Evaluation of Yield and Some Agronomical Traits in Garlic Genotypes (*Allium sativum L*)

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Authors’ contributions

This work was carried out in collaboration between all authors. Author HF designed the study and wrote the protocol and manuscript. Author MN performed the statistical analysis and managed the literature searches. Author MF managed the farm activity. Author MG prepared the experimental materials. All authors read and approved the final manuscript.

ABSTRACT

**Aims:** The specific objective of this study was yield comparison of garlic genotypes for cultivation in region and evaluation of some agronomic traits and determination of correlation coefficients these with yield in order to use in breeding programs.

**Study Design:** Randomized Complete Block Design (RCBD) with 3 replications.

**Place and Duration of Study:** The present research was conducted in Agriculture and Natural Resources Research Center of Sistan and Baluchistan Province, Zabol, Iran in October 2012 during one crop season.

**Methodology:** Garlic cloves ten genotypes were planted in early October. Each plot consisted of four rows: 5 m length, with 30 cm apart. Fertilizers were applied at ratio of 100 kg N /ha, 150 kg sulphate dipotash /ha and 100 kg super-phosphate, /ha respectively, (according to results of soil analysis). All plots received one-third of N and all sulphate dipotash and super-phosphate prior to sowing. Other two-third of N top dressed at the start of leaf four and before of bulbing stage, respectively.

**Results:** The results showed that there was significant difference among genotypes for traits of cloves length, the number of cloves per bulb, clove weight, bulb weight, and bulb yield per hectare. Among genotypes, Mazand with yield (25508 kg/ha) and Chinese with...
yield (23132 kg/ha) than other genotypes, showed maximum yield. Simple correlation analysis showed that there were positive and significant correlation among bulb yields with clove weight and bulb weight.

**Conclusion:** Based on results can be conclude that traits, bulb weight, number of cloves per bulb and Clove weight may be used as criterion of selection, for improving agronomic characters of garlic in breeding programs and Mazand and China varieties due to higher yield were recommended for replacement with local variety in Sistan region.

**Keywords:** Bulb yield; correlation; garlic medicinal plant; cultivars.

1. **INTRODUCTION**

Garlic “*Allium sativum L*” is considered as one of the most important species in the onion family Alliaceas [1,2]. Alliums are large genus of the family Alliaceae including 700 species of ornamental flowering plants are Species are economically important for various reasons. The flavor in allium such as onion, garlic, leek Chao are easily diagnosed [3], and has anti-infective properties such as power suppliers, insecticidal, anti-bacterial, antifungal, anti-cancer, lowering of blood sugar, blood lipids, and reduction of blood platelet aggregation [4]. Garlic is a cold weather perennial crop with high nutrient and water requirements [5]. The selection of the cultivar should take into consideration several different factors and characteristics, some of which include the adaptability of the cultivar to the climate of the growing area, the market demand of the particular cultivar and the resistance or tolerance of the cultivar to various diseases and pests. There are actually many different cultivar strains of garlic. They may differ in pungency, length of storage, colour, size, number of cloves per bulb, hardness, and suitability for cooking. Some even store longer, some are more gourmets in flavor and some mature earlier and others later [6]. Stavelikova [7]; revealed high diversity in garlic genotypes from point morphological characterizations and reported that the first step of description of garlic collection genetics resources comprised of morphological characterization. Panthee et al. [8]; with study diversity analysis of Garlic “*Allium sativum L*”Germplasms available in Nepal based on morphological characters reported that four principal components were identified explaining more than 86% of total variation, so major characters included in the principal components were bulb weight, diameter, yield, number of cloves per bulb, maturity, plant height, number of green leaves at 135 days after planting, and bulbing period. Noorbakhshian et al. [9]; evaluated some agronomic traits related to yield components for several garlic cultivars and reported that there were significant differences among genotypes for all traits include: garlic yield per plant and per plot, bulb diameter, the number of cloves per bulb, clove weight, clove length and diameter and dry matter per plot. Sood et al. [10]; in study that performed on genetic diversity among garlic five varieties showed high variation between traits such as: garlic yield in area unit, (both fresh and dry) diameter, length and weight cloves. These presented HG-6, HG-17 as over yield varieties.

Determination of correlation coefficients is an important statistical procedure to evaluate breeding programs for high yield [11]. Noorbakhshian et al. [9]; reported that cloves weight had maximum positive effect on the yield character. Garlic Production by breeding programs with high yield can be a critical role for increasing production. Increasing of economic yield such as bulb yield in unit area increases export potentials. Traits that improve yield are therefore very important for productivity. The present work aims to study the garlic
genotypes from aspect yield and some agronomic traits and determine correlation these with yield.

2. MATERIALS AND METHODS

An experiment was carried out to evaluate the agronomic characteristics of garlic genotypes. Ten genotypes were evaluated, using a Randomized complete Block Design (RCBD) with 3 replications in October 2012, in Zahak Agriculture Research Station of Sistan, located at Eastern Iran with Mean annual precipitation of less than 50 mm per year. Soil analysis was represented in Table 1.

Table 1. Physical and chemical properties of experimental soil (0-30cm)

| Particulars      | Value | Methods                        |
|------------------|-------|--------------------------------|
| Sand (%)         | 54    | Hidrometr Method [12]          |
| Silt (%)         | 33    |                                |
| Clay (%)         | 13    |                                |
| K (Ava), ppm     | 125   | Olson Method [12]              |
| P(Ava), ppm      | 9.2   | Olson Method [12]              |
| Organic carbon (%)| 0.44  | Walkli-Blake Method [12]       |

From ten garlic genotypes choiced, Mazand, Chienes were variety and Tarom, Orumia, Zabol local, Zabol/Ariel origin, Hiranni, Tafresh, Gillan and Niksharie were landrace. Ten garlic cloves genotypes were planted in early October. Each plot consisted of four rows: 5 m length, with 30 cm apart. Fertilizers were applied at ratio of 100, kg N /ha, 150 kg sulphate dipotash /ha and 100 kg super-phosphate, /ha respectively, (based on the results of above soil analysis). All plots received one-third of N and all sulphate dipotash and super-phosphate prior to sowing. Other two-third of N top dressed at the start of leaf four and before the bulbing stage, respectively. All other agricultural practices (weeds control and irrigation), were performed when they were required and as recommended for commercial garlic production. A random sample of five plants of each genotype was collected from each plot in physiological ripening to estimate the following parameters; plant height, number of cloves/bulb, clove weight, clove length, clove width and bulb weight. In each plot, plants of two central rows were harvested to determine bulb yield [9]. Data were analyzed by using MSTAT-C statistical package[13]. Mean comparison was done by using Least Significant Difference (LSD) test at 0.05 probability level [13].

3. RESULTS AND DISCUSSION

Results of analysis of variance of data showed that there was significant difference at P=0.001, among various genotypes on number of cloves/bulb, clove weight, clove length; clove width, bulb weight and bulb yield Table 2. Table 2 shows that there was significant difference at P = 0.05 on plant height. Data of mean comparison Table 3 showed that there was difference among the genotypes on number of cloves/bulb. The highest number cloves/bulb was observed in Mazand variety with mean 11 clove and the lowest with mean 6 clove in genotypes, Viranie, Tafresh, Gillan and Niksharie. It seem that number of clove/ bulb may be important trait in increasing bulb yield that should be considered in breeding of local varieties. Noorbakhshian et al. [9]; reported number of cloves/bulb in Tafresh (8/6), Hammedan (12), Mazand (9/5), Gillan (7/3) and Iranshare (6/3) that with result of this study in similarity . Al-Otayk et al. [14]; also found that cultivar of Balady produced more number of
clove weight was between 2.93 - 5.2 g. Table 3. So, the largest and lowest clove weight was for Tarom and Hiranie respectively. Norbakhshian et al. [9] and Abbasifar [15]; in two separate experiments reported the most clove weight for Tafresh cultivar. But in the findings of Al-Otayk et al. [14]; Chinese cv. gave the highest values of clove weight, bulb diameter and clove diameter characters compared with Balady cultivar. Planting and agro-climatic conditions of the areas be said to have profound affect on difference of results in experiments [5].

Table 2. Variance analysis of traits in the garlic genotypes

| S.O.V | df | Clove length | Clove width | cloves per bulb | Clove weight | Bulb weight | Bulb yield | Plant height |
|-------|----|--------------|-------------|-----------------|--------------|-------------|------------|-------------|
| Replication | 2 | 0.028 | 0.300 | 3.633 | 0.134 | 44.801 | 1695.64300 | 32.033 |
| Genotypes | 9 | 0.426** | 49.352** | 9.856 | 2.623** | 217.281** | 209363172.46** | 85.663* |
| Error | 18 | 0.041 | 1.707 | 1.856 | 0.425 | 9.001 | 1115704.263 | 26.107 |
| C.V % | 2 | 10.88 | 12.44 | 18 | 15.58 | 8.64 | 10.25 | 10.35 |

*and ** Significant at 5% and 1% statistical levels

Table 3. Comparison of means of different agronomic traits in the garlic genotypes

| Genotypes | Clove length | Clove width | cloves per bulb | Clove weight | Bulb weight | Bulb yield | Plant height |
|-----------|--------------|-------------|-----------------|--------------|-------------|------------|-------------|
| Mazand | 2.767a | 17a | 11a | 4.9a | 50a | 25508a | 57a |
| Chienes | 2.100b | 13b | 10ab | 5.1a | 48ab | 23132b | 51ab |
| Tarom | 1.967bcd | 17a | 8bcd | 5.2a | 41c | 12068a | 58a |
| Orumia | 1.633de | 10d | 9bcd | 4.8a | 44bc | 13974c | 42c |
| Zabol local | 1.567e | 7e | 7d | 4.8a | 32d | 8891e | 47bc |
| Zabol/Ariel origin | 1.567e | 8cde | 8bcd | 3.1b | 25e | 3937g | 50abc |
| Hiranii | 1.733cde | 8cde | 6d | 2.93b | 24e | 2845g | 48bc |
| Tafresh | 1.667de | 9cd | 6d | 3.3b | 25e | 3583g | 45bc |
| Gillan | 1.600e | 8cde | 6d | 4.5a | 33d | 6308f | 51abc |
| Niksharie | 2.067bc | 7de | 6d | 3.2a | 24e | 2788g | 44bc |

Means followed by the same letters in each column are not significantly different at the 5% level.

The maximum clove length (2.76 cm), clove width clove (17 mm) and plant height (57 cm) was found in Mazand cultivar. In studies of Stavělíková [7], and Panthee et al. [8]; revealed high diversity in garlic genotypes from view, morphological traits that in accordance with the result of this study. Bulb weight indicates significant differences between genotypes from aspect of statistical analysis Table 2. This trait ranged from 24 to 50 garm. Data in Table 3 indicated that among the genotypes, Mazand, Chinese and Ouromia had maximum of bulb weight with mean 50, 48 and 44 garm, respectively. The lowest bulb weight (24 cm) was found in Hiranie and Niksharie genotypes. These results might be due to the genetic variations among garlic cultivars and their ability for exploiting the environmental sources particularly, light, CO2, water and nutrients [16]. Also increase the number of clove/bulb will cause increasing bulb weight.

Variance of analysis bulb yield indicate significant differences between genotypes at 1% probability level Table 2. So among genotypes, cultivar Mazand with yield (25508 kg/ha) and Chinese with yield (23132 kg/ha) were better than other genotypes. Zabol genotype with yield (8891 kg/ha) located in fifth grade. Hiranie and Niksharie had lowest bulb yield with mean 2788 and 2845 kg/ha, respectively Table 3. Garlic Mazand and Chinese showed
superior bulbs yield due to increasing number of cloves/bulb as well as bulbs major bulb weight in comparism with other genotypes. Abbasifar [15] reported that Mazand garlic was better than other varieties. In experiment Norbakhashian et al. [9] cultivars Tafresh and Hammadan had highest bulb yield.

Simple correlation analysis showed that there were positive and significant correlation among bulb yields, clove weight and bulb weight, so that genotypes with greater bulb weight and more number of cloves per bulb produced more yield Table 4. Such a correlation is also reported by Norbakhashian, et al. [9] that was according to result this experiment. Yield of Garlic (bulb) had a significant correlation with the length of clove and clove width. Rajalingam and Haripriya [17] reported a significant relationship between yield and bulb length. Clove weight with clove number in bulb not significant. Seems that with increase clove number in bulb less provides assimilate photosynthesis for cloves and consequently is limited cloves of growth. Norbakhashian, et al. [9] announced that altught number of clove in bulb is important factor in marketing of garlic but with increasing number of clove in bulb remarkably will decreased marketing crop.

| Traits               | Clove length | Clove width | cloves/ per bulb | Clove weight | Bulb weight | Bulb yield | Plant height |
|----------------------|--------------|-------------|------------------|--------------|-------------|------------|--------------|
| Clove length         | 1            |             |                  |              |             |            |              |
| Clove width          | 0.59**       | 1           |                  |              |             |            |              |
| cloves/ per bulb     | 0.42*        | 0.65**      | 1                |              |             |            |              |
| Clove weight         | 0.31 ns      | 0.51**      | 0.29 ns          | 1            |             |            |              |
| Bulb weight          | 0.51**       | 0.73**      | 0.64**           | 0.77**       | 1           |            |              |
| Bulb yield           | 0.65         | 0.74        | 0.77*            | 0.66         | 0.91*       | 1          |              |
| Plant height         | 0.44*        | 0.57        | 0.17 ns          | 0.41         | 0.38        | 0.38       | 1            |

ns, * and **: Indicate not significant, significant at 5% and 1% probability levels respectively

4. CONCLUSIONS

Based on results can be conclude that there are variation in garlic genotypes specially in bulb yield, bulb weight, number of cloves per bulb and Clove weight. These traits may be used as criterion of selection, for improving agronomic characters of garlic in breeding programs. Among genotypes, Mazand variety with yield (25508 kg/ha) and China variety with yield (23132 kg/ha) than other genotypes, showed the most yield. So these cultivars may be considered for replacement with local variety garlic in Sistan region.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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