EVALUATION OF SOME HORTICULTURAL CHARACTERISTICS
AND ALLICIN CONTENT FOR SOME GARLIC GENOTYPES

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ABSTRACT
A field experiment was carried out during the two successive winter seasons of 2017/2018 and 2018/2019 at the Farm of Sids Hort. Res. Station, Agric. Res. Center, Beni–Suief Governorate, Egypt, to evaluate of some five garlic genotypes, namely Egyptian (Balady) and Sids-50 (soft neck garlic white), Sids-40, Eggaseed-1 and Eggaseed-2 (hard neck garlic purple) on some vegetative growth, bulb characteristics and productivity as well as Allicin content in cloves during fresh and cured yield.

The results showed the uppermost plant height, maximum leaves number per plant and longest leaf, highest total plant fresh weight/plant, bulb diameter, both fresh and cured yield/fed. were obtained by Sids-50 genotype in both seasons. Meanwhile, Eggaseed-2 cultivar gave the largest leaf width and bulbing ratio. However, Balday cultivar recorded the highest number of cloves/bulb in both seasons.

The relative increases in cured yield due to Sids-50 genotype were about (6.15 and 22.58 %) over Balady cultivar, (30.18 and 31.03 %) over Sids-40, (15.0 and 24.59 %) over Eggaseed-1 and (68.29 and 80.95 %) over Eggaseed-1 in the 1st and 2nd seasons, respectively.

The maximum concentrations of Allicin content in fresh and cured cloves of garlic were recorded with the two cultivars Eggaseed-2 and Sids-40, while the minimum concentrations were recorded with Sids-50 genotype and Balady cultivar in both growing seasons.

Conclusively: It could be concluded that the highest garlic growth, yield and its components can be achieved from Sids-50 garlic cultivar followed by cv. Balady, and Eggaseed-1 (purple). In order to obtain the highest Allicin content it is recommended to cultivate Sids-40 or Eggaseed-2.

Key words: Garlic, cultivars, Balady Sids-40, Sids-50, Eggaseed-1, Eggaseed-2, growth, yield and Allicin content.
INTRODUCTION

Garlic *Allium sativum* L. belongs to the family Alliaceae (Kilgori et al., 2007), the same family as onions, shallots and leeks which are grown for spices/condiment. Majority of the garlic is sold to the fresh market as a whole, fresh bulbs, green garlic or escapes. Processed products such as garlic spreads or chopped garlic are also sold, but to a lesser extent. It has a higher nutritive value than other bulbs crops and it is the 2nd most widely used member of the *Alliums* species (Abou El-Magd et al., 2012). The major garlic areas are El-Minia and Beni-Suef governorates (Ammar, 2007).

For many countries, various species of the genus *Allium* have been used as vegetables, spices and as folk medicines. Garlic is a common food spice, and is used widely in many parts of the world as a condiment in various prepared food (Ahmed et al., 2001) and is also cultivated for its medicinal properties and this aspect is steadily on the rise worldwide. It lowers total plasma cholesterol, reduces blood pressure and decreases platelet aggregation (Sterling and Eagling, 2001).

Most of the medicinal effects of garlic are attributable to a sulfur compound known as Allicin (Schulz et al., 1998). Allicin of garlic which has antibacterial properties Al-Otayk et al., 2008).

The great variation on the growth and production of different garlic cultivars according to the different locations in Egypt was a wide field for many workers (Gad El-Hak and Abd El-Mageed, 2000, Hassan, 2002, El-Sayed, 2004, Mohamed, 2004, Gowda et al., 2007; Moustafa et al., 2009; Aly, 2010; Dawood et al., 2011; Anwar, 2012; Ahmed, 2013; El-Nagar and El-Zohiri, 2015, Asiya et al., 2017, and Shibana and Jalaja, 2019).

Furthermore, genetic factors can play an important role in differences of Allicin content between ecotypes (Baghalian et al., 2005). Clonal selection of garlic with suitable content of Allicin and agronomical traits is desirable for large-scale culture and drug production. Lee (2005) showed that hardneck garlic (similar to Sids-40. Eggaseed-1 and Eggaseed-2) contains higher Allicin content than soft neck garlic (similar to Balady cultivar and Sids 50 genotype). Camargo et al. (2005) stated that the Allicin content can vary significantly between cultivars, keeping constant of the variability attributed to the climate conditions and dormancy state of the cloves. Raslan et al. (2015) found a significant differences in Allicin content among the two cultivars (Balady and Sids-40), furthermore, cultivar type showed more differences in Allicin content in case of cured mature bulb stage than in fresh premature bulb stage , where cured Sids-40 mature bulbs had higher Allicin content (3.02 mg/g FW) than Balady cv. (2.59 mg/g FW). (Wongsa et al., 2016) observed the differences in
Allicin content, which affected by garlic genotypes, agronomical practices and locations. The amount of Allicin varied from 4.5 to 26.8 mg/ g DW.

Therefore, the objective of the current study was to evaluate of some vegetative growth, bulb characteristics and productivity as well as Allicin content of some garlic genotypes.

MATERIALS AND METHODS

A field experiment was carried out during the two successive winter seasons of 2017/2018 and 2018/ 2019 at the Farm of Sids Hort. Res. Station, Agric. Res. Center, Beni–Suief Governorate, Egypt, to evaluate of some five garlic genotypes, namely Egyptian (Balady) and Sids-50 (soft neck garlic white), Sids-40, Eggaseed-1 and Eggeseed-2 (hard neck garlic purple) on vegetative growth, bulb characteristics and productivity as well as Allicin content in cloves. The genotypes were obtained from Sids Hort. Res. Station. The soil of the experimental field was clay loam in texture. The physical and chemical analysis of the soil was determined according to the methods described by Jakson (1958) as shown in Table (1).

Table (1): Physical and chemical properties of the experimental soil during 2017/18 and 2018/19 seasons (average two seasons).

<table>
<thead>
<tr>
<th>Mechanical analysis</th>
<th>Chemical analysis</th>
<th>Available nutrients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand %</td>
<td>Silt %</td>
<td>Clay %</td>
</tr>
<tr>
<td>21.16</td>
<td>31.34</td>
<td>46.43</td>
</tr>
<tr>
<td>22.12</td>
<td>33.19</td>
<td>44.69</td>
</tr>
</tbody>
</table>

The above mentioned genotypes were arranged in a Randomized Complete Blocks Design (RCBD) with four replicates. The experimental unit area was 6.3 m². It contained three ridges with 3.5m length and 60 cm in width. One ridge was used for the samples to measure vegetative growth and the other ridges were used for yield determination.

Garlic cloves were selected for uniformity in shape and size. The cloves were soaked 12 h in tap water and followed soaked in aqueous sulfur solution
for 30 minutes before planting. The principal target of water and sulfur dipping was to enhance sprouting and to control pests if present on the clove surfaces and then planted at a distance of 10 cm apart in both sides of the ridge on 4th and 10th October in both growing seasons, respectively.

All plots received the recommended dose of N, P and K at the rates of 180 kg/N, 60 kg P₂O₅/fad., and 75 kg K₂O/fed., in the form ammonium sulphate (20.6%), calcium super phosphate (15.5% P₂O₅) and potassium sulphate (48-50% K₂O), respectively. One third of ammonium sulphate, potassium sulphate and all calcium super phosphate were added during soil preparation with farmyard manure (FYM) at 20 m³/fad., while the two third of N and K₂O was added at three portions as soil application by one month intervals beginning one month after planting. The other normal agricultural practices for growing garlic were carried out as commonly followed in district.

Data recorded:

At two weeks before harvesting, ten plants were randomly taken from each experimental plot (170 days after planting) to determine:

**Vegetative growth parameters**

1. Plant height (cm)
2. Number of leaves/plant
3. Leaf length (cm)
4. Leaf width (cm)
5. Fresh weight of whole plant (g).

**At the harvest time:**

Garlic plants were harvested on the first week of April in both seasons (185 days after planting). Total fresh yield (kg/plot) were recorded. All data were converted to ton/fed.

**Cured yield and bulb quality:**

The harvested garlic plants were left to be cured for 21 days and cured plants were weighted. Cured yield (ton/fed.) were calculated. After curing, ten plants from each experimental plot were randomly taken to determine the cured bulb diameter, number of cloves/bulb.

**Determination of Allicin content in fresh and cured cloves:**

Freshly peeled garlic cloves (2g) were chopped and blended for one min in 20 ml water. The results homogenate was allowed to stand for min at room temperature to ensure maximum production of thiosulfates. The chloroform extract was separated dried over anhydrous sodium sulfate and evaporated at 40°C. The residue was re-dissolved in 3 ml aqueous methanol (50%), filtered
through 0.2μm filter and directly injected into HPLC. The HPLC system consisted of reversed phase (C18), 250 X 2.6 mm, 5 μm particle size columns. The mobile phase consisted methanol: water: formic acid (40:60:1) at a flow rate of 1.2 ml/min. The eluate was monitored at a wavelength of 254 nm. Allicin was isolated from garlic extract using preparative silica gel thin layer chromatography using toluene: ethyl acetate (100:30) as developing solvent then identified by spectroscopic data. The resulting spectra were compared with that reported by (Jansen et al., 1987, Lawson et al., 1991 and Cruz-Villalon, 2001). Pure compound was used to prepare calibration curve.

**Statistical analysis:**

Data from both seasons were combined in a single analysis. Analysis of variance and Duncan (1955), means separation tests using MSTST C Ver. 4 software were used to compare the means of the collected data.

**RESULTS AND DISCUSSION**

1. **Vegetative Growth characters:**

   Data presented in Table (2) show clearly that there were a significant differences among the four cultivars (Balady, Sids-40, Eggaseed-1 and Eggaseed-2) and Egyptian genotype (Sids -50) respecting plant height, number of leaves/ plant, both leaf length and width as well as total plant fresh weight (g) in both growing seasons. In this concern, (Sids-50) genotype was the best for plant height (94.2 and 90.0 cm), number of leaves/ plant ( 12.5 and 12.7), leaf length ( 43.7 and 42.2 cm) and total fresh weight / plant ( 149.9 and 154.2 g), followed by Eggaseed-2 for plant height ( 88.9 and 89.8 cm), Eggaseed-1 for number of leaves/ plant ( 12.0 and 12.1) and Baldy cultivar for total fresh weight / plant ( 141.5 and 140.3 g). on the other side, Eggaseed-2 recorded the highest width leaf (3.1 and 3.4 cm), followed by Sids-40 cv. ( 2.2 and 2.5 cm) in both seasons.

   On the other hand, the shortest plant (59.9 and 60.9 cm) with Eggaseed-1, lowest number of leaves ( 11.3 and 11.1 leaf/ plant) and total fresh weight/ plant (125.6 and 127.3 g) with Eggaseed-2, minimum leaf length (32.4 and 27.96 cm) with Sides -40 and leaf width ( 0.9 and 0.8 cm) with Balady cv. In the 1st and 2nd seasons, respectively.

2. Yield and its components:

After 170 days from planting (two weeks before harvest), the obtained data in Table (3) revealed that there were significant differences in bulb diameter, number of cloves/bulb and bulbing ratio among cultivars and the genotype. In this concern, Sids-50 genotype significantly increased bulb diameter (8.5 and 8.0 cm) without significant differences with Balady and Eggaseed-1 in the 2nd season. Number of cloves/bulb were the highest with Balady cultivar (28.0 and 28.3 cloves) in both seasons without significant differences with Sids 50 genotype in both seasons.

Meanwhile, Eggaseed-2 cv. gave the lowest values of bulb diameter (4.6 and 4.0 cm), number of cloves/bulb (13.0 and 12.9 cloves) and gave the highest bulbing ratio than that of other cultivars (0.38 and 0.38) in both seasons. This indicated that Eggaseed-2 cv. was more later in maturity than other cultivars in both seasons. These results are in agreement with those obtained by Anwar (2012), Khan et al. (2018) and Shibana and Jalaja (2019), who reported that number of cloves per bulb was maximized in garlic Balady El-Wady followed by Balady garlic cvs. Bulbs of cvs Sids-40 and Egaseed-2 clone contained the lowest number of cloves in both seasons.

Such data in Table 3 that significantly highest total fresh yield were recorded in Sids-50 garlic genotype (15.4 and 15.7 ton/fed) and cured yield (6.9 and 7.6. ton/fed. in the 1st and 2nd seasons, respectively), followed by cv. Balady (13.7 and 13.2 ton/fed. fresh yield) and (6.5 and 6.2 ton/fed. cured yield, in the 1st and 2nd seasons, respectively), while it was lowest in fresh yield produced by cv. Eggaseed-2 (7.3 and 6.9 ton/fed.) and cured yield (4.1 and 4.2 ton/fed.) in the 1st and 2nd seasons respectively. The remained Sids-40 and Eggaseed-1 cultivars occupied an intermediate position between the maximum and minimum total fresh and cured yield.

The relative increases in cured yield due to Sids-50 genotype were about (6.15 and 22.58 %) over Balady cultivar, (30.18 and 31.03 %) over Sids-40, (15.0 and 24.59 %) over Eggaseed-1 and (68.29 and 80.95 %) over Eggaseed-1 in the 1st and 2nd seasons, respectively. These results are in agreement with those obtained by Asiya et al. (2017) who found that the genotype Yamuna Safed-3 recorded maximum bulb yield per hectare (14.51 t/ha). On the basis of growth and yield parameters Yamuna Safed-3, Yamuna Safed-2, Yamuna Safed-9 and Yamuna Safed-5 produced highest yield when grown under Eastern Dry Zone of Karnataka, Omnalayan and Bhupendra (2018) reported that best results were recorded on all the parameters in variety KS–2 followed by variety G–4 and the minimum were recorded with the genotype Agrifound White. Best results on quality parameters were also recorded in KS–2. Khan et al.(2018) indicated that the NARC-G1 cultivar gave maximum fresh yield (25.6 t/ha), followed by Cultivar
Italian, which gave (22.4 t/ha), while cultivar LehsonGulabi was noted at the bottom and gave (15.2 t/ha). Hence, NARC-G1 cultivar could be utilized in term of better yield and as well as industrial use for value addition purposes. Shibana and Jalaja (2019) stated that the genotype Yamuna safed-3 recorded a highest yield of 1.19Kg/2m2 followed by local cultivar and Ooty-1 (0.90 Kg/2 m² and 0.89Kg/2 m² respectively). While considering both yield and quality aspects in trade, local cultivar, Yamuna Safed-3 and Ooty-1 were found to be the promising genotypes.

3. Allicin content mg/g Fresh and cured cloves:

In general, Allicin content in cured cloves were the highest than fresh cloves (Fig. 1). Such data in the Fig.1 show that Allicin contents of fresh and cured cloves were highest in two garlic cultivars Eggaseed-2 and Sids-40 compared with other cultivars. Whereas, Eggaseed-1 cultivar was ranked as the second order in cases of Allicin contents of fresh and cured cloves in both seasons. While, Balady cultivar and Sids-50 genotype produced the lowest

![Fig. (1). Allicin content on five garlic cultivars and genotype](image)

Allicin content of fresh and cured cloves. (Lee, 2005) showed that hard neck garlic (similar to Sids-40, Eggaseed-1 and Eggaseed-2) contains higher Allicin content than soft neck garlic (similar to Balady cultivar and Sids-50 genotype). Al-Otayk et al. (2008) found contrast result on Allicin content and Raslan et al.
(2015) on garlic found that Sids-40 had a higher Allicin content than the cv. Balady. (Wongsa et al. 2016) reported that a significant differences were observed in Allicin content between garlic genotypes. The amount of Allicin varied from 4.5 to 26.8 mg/ g DW. The difference in Allicin concentration between genotypes and agronomical practices was significant.

CONCLUSIONS

Referring to the obtained results, it could be concluded that the highest garlic yield and its components can be achieved from Sids-50 garlic cultivar followed by cv. Balady, and Eggaseed-1 (purple). In order to obtain the highest allicin content it is recommended to cultivate Sids-40 or Eggaseed-2.

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تقييم بعض الخصائص البستانية ومحتموى الأليسين لبعض الطرز الوراثية للثوم

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قسم البساتين - كلية الزراعة - جامعة المنيا - المنيا - مصر 2


وقد أظهرت النتائج أن أعلى ارتفاع للنباتات قصي عند أوراق النبات، أطول ورقة، أعلى وزن طازج للنبات، قطر الصلصة، كل من المحصول الطازج والمحصول المعالج. كانت مع السلالة سدس- 50 في كل الموسمين. بينما تم تسجيل أكبر عرض لورقة ومعامل التبديل في الصنف إمجاسي- 2، علامة على ذلك، كان فقد سجل الصنف البلدي أعلى عدد للقصوص في البصلة في كل الموسمين.

كانت مقدار الزيداد النسبي في المحصول المعالج للسلاله سدس- 50 تتراوح بمقدار (6.15، 22.58% عن الصنف البلدي، 31.03% عن الصنف سدس- 50، 30.18% عن الصنف إمجاسي- 1، 15.0% عن الصنف إمجاسي- 2). في الموسم الأول والثاني على التوالي. كان أعلى تركيز لمحتوي فصوص الثوم الطازج والمعالجة من الأليسين مع الصنفين إمجاسي- 2 والصنف سدس- 40، بينما أقل تركيز من الأليسين مع السلالة سدس- 50 والصنف البلدي في كل الموسمين.