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Morpho-agronomic characteristics of two Roselle varieties (*Hibiscus sabdariffa L.*) in tropical Iranshahr

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Abstract

Tea sour or tea Maki (*Hibiscus sabdariffa* L.) is one of the most important and popular medicinal plants. Roselle has been used traditionally as a medicinal. This plant has many benefits as a traditional medicine in Iran, such as for curing hypotensive. Roselle (*Hibiscus sabdariffa* L.) is a relatively new crop in Iran. The aim of the investigation was to describe some of the main morpho-agronomic characteristics of the two Roselle varieties. In present research work 2 genotypes of Roselle were evaluated to find out their similarities and differences based on numerical traits. The experiment was laid out in Randomized Complete Block Design (RBCD) with 3replications.A number of Morpho-agronomic and physico-chemical characteristics including plant height, stem diameter, number of branches per plant, number of fruits per branch, number of fruits per plant, weight of fruits per plant, weight of fresh calyx per plant, weight of dry calyx per plant, weight of capsule per plant were evaluated in tropical environment of Iranshahr. Significant differences were observed in morpho-agronomic characters in these two. Arab showed better performance for weight of fruits per plant and weight of fresh calyx per plant; whereas for number of fruits per branch, number of fruits per plant and Number of branches per plant Terengganu showed better performance.

Keywords: Arab, Morpho-agronomic,Terengganu

Introduction

Roselle (*Hibiscus sabdariffa* var *sabdariffa* L.) is an important crop in the tropics and subtropics. Roselle (*Hibiscus sabdariffa* L.) is an annual and flowering plant(Javadzadeh, 2015) that belongs to the family of Malvaceae and cultivated mainly for its leaves, stem, seed and fruits (Fasoyiro et al. 2005). Roselle is categorized as a vegetable crop that widely grown in tropical Asia, Australia, West and Central Africa and in Central America. However, the origin of Roselle is believed to be from West Africa (Mohamad et al. 2011). Genus Roselle which belongs to Malvaceae has more than 300 known species which are used as ornamental plants. Roselle (*Hibiscus sabdariffa* L.) is a relatively new crop in Iran (Javadzadeh, 2013).

Roselle is an annual, erect, bushy, herbaceous subshrub that can grow up to 8 ft (2.4 m) tall, with smooth or nearly smooth, cylindrical, typically red stems. The leaves are alternate, 3 to 5 in (7.5–12.5 cm) long, green with reddish veins and long or short petioles. The leaves of young seedlings and upper leaves of older plants are simple; lower leaves are deeply 3 to 5 or even 7 lobed; the margins are toothed. Flowers, borne singly in the leaf axils, are up to 5 in (12.5 cm) wide, yellow or buff with a rose or maroon eye, and turn pink as they wither at the end of the day. At this time, the typically red calyx, consisting of 5 large sepals with a collar (epicalyx) of 8 to 12 slim, pointed bracts (or bracteoles) around the base, begins

to enlarge, becomes fleshy, crisp but juicy, 1 1/4 to 2 1/4 in (3.2–5.7 cm) long and fully encloses the velvety capsule, 1/2 to 3/4 in (1.25–2 cm) long, which is green when immature, 5-valved, with each valve containing 3 to 4 kidney-shaped, light-brown seeds, 1/8 to 3/16 in (3–5 mm) long and minutely downy. The capsule turns brown and splits open when mature and dry. The calyx, stems and leaves are acid and closely resemble the cranberry (*Vaccinium* spp.) in flavor (Morton, 1987 and Ross, 2003). The size of the calyx varies with each variety, but ranges from ½ to 1 ½ inches in diameter (James, 1994).

The red persistent calyx of its flowers is the major component which has a sour taste and is commonly used in the preparation of cold and hot beverages and as a food colorant (Maganha et al., 2010).The commercially important part of Hibiscus is the fleshy calyx (sepals) surrounding the fruit (capsules). The whole plant can be used as beverage, or the dried calyces can be soaked in water to prepare a colorful cold drink, or may be boiled in water and taken as a hot drink. It also has some medicinal properties (Mohamed et al., 2012).

The origin is believed to be from West Africa. It was introduced into Iran in early 1990s. Presently, the planted area is quite small approximately 180 ha. It is locally known as “tea sour"and”tea Maki"(Javadzadeh, 2017).

The brilliant red and fleshy cup-shaped fruits are the most important part of Roselle plants that can be processed into food and beverages, pharmaceuticals and cosmetic products (Mohamad et al. 2011).

Roselle is a tetraploid(2n=72) species and therefore their segregating populations need longer time for purification compared to diploid species. Furthermore, Roselle has cleistogamous flowers. Thus, crop improvement through conventional hybridization is very difficult to be carried out (Jain, 1979; Vaidya, 2000).

The most exploited part of Roselle plant is its calyces which may be green, red or dark red (Schiffers, 2000).The micro nutrient composition of *Hibiscus sabdariffa* calyx, seed and leave parts varies between studies, probably due to different varieties, genetic, environmental, ecology and harvest conditions of the plant. The nutrient composition of *Hibiscus sabdariffa* calyx and seed was different depending on Ecotype (Atta *et al.*, 2013). Many researchers had done the photochemical analysis of Roselle by various methods. The Roselle calyx is also rich in malic acid, anthocyanins, ascorbic acid and minerals, especially Ca and Fe, but low in glucose (Jung *et al.*, 2013).

In this study two Roselle and Morpho-agronomic traits of calyx colour (red & dark red),were evaluated. This crop is a good choice for low-rainfall areas because it is drought tolerant. Germplasm identification and characterization is important for the conservation and utilization of plant genetic resources. The objective of the present study is to survey yield, to contribute the basic knowledge on Roselle in the aspect of Morpho-agronomic in Iranshahr climatic region and similar areas.

Materials and Methods

Two genotypes of Roselle (*Hibiscus sabdariffa* L.) with obvious phenotypic differences were used in this study. Each genotype was given a unique code (Table 1). Differences between genotypes in respect of the morphologies of the calyx and leaves are presented in Fig. 1.The experiment was conducted in Iranshahr (Latitude: 40' and 28°; Longitude: 11' and 61°); Average yearly raining: 60 mm; Altitude: 490 meter above sea level; Maximum and minimum temperature: 50 and 7°C. The Weather of the area based on Ambezhe evaluating method, was assessed to be hot and dry. Roselle variety seeds were purchased from Dalgan region. Two Roselle varieties (Terengganu and Arab) were selected in order to evaluate the amount of variation that may exist for morphogenetic characteristics. The research was conducted at Iranshahr Islamic Azad University during May to August 2015. Land was ploughed once with mould board plough. Soil was brought to a fine tilt by crushing the clods and harrowing two times. Later, the land was smoothened with wooden plank. The experiment design was Randomized Complete Block Design (RBCD) with 3 replications. The total area of the experiment was 893 m^2. Each replication consisted of 20 rows. Seed planting method was manual. Depth of planting was 2 cm. Planting densities were 40 to 60 plants in each square meter and irrigation period was chosen for 8 to 10 days. The crop was seeded directly after the soil is well prepared. Fertilizers, Irrigation and Pest management was done on proper time. Half dose of fertilizers was applied at the time of sowing and half dosage of fertilizers was applied after 60 days. Randomly Three plants from each row were selected for data. Statistical analyses were made through (SAS) and (MSTAT_C) software (version 9.1). Comparisons among treatment averages were made by Dunkan multi-level test in 5% certainty level.

Fig 1. Location map of study area.

Results and Discussion

In the present investigation, the two varieties Roselle exhibited significant differences for most of the traits studied (Table 3). The observed differences among these two varieties can be attributed to genetic as well as to environmental factors. Similar results had been reported by many workers. In addition, the analysis of variance (Table 2) revealed highly significant differences among the evaluated two varieties for most of the studied characters. Ibrahim and Hussein (2006) detected significant differences among genotypes for plant height, number of branches, seed weight and sepals dry weight. Although phenotypic differences in leaf shape, calyx size and weight, plant height, and fiber content have been observed between plants cultivated in Iran, there are no reports on crop breeding trials or registration of varieties. Brief descriptions of these varieties are shown in Table 1.

Analysis of variance (ANOVA) and Dunkan tests were performed in the five fruit characteristics (fruit weight, fruit length, fruit diameter, weight of fresh calyx per fruit and weight of capsule per fruit). The results of ANOVA and Dunkan test shown in Table 2 and 3. It was observed that there were significant differences among the varieties for all traits at $p<0.01$ level. It was observed that Terengganu and Arab with the average of 1.96 kg and 1.25 kg of fruit weight showed significant difference. Osman et al. (2013) reported that average fruit weight, 11.178 g and 9.786 g for Terengganu and Arabic, respectively.

Fruit Length trait was significantly different among varieties at significant level $p<0.01$ (Table 2).

According to the results, weight of fresh calyx per fruit ranged from 1.50 to 1.58 g in which the Arab variety showed the best performance (Table 3).Osman et al. (2013) reported that weight of fresh calyx per fruit ranged from 4.97 to 12.31 g for Terengganu and Arabic, respectively. Arab with the mean of 1.25 g for weight of fresh calyx per fruit showed better performance compared with Terengganu. Osman et al. (2013) reported that mean of 9.95 g for weight of fresh calyx per fruit showed better performance compared Terengganu.

According to the result, it was indicated that there was a significant difference among varieties at significant level $p<0.01$ for this trait. Moreover, Arab was not significantly different from Terengganu (Table 3). The average weight of capsule per fruit ranged from 3.42 to 5.75 g in which Arab with the mean of 5.75 g exhibited the best performance among the varieties. While, Terengganu had the lowest weight of capsule per fruit (3.42 g).

The results of ANOVA are shown in Table 2. The plant height, stem diameter, number of branches per plant, number of fruits per branch, number of fruits per plant, weight of fruits per plant, weight of fresh calyx per plant, weight of dry calyx per plant and weight of capsule per plant were measured and included in the analysis.

Significant differences in plant height was observed among the varieties (significance level $p<0.01$). Results from Dunkan's test showed that Terengganu and Arab varieties were significantly different.

The means of plant height for these varieties, shown in Table 3, indicates that Arab variety had the highest mean (112.92 cm) among the varieties.

However, Chang et al (2006) found that Roselle plant with higher main stem are stronger and does not fall easily in production levels compared to short plants. Similar pattern of variability in germplasm evaluation have been earlier reported by Ibrahim and Hussein (2006) and Koorsa (1987).

Significant difference was observed in diameter of the varieties (significance level $p<0.01$). Results from Dunkan's test in Table 2 showed that Terengganu and Arab varieties were significantly.

Stem diameter for Terengganu variety was significantly different with Arab variety based on the result of from Dunkan's test (Table 2).

The largest range was observed in Terengganu and the lowest range was observed in and Arab(Fig 2).

Results from Dunkan's test indicated that Terengganu and Arab varieties were significantly different (Table 2 The means for number of branches per plant in this study ranged from 7 to 7. Based on the results, Terengganu variety had the most number of branches among the varieties. Osman et al. (2011) reported that means for number of branches per plant ranged from 6.2 to 10.4. In addition, Terengganu varieties had more number of branches in contrast to the Arab varieties. Mostofa et al., (2002) also observed variation in number of branches/plant in different growing seasons; however the variations were sometimes significant and sometimes no significant.

Significant difference was observed among the varieties for number of fruits per branch at $p<0.01$ significance level (Table 2). The results obtained from Dunkan's test indicated that Terengganu and Arab varieties were not significantly (Table 4). The means for number of fruits per branch ranged from 14 to 18 (Table 3), in which Terengganu variety with the highest mean of 18.43 showed the best performance among the varieties. Osman et al. (2011) reported that means for number of fruits per branch ranged from 9 to 16.8.

Terengganu variety | **Arab variety**

Fig.2.Two varieties are planted in Iranshahr

Table 1. Morphological characters of two varieties Roselle

varieties	Descriptions			
	Stem color	**Leaf shape**	**Flower color**	**Calyces color**
Terengganu	Smooth reddish	3-5 lobed	Red	Light red
Arab	Smooth reddish	3-5 lobed	Light red	Dark red

Table 2. Mean square values from ANOVA of Characteristics of Morpho-agronomic the two Roselle

Source of Variation	DF	Mean square												
		Plant height (cm)	Canopy diameter (cm)	Number of branches per plant	Number of fruits per branch	Number of fruits per plant	Weight of fruits per plant (kg)	Weight of fresh calyx/ plant (kg)	Weight of dry calyx / plant(kg)	Fruit weight (g)	Fruit length (cm)	Fruit diameter (cm)	Weight of fresh calyx /fruit (g)	Weight of capsule /fruit (g)
Varieties	1	1775.18 **	2123.89**	5.26 **	38.01 **	1559.33 **	1.02 **	1.24 *	0.008 *	101.17 *	26.97 **	1.37 **	144.58 **	10.83 **
Error	3	6.87	32.49	0.012	0.39	1.49	0.002	0.039	0.001	1.99	0.18	0.007	0.89	0.021
Total	8													

**significant at 0.01 levels ($p<0.01$)

Table 3. Means of Characteristics of Morpho-agronomic the two Roselle varieties (*Hibiscus sabdariffa* L.) in tropical Iranshahr

Treatment	Plant height (cm)	Canopy diameter (cm)	Number of branches per plant	Number of fruits per branch	Number of fruits per plant	Weight of fruits per plant (kg)	Weight of fresh calyx/ plant (kg)	Weight of dry calyx / plant(kg)	Fruit weight (g)	Fruit length (cm)	Fruit diameter (cm)	Weight of fresh calyx/fruit (g)	Weight of capsule/fruit (g)
Arab	142.68 a	103.81b	5.30 b	14.07 b	102.75 b	1.96 a	1.58 a	0.15a	17.27 a	8.12 a	3.91 a	14.56 a	5.75 a
Terengganu	112.89 b	136.39 a	6.92 a	18.43 a	130.67 a	1.25 b	0.79 b	0.09 b	10.16 b	4.45 b	3.08 b	6.06 b	3.42 b

Means with the same letter within a column are not significantly different at $p<0.05$

Conclusion

This study was conducted at Department of Agriculture, Iranshahr Branch, Islamic Azad University, Iranshahr in order to Morpho-agronomic characteristics of two Roselle varieties (*Hibiscus sabdariffa* L.) in tropical Iranshahr. Morpho-agronomic traits characteristics of two new varieties of Roselle (*Hibiscus sabdariffa* L.), Arab and Terengganu were evaluated. Fruits traits and physico-chemical characteristics of two of Roselle (*Hibiscus sabdariffa* L.) namely Terengganu and Arab were evaluated in this study to gather additional information of these new mutant varieties developed from Arab variety. All the varieties showed significant differences for fruit characteristics. In general, Arab showed lower performance than Terengganu and demonstrated intermediate performance. For fruit characteristics, with the exception for Terengganu where capsule weight per fruit showed similar performance compared to the Arab.

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