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Sowing date as a determining factor for Roselle, *Hibiscus sabdariffa*, production: I. Effect on vegetative and yield components

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Abstract

Roselle holds a crucial role in both the pharmaceutical and food sectors, underscoring its economic and cultural significance. Given the global challenges to face climate change, determining the optimal sowing date for Roselle crop has become pivotal in agricultural practices. This study aimed to investigate the impact of planting dates on the morpho-physiological traits and productivity of Roselle in the newly reclaimed soil of Aswan governorate. Four planting dates were employed in the experiment; April 15th, April 30th, May 15th, and May 30th. The varying sowing date resulted in noteworthy differences in growth parameters, including plant height, stem diameter, number of branches and fruits per plant, shoot fresh and dry weights, as well as yield parameters including calyxes' fresh and dry yield and seeds' fresh and dry weights. Analysis of variance revealed that planting on May 15th consistently yielded higher values across vegetative traits. The observed growth performance during mid-May could be attributed to favorable conditions for plant development during this period. The planting on May 15th also demonstrated superior performance in terms of calyxes' fresh and dry yield and seeds' fresh and dry weights. The results of this study suggest that this positive effect might be influenced by environmental conditions, particularly temperature and day length. Conclusively, the study emphasizes that planting on May 15th significantly enhanced the economic yield of Roselle, manifested through improved plant growth and increased fruit quantity per plant.

Keywords: Roselle; vegetative growth; calyxes yield; seed yield; sowing date

Introduction

The Roselle plant (*Hibiscus sabdariffa* L.) is botanically belonging to the Malvaceae family, commonly known by various names such as Roselle, hibiscus, red sorrel in English, and karkadeh in Arabic **[1, 2]**. It is shrub-like herbaceous plant typically grows to a height of 1.5-2 meters and is believed to be native to tropical central and West Africa, thriving in tropical and sub-tropical regions **[3]**.

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Its suitability for cultivation in developing countries is due to its ease of growth, adaptability to multi-cropping systems, and versatility for use as both food and fiber. In China, the seeds are valued for their oil content, and the plant itself is utilized for its medicinal properties. In West Africa, the leaves and powdered seeds add in meals, showcasing the plant's diverse uses. Furthermore, Roselle is incorporated into the pharmaceutical and food industries, highlighting its economic and cultural importance **[4]**.

Roselle plant holds significant medicinal value. Traditionally used for various ailments such as abscesses, bilious conditions, cancer, cough, and fever, its leaves are known for their emollient and sedative properties, while the succulent calyx, when boiled in water, is considered a folk remedy for cancer **[5, 6]**. The flowers of Roselle contain gossyperin, anthocyanin, and glycoside hibiscin, potentially offering diuretic and choleretic effects, reducing blood viscosity, lowering blood pressure, and stimulating intestinal peristalsis **[7]**. The plant's phenolic compounds contribute to its antimicrobial activities, and it is a rich source of protein, fibers, calcium, iron, carotenes and vitamin C **[8]**.

In Egypt, Roselle cultivation is significant particularly in regions with hot summers and mild winters like Aswan Governorate. Aswan possesses a comparative advantage in Roselle production, especially with the expansion of land reclamation projects aimed for increasing the agricultural area. Climate change poses a threat to agricultural production in food-unstable regions, with extremes environmental stress such as drought, heat waves, storms, etc. Future climate predictions indicate a substantial increase in temperature and erratic, intense rainfall patterns, making climate-resilient and smart agricultural practices crucial for sustainable productivity **[9]**. Given these challenges, determining the optimal sowing date for Roselle crop has become a vital agricultural practice, particularly in recent years in response to climate change.

In light of these considerations, this experiment aimed to explore morpho-physiological traits and productivity of Roselle in the newly reclaimed soil of Aswan governorate as influenced by sowing date.

Materials and methods

The present study was conducted during the two seasons of 2021 and 2022 in the experimental farm of Faculty of Agriculture and Natural Resources, Aswan University, Aswan, Egypt (Lat. 24° 05′ 53′ 26.95" N., Long. 32° 53′ 57.91" E.) to investigate the influence of different sowing dates on the growth and productivity of Roselle plants under newly reclaimed soil.

3.1. Plant materials and growth conditions:

Seeds of Roselle (*Hibiscus sabdariffa* L.) were obtained from the Faculty of Agriculture and Natural Resources, Aswan University, Aswan, Egypt. The experimental site was prepared as recommended before sowing the seeds. In the different planting dates for both seasons, Roselle seeds were sown by hand in the prepared soil,

where each sub-plot size was 3×1.5 m comprising two rows and the spacing was at 30 cm in a row. 30 days after sowing, the plants were thinned to one plant/hill (20 Roselle plants/sub-plot, 10 plants per row). Drip irrigation system was used for irrigation purpose and all other agricultural practices were performed as recommended during both seasons. The soil texture was sandy; its physical and chemical properties were analyzed according to the methods described by **[10]** and **[11]** as shown in Table (1).

Table 1. The physical and chemical properties of the soil before planting in the two seasons of 2021 and 2022

Soil property	**Season**	
	2021	**2022**
Physical properties		
Clay (%)	3.00	3.50
Silt (%)	0.00	0.00
Sandy (%)	97.00	96.50
Textural class	Sandy	Sandy
Chemical properties		
Soluble cations (mmol/l)		
Ca^{++}	3.06	3.10
Mg^{++}	1.02	1.05
K^{+}	0.83	0.85
Na^{+}	0.76	0.80
Soluble anions (mmol/l)		
CO_3^{--}	0.00	0.00
HCO_3^{-}	7.10	7.06
Cl^{-}	3.60	3.57
SO_4^{--}	0.40	0.44
pH (1:1 soil suspension)	7.64	7.70
EC (dS/cm) at 25°C	0.33	0.32
Available N (mg/kg soil)	128.31	130.00
Available P (mg/kg soil)	8.00	10.00
Available K (mg/kg soil)	175.00	180.00

3.2. Experimental design:

The experiment was based on a randomized complete block in a factorial design with three replicates. Four-planting date have been used; April 15th, April 30th, May 15th and May 30th.

3.3. Collected data:

Samples of Roselle plants (10 plants) were randomly selected from each sub-plot and harvest was conducted on November 1st for both seasons by cutting the aerial parts above the soil surface in the early morning and immediately transferred to the laboratory to study the following characteristics:

1- Plant height (cm): was measured from the cotyledon node to plant top of the main stem.

2- Number of branches/plant: was estimated by counting the number of branches distributed on the main stem of the plant.
3- Stem diameter (cm): was measured at the base above soil surface by 10 cm using by Vernier Caliper.
4- Shoot fresh weight/plant (g): were estimated by taking the average weight of ten plants excluding fruits directly after harvesting during both seasons.
5- Shoot dry weight/plant (g): the samples were dried in an electric oven at 70ºC±2 till constant weight was reached (almost after 48 hours).
6- Number of fruits/plant: was estimated by counting distributed fruits on the main and lateral branches of plant.
7- Fresh and dry weight of calyx/plant (g): were recorded after separating the calyxes from seeds in fresh form. Then, calyxes were air dried in shade conditions for one week, and the dry weight was recorded.
8- Calyxes' fresh and dry yield/Feddan was calculated by multiplying plant weight with number of plants per Feddan.
9- Fresh weight of seeds/plant (g): seeds were removed manually and directly weighted.
10- Dry weight of seeds/plant (g): seeds were air dried at room temperature until constant weight.

3.4. Statistical analysis:

The obtained data were subjected to statistical analysis using "F" Test **[12]**, and the means were compared using a least significant difference (L.S.D.) test according to **[13]**. Statistical analysis was performed using Statistix 8.1 program.

Results

Analysis of variance proved significant differences in term of plant height of Roselle during the two seasons as affected by planting date. As shown in Figure (1), the tallest plant (200 and 193.7 cm) were recorded with the 3rd and 4th planting date (May 15th and May 30th) in the 1st and 2nd seasons, respectively. Also, applying different planting date caused significant differences in stem diameter (Figure 1). Higher values of stem diameter of Roselle (1.9 and 1.7 cm) were recorded with planting on April 30th and May 15th in the 1st and 2nd seasons, respectively.

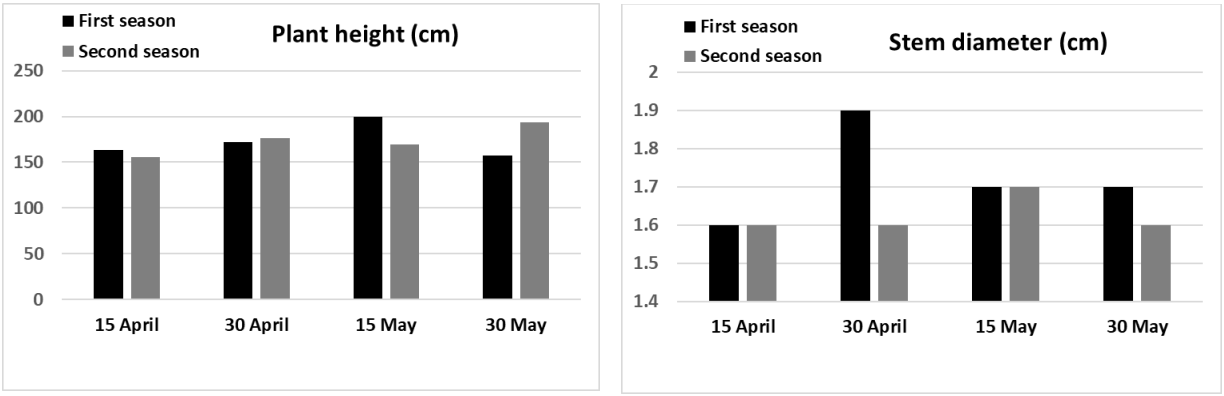

Figure (1): Effect of sowing date on plant height (cm) and stem diameter (cm) of Roselle plant.

Figure (2) showed the number of branches/plant and number of fruits/plant of Roselle as affected by planting date. Analysis of variance revealed significant differences in the number of branches during the two studied seasons. The highest values of number of branches (5 and 5.2) were registered when planting on April 15th and May 30th in the 1st and 2nd seasons, respectively. In addition, it was clear that sowing date significantly increased mean fruits number/plant in both seasons compared to the control. Sowing on May 15th and April 30th gave the highest fruits number/plant (37.3 and 39.3) in the 1st and 2nd seasons, respectively.

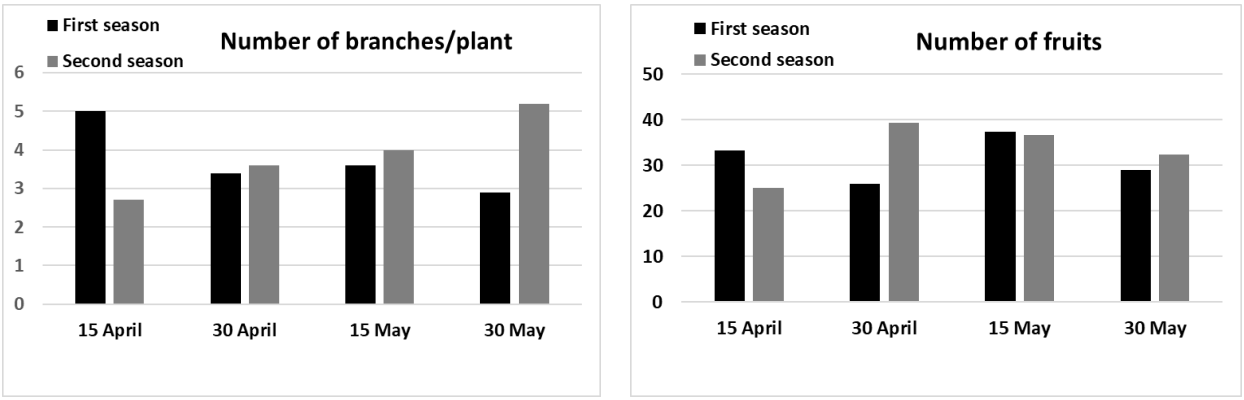

Figure (2): Effect of sowing date on number of branches and fruits of Roselle plant.

Statistically, it was found that sowing date have a significant effect on the shoot' fresh and dry weights during the two seasons (Figure 3). Roselle planted on the earliest date (April 30th) showed maximum plant fresh weight (754.7 and 810.3 g) in both seasons. Meanwhile, the highest shoot dry weight (186 and 194.3 g) were associated with those planted on May 15th and May 30th in the 1st and 2nd seasons, respectively.

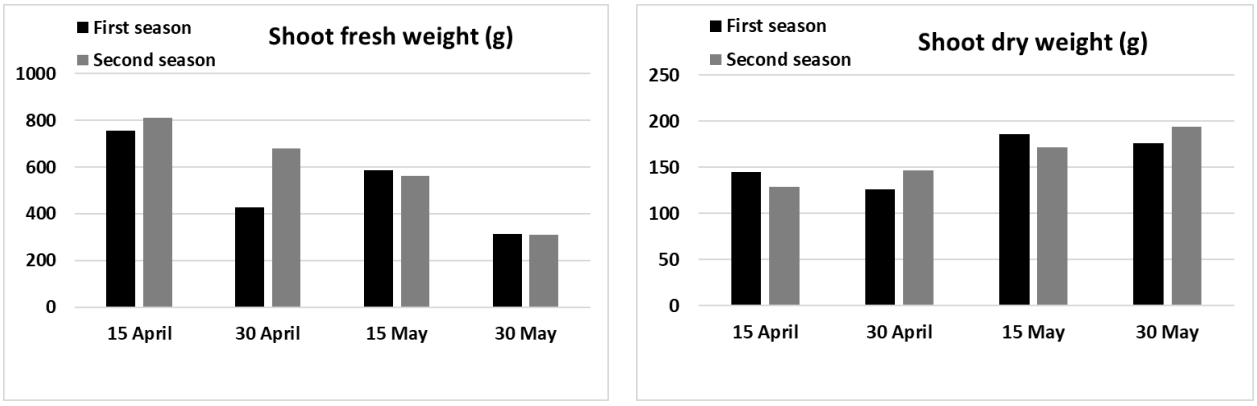

Figure (3): Effect of sowing date on shoot fresh and dry weight (g) of Roselle plant.

Applying different planting date caused significant differences in the calyxes' fresh and dry weights per plant, which in turn fresh and dry yield per Feddan (Figure 4). The highest values of calyxes' fresh weight of Roselle (259.7 and 282.3 g/plant) yielding (5194 and 5646 kg/Feddan) were recorded with planting on May 15th and April

30th in the 1st and 2nd seasons, respectively. In the same line, the highest weights of dry calyxes of Roselle (26.7 and 29.4 g/plant) which resulting total calyxes dry yield (534 and 588 kg/Feddan) were recorded in Roselle planting on May 15th and April 30th in the 1st and 2nd seasons, respectively.

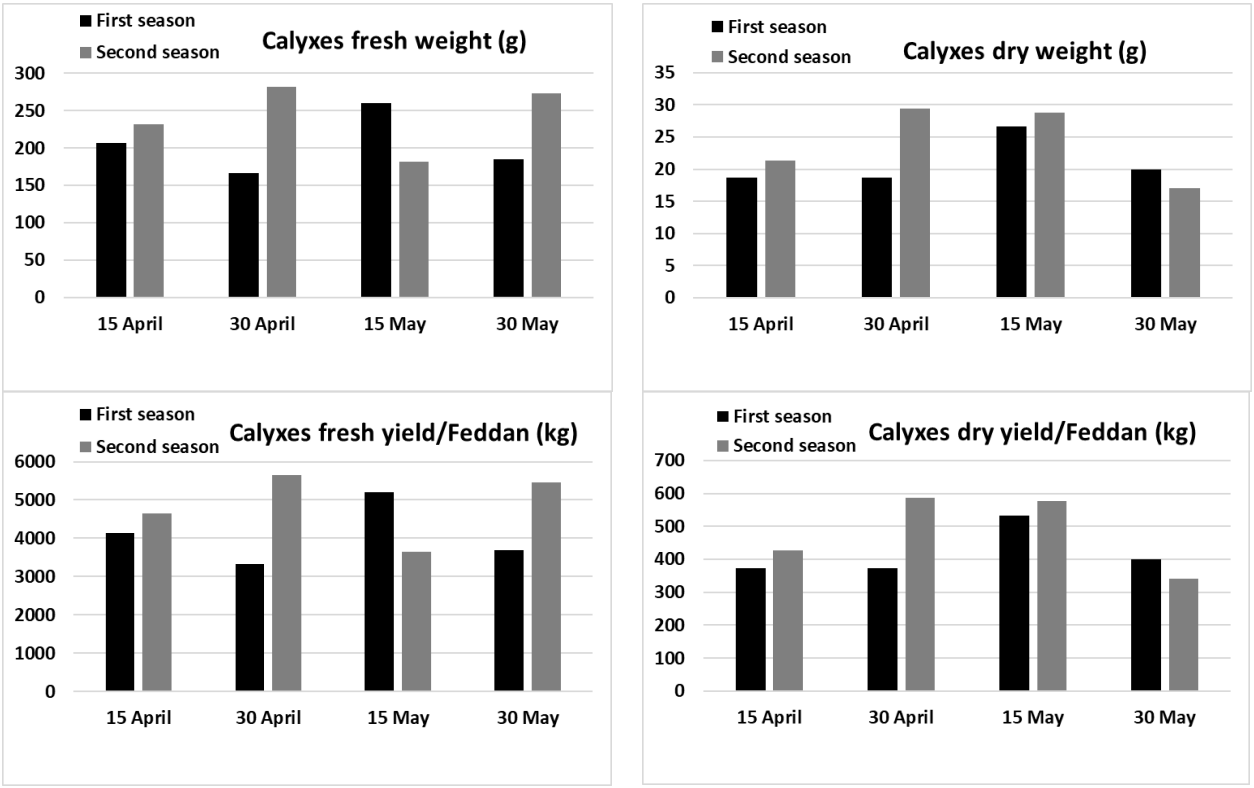

Figure (4): Effect of sowing date on calyxes fresh and dry weight/plant (g) and calyxes fresh and dry yield/Feddan (kg) of Roselle plant.

Statistically, it was found that sowing date have a significant effect on fresh and dry weight of seeds/plant during the two seasons (Figure 5). Sowing Roselle plants on the May 15th date showed maximum seeds fresh weight (149.7 g/plant) in the 1st season, while the Sowing on April 30th showed maximum seeds fresh weight (155.3 g/plant) in the 2nd season. Similarly, seed dry weights were superior (39.7 and 41.3 g/plant) associated with those planted on May 15th and April 30th in the 1st and 2nd seasons, respectively.

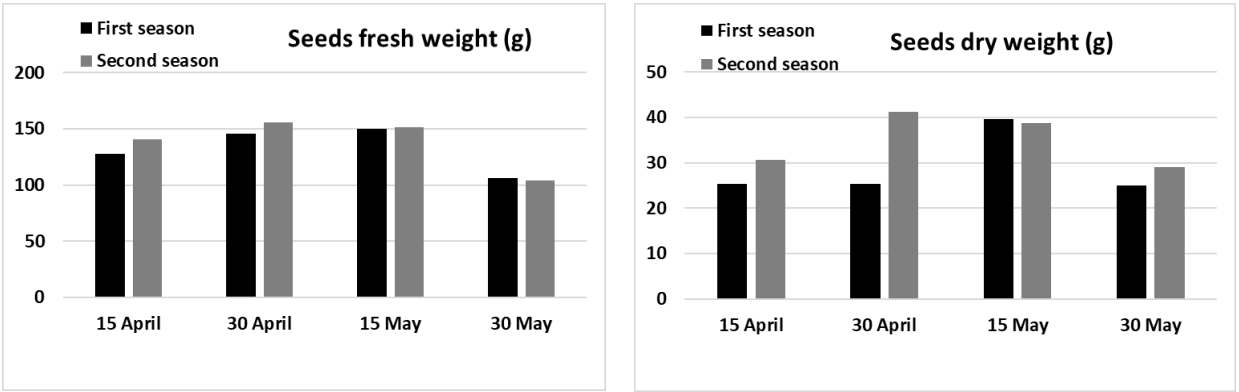

Figure (5): Effect of sowing date on seeds fresh and dry weight/plant (g) of Roselle plant.

Discussion

Given the economic importance of the Roselle plant, especially in Aswan Governorate, which is the main producer of this medicinal plant in Egypt, there is a need to improve its growth and productivity in light of climate changes. So, the current study was conducted on the experimental farm of the Faculty of Agriculture and Natural Resources, Aswan University, Aswan, Egypt to investigate the performance of Roselle plant grown under different sowing dates in sandy soil. In this discussion, the vegetative growth, yield of fruits, calyxes and seeds were discussed under the influence of the sowing dates.

Applying different sowing dates caused significant differences in the plant height, stem diameter, branches number per plant, fruits number per plant, shoot fresh weight and shoot dry weight (Figures 1-3). Mostly, higher values of these traits were recorded with planting on 15th May. The increment in growth measurements in the middle of May could be due to the fact that the conditions for plant growth were suitable during these periods, especially temperature in Aswan Governorate, which was more suitable for plant height, and more number of branches, which was reflected in the plant growth measurements. These results were in harmony with the previous studies of **[14-18].** Also, it seems that sowing Roselle from late of March to 22nd of May under hot and dry climate condition would be suitable for improve plant growth of Roselle **[19]**. On the other side, at El-Qantara Sharq Research Station, North Sinai Governorate, North-Eastern part of Egypt, the effect of planting dates (15th April, 1st May and 15th May) on growth and productivity of Roselle. It was proved that early planting date (15th of April) resulted in increasing in all growth parameters, while delaying the planting date decreased it. It was suggested that these effects might be attributed to the environmental conditions of the experiment such as day length and temperature **[20]**. In the Sudan Savannah of Northern Nigeri, planting Roselle on the mid of July resulted in more growth parameters **[21].** Moreover, it was revealed that the maximum plant height, stem diameter and number of branches per plant were obtained from the sowing at 10th of May. They suggested that prolonged of the growth period allowed plants to perfectly use nutrients, water and radiation which increased the photosynthesis and the plant growth **[22]**.

It is clear from our results in Figures (4 and 5) that the highest values of calyxes' fresh weight/plant and yield/Feddan, calyxes dry weight/plant and yield/Feddan and seed fresh and dry weights per plant were recorded with planting on 15th of May and/or 30th of April. This effect might be due to the environmental conditions, especially temperature and day length. The increase in the fruit characteristics and productivity of Roselle may be due to the fact that the growing conditions at those dates are suitable for the growth and development of the plant. These results were consistent with previous studies of **[15, 16, 18, 20, 23, 24]**. It pointed out that planting dates significantly influenced seed and calyx yield/ha of *Hibiscus sabdariffa* **[21]**. They added that sowing at the mid July significantly had more productivity compared to the other planting dates. These results were in agree also with those of **[25, 26].**

Conclusion

In this study, we evaluated the effects of different sowing dates on the growth and productivity of Roselle plants. According to the obtained results, it can be concluded that sowing date had significant effects on the growth, yield and its related traits of Roselle. However, sowing plants on the 15th of May significantly induced its economical yield (calyxes and seed yield) through improving the plant growth and the fruit number/plant. Therefore, in light of this study, to increase the growth and productivity of Roselle, we recommend sowing plants in the middle of May.

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