا في مزرعة عضوية لأرض رملية تزرع لأول مرة بمزرعة الزراعة العضوية –مركز البحوث الزراعية لكل السلالات والأصناف محل الدراسة، حيث تم إضافة الكمبوست النباتي (سماد عضوي) يحتوي علي (١.٥٥%نيتروجين، ٠.٨٢ % فوسفور و ١% بوتاسيوم علي أساس المادة الجافة). بكمية ١٠.٥ طن للفدان (١٢٠ كجم نيتروجين/الفدان). وكذلك تمت دراسة معامل الإرتباط بين هذه الصفات وبعضها وتم أخذ البيانات عن الصفات التالية: إرتفاع النبات، عدد الأوراق/النبات، طول الجذر/النبات، وزن الجذر/النبات، وزن الجزءالخضري/النبات، ووزن النبات كاملا (الكتلة الخضرية) وكذلك المحصول/النبات (وزن النبات عند الحصاد).

وأظهرت النتائج إختلاف السلالات في صفاتها المظهرية وكذلك كان هناك معنوية عالية لمعامل الإرتباط بين الصفات المدروسة وبعضها خاصة بين صفة محصول النبات والصفات الأخري سواء للأصناف أوالسلالات الملونة أو تلك البيضاء أو كل معا عند حساب معامل الإرتباط. وتعتبر هذه النتائج جيدة ومشجعة لزراعة بعض هذه السلالات والأصناف عضويا تحت ظروف محافظة المنيا والظروف البيئية المشابهة.