Plant Archives Volume 20 No.2, 2020 pp. 5980-5986 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

GROWTH AND PRODUCTIVITY OF ROSELLE (*HIBISCUS SABDARIFFA* L.) AS AFFECTED BY COMPOST FERTILIZER

Media Izaddin Mohammed Amin* and Sawsan M.S. Ali Kanimarani

Horticulture Department, College of Agricultural Engineering Sciences, University of Salahaddin, Erbil, Iraq.

Abstract

This experiment was done to study the effect of local compost on *Hibiscus sabdariffa* L. vegetative and reproductive growth. The experiment was done through May 22th 2017 to December 31th 2017 in Girdarasha farm of Agricultural engineering science College, Salahaddin University, Erbil, Iraq. The results show that compost significantly increased vegetative growth parameters as (plant height, number of branches. plant^{-1} and stem diameter) and reproductive parameter as node sequence of 1st flower. plant^{-1} after 20 weeks of sowing date especially when 2 and 3 tons. ha^{-1} of compost was used. Whereas, yield and yield components as (fruit diameter (mm), number of fruits. plant^{-1}, fresh and dry weight of fruits. plant^{-1} and fresh and dry weight of calyxes. plant^{-1}) were significantly increased when 3 tons. ha^{-1} of compost was applied to the soil. Finally compost significantly decreased dry weight of 100 seeds compared to control.

Key words : growth, productivity, *Hibiscus sabdariffa* L., compost.

Introduction

Roselle plants (*Hibiscus sabdariffa* L.) belong to the Malvaceae family and are grown mainly for the important commercial part of the plant which is the fleshy sepals (calyx) that surround the fruit (capsules). This plant can grow on a wide range of soil conditions but soil should be well supplied with essential nutrients for economic production, which can improve the yield and quality of sepals. Organic compost waste can therefore be used in the soil as a nutrient source for crop production (Parr and Hornick, 1990). Increasing application of compost in freshly recycled soils increased dry matter production and fruit yield significantly (Abou El-Seoud *et al*., (1997). Organic fertilization is a very important method of supplying plants with their nutritional requirements without having an undesired environmental impact. Significant amounts of organic matter must be applied in order to improve the physical and chemical conditions of the manures, depending on its price in relation to this agronomic value, composition, environment and crop characteristics (Ali and Abdel-Mouty, 2000).

Haruna *et al*., (2011) stated that roselle's plant height, number of leaves per plant, number of branches per plant and total dry matter per plant were all significantly increased by both nitrogen and poultry manure application up to 120 kg N ha^{-1} and 5 tons. ha^{-1} respectively. Whereas, significant increase in the number of calyx. plant^{-1}, calyx yield. plant^{-1} and dry calyx yield. ha^{-1} was obtained by the application of 60 kg N ha^{-1} and 2.5 tons. ha^{-1} poultry manure. Vanmathi and Selvakumari (2012) found that Application of vermicompost increased the vegetative growth and yield followed by urea and lowest in control when applied on *Hibiscus esculentus* plants. Khatab (2016) discovered that the investigated compost types used in the study exerted significant effects on plant height (cm), number of branches. plant^{-1} and seed yield (g. plant^{-1}). Hewidy *et al*., (2018) noticed that the positive effect of irrigation and compost application was monitored on plant height, stem diameter, number of leaves, branches and fruits, dry weight of plant and calyx of Roselle plants. The experiment was done to study the impact of local compost on vegetative and reproductive growth of roselle *Hibiscus sabdariffa* L. which no previous studies on

***Author for correspondence :** E-mail: media.mohammedamin@su.edu.krd

roselle plants had been done in the location of study.

Materials and Methods

The experiment was done through May 22th 2017 to December 31th 2017 in Girdarasha farm of Agricultural engineering science College, Salahaddin University, Erbil-Iraq. Some chemical and physical properties of the field soil for the location of study (0-30 cm depth) are shown in table 1. Monthly averages of temperature and humidity through experiments period are shown in table 2.

Plant Material

Seeds of Roselle *Hibiscus sabdariffa* L. were obtained from the Agriculture research centre, Ministry of Agriculture and Water Resources, Kurdistan Region, Erbil-Iraq. It is perennial woody shrub rising to 200-250 cm tall. The leaves are densely three-to five-lobed, 4–15 cm long, alternately arranged on the stems. The flowers are 2–4 cm in diameter, white light purple with a dark red spot at the base of each petal, and have a hard fleshy calyx at the base of flower, 1–3 cm wide, extending to 2–3.5 cm, fleshy and bright red as the fruit matures, they take to mature for about 15-20 days.

Table 1: Some physical and chemical properties of precropping soil samples used in the study.

Soil properties	Girdarasha farm Soil*	Zanco Village Field Soil**
pH		
Electro conductivity (EC)		
Organic matter (OM)		
Total potassium (K_2O)		
Total iron (Fe)		
Clay		
Silt		
Sand		
Soil Texture		

*Laboratory of Salahaddin University College of Agriculture/ Soil and Water Department

**Laboratory of Agriculture Research Center- Ministry of Agriculture and Water Resources, Kurdistan Region, Erbil-Iraq.

Field Preparation

The land of the location of study was ploughed 3 times by Reversible and Disk plow, after that looseness was done. The experiment was considered Randomized Complete Block Design with 3 blocks and there were altogether 12 plots, the plot area was (120×150 cm), 50 cm spacing each in width between two lines of plants in the same plot, 100 cm between two plots, the space between two plants in the same plot was 40 cm and between two plots was 80 cm. Roselle seeds were dressed by (1.5 kg/ton) Raxil fungicide three days before sowing, 18 seeds were sown in each plot at a rate of 3 seeds per hole at about 2.5 cm depth. First irrigation was given just after transplanting while subsequent irrigation was applied when needed. After 4 weeks of sowing date thinning was done to 1 plant per hole and 6 plants per plot. Cultural and management practices like weeding, hoeing etc. were similar for all treatments in all replications throughout the experiment.

Table 2: The metrological data during the study periods.

Months	Temperature (C°)				Average Relative Humidity (%)		Sum of rain (mm)	
	Minimum		Maximum					
	2017	2018	2017	2018	2017	2018	2017	2018
May								
June								
July								
August								
Septembe								
October								
Novembe								
Decembe								

*Agriculture research center, Ministry of Agriculture and Water Resources, Kurdistan Region, Erbil-Iraq.

Description of the Experiment

In this experiment the effect of different levels of local compost (0, 1, 2 and 3 tons. ha^{-1}) table 3, were investigated on the vegetative and reproductive growth of *H. sabdariffa* L. Each block in this experiment contained 4 experimental units. The compost was added to soil three days before seeds sowing around each hole in a diameter of 15 cm in the experimental unit the compost rates were according to their treatments (Ahmed *et al.,* 2011).

The data of vegetative and reproductive growth for studied parameters were collected from 3 selected plants every four weeks starting from 10 days after sowing date until the harvest of fruits, after (4, 8, 12, 16 and 20) weeks of row application.

Experimental Measurements, Morphological Parameters, Vegetative growth parameters AND Plant height (cm)

was measured from the contact point (crown) of the stem with the root to the apical point of the main shoot by using metric ruler.

Number of branches.plant

Number of branches per plant was counted when they can be seen by naked eye.

Stem diameter (mm)

Table 3: some physical and chemical properties of local compost.

Compost properties	Amount
Potential of Hydrogen (pH)	
Electric Conductivity (EC)	
Nitrogen (N)	
Phosphor (P)	
Potassium (K)	
Organic Matter	

* Laboratory of Agriculture Research Center- Ministry of Agriculture and Water Resources, Kurdistan Region, Erbil-Iraq.

Stem diameter was measured using digital Vernier callipers' at the height of 5cm from the soil surface.

Dry weight of 100 leaves (g)

One hundred of full expanded leaves of the plants were selected randomly (for second year experiments). Immediately after cutting, leaves were placed in paper bags and oven dried at 40± 2 ! (till constant weight) and then ground to determine the chemical constituents.

Reproductive Parameters

Days to 50% flowering

measured by measuring the number of days from planting till 50% of the plants of each plot bear at least one open flower.

Flower diameter (mm)

Flower diameter was measured using digital Vernier callipers.

Sequence of 1st flower node. plant

The sequence of first flower node per plant was measured on the main shoot according to 50% flowering.

Number of fruits. plant

Number of harvested fruits was counted for the same selected plants in each plot, thereafter the number of fruits. plant^{-1} was measured as follows:

Number of fruits. plant^{-1}= Number of fruits. plot^{-1}/ Number of plants.plot^{-1}

Fruit length (mm)

Fruit length was measured by digital Vernier callipers' for six randomly fruits of same selected plants.

Fruit diameter (mm)

3 Fruit diameter was measured at the middle portion of same fruits by digital Vernier callipers.

Fresh weight of fruits. plant^{-1}(g)

Fresh weight of fruits per plant calculated by the following equation:

Fresh weight of fruits. plant^{-1}(g)= Total fresh weight of fruits. plot^{-1}(g)/ Number of plants. plot^{-1}

Dry weight of fruits. plant^{-1}(g)

Harvested fruits were oven dried until constant weight at 40± 2 ! (till constant weight) and calculated as follows:

Dry weight of fruits. plant^{-1}(g)=Total dry weight of fruits. plot^{-1}(g)/ Number of plants. plot^{-1}

Fresh weight of calyxes. plant^{-1}(g)

The calyces were peeled off from the capsules of harvested fruits by hands and weighted immediately and calculated as follows:

Fresh weight of calyxes. plant^{-1}(g) = fresh weight of calyxes. plot^{-1}(g)/ Number of plants. plot^{-1}

Dry weight of calyxes. plant^{-1}(g)

Fresh calyxes were oven dried until constant weight at 40± 2 ! (till constant weight) then ground to determine the chemical constituents and calculated as follows:

Dry weight of calyxes. plant^{-1}(g) =dry weight of calyxes. plot^{-1}(g)/Number of plants. plot^{-1}

Dry weight of 100 seeds (g)

100 mature seeds were counted from three plants of each replicate and weighed (ISTA, 2011).

Statistical Analysis

All data collected were statistically analysed using Randomized Complete Block Design RCBD, and the comparison between means were made by using Duncan's Multiple Range Test at 0.05 probability (Al-Rawi and Khalaf-Allah,1980), but for 2nd year experiments (7 and 8) the means of single effects of fertilizers and PGRs were compared by T-test at 0.05 probability level according to "Levene's Test for Equality of Variances". The data was analysed using Statistical package for social sciences SPSS software.

Results and Discussion

Vegetative Growth Parameters

Plant height

It is obvious from the fig. 1 that the tallest plant (90.20 cm) was obtained when 3 tons. ha^{-1}compost were used, when the data collected 20 weeks after sowing date and it was significantly different with (1 and 2 tons. ha^{-1}) treatments at the same time with no significant differences with the control.

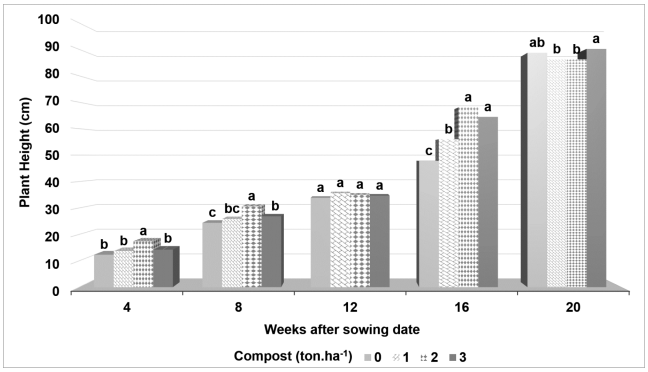

Fig. 1: Effect of compost on plant height of *Hibiscus sabdariffa* L.

*Columns with the same letters of each date are not significantly differ from each other according to Duncan's Multiple Range test at 0.05 level.

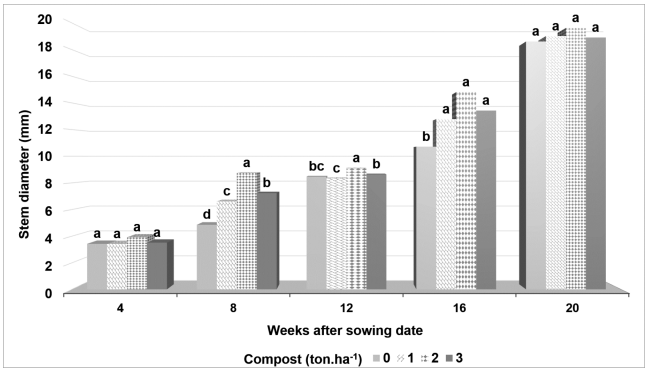

Fig. 3: Effect of compost on stem diameter of *Hibiscus sabdariffa* L.

*Columns with the same letters of each date are not significantly differ from each other according to Duncan's Multiple Range test at 0.05 level.

Number of branches. plant^{-1}

Data in fig. 2 shows the number of branches as affected by compost on roselle. The highest number of branches. plant^{-1} (51.00) was noticed in roselle plant treated with (2 tons. ha^{-1}) compost collected 20 weeks after sowing date which is differ significantly from the other treatments at the same time of data collection. This

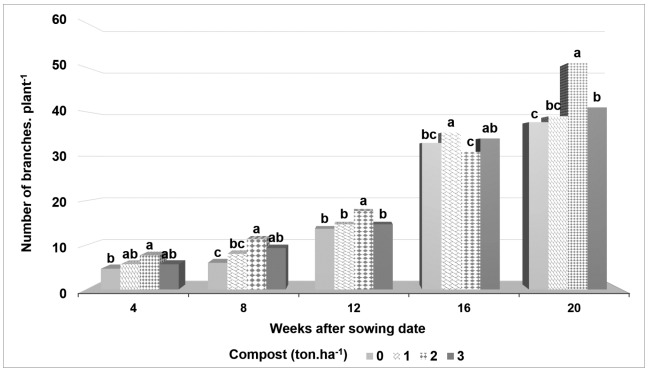

Fig. 2: Effect of compost on number of branches. plant^{-1} of *Hibiscus sabdariffa* L.

*Columns with the same letters of each date are not significantly differ from each other according to Duncan's Multiple Range test at 0.05 level.

treatment recorded the highest number of branches in the other collection dates 4, 8 and 12 weeks after sowing date (7.67, 11.33 and 17.66 respectively).

Stem diameter

Fig. 3 shows that the stem diameter in roselle is not affected significantly by compost levels when the data collected 4 and 20 weeks after sowing. Furthermore, it shows significant differences at 8 and 12 weeks' data collection dates after sowing. Whereas, the same figure shows that 1, 2 and 3 tons. ha^{-1} had superior effect over the control treatment at 16 weeks after sowing date, At the same time, there was no significant differences between them. However, the thickest stem (19.64 mm) was obtained by the treatment (2 tons. ha^{-1}) at 20 weeks after sowing date.

Many studies suggested that compost contributes to the stabilisation and enhancement of agricultural production and plant quality due to its numerous beneficial effects on soil physical, chemical and biological properties. The availability of plant nutrients as well as the soil characteristics should therefore be improved (Amlinger *et al.,* 2007 and Tayebeh *et al.,* 2010**)**. The beneficial effect of compost may be due to increased macro and micronutrient availability, the presence of plant growth regulators or the existence of beneficial micro-organisms in compost (Subler *et al.,* 1998). Such results are in accordance with those reported by (Abdel-Seoud *et al.,* 1997; El-Sherif and Sarwat, 2007 in roselle; Mohamed-Fahmy, 2012 in cucumber and melon). They are also partially similar with the results of (Vanmathi and Selvakumari, 2012 in *Hibiscus esculentus*; Gupta *et al.,* 2014 in Marigold) and it similar with those obtained by (Salem *et al.,* 2012 in *Hibiscus sabdarriffa* and *Zea may;* Islam *et al.,* 2016 in bean bush; Khatab, 2016 and Hewidy *et al*. 2018 in roselle).

Reproductive Growth Parameters

Node sequence of 1st flower. plant^{-1}

Results in Fig. 4 indicates the significant effect of compost levels on node sequence of first flower. It is clear that the compost level of (2 tons. ha^{-1}) gave the distant node sequence of first flower which is (49.33) and it was significantly different with other levels of compost whereas, there are no significant differences between the (0, 1 and 3 tons. ha^{-1}) treatments.

Days to 50% flowering

A significant variation in days to 50% flowering noticed

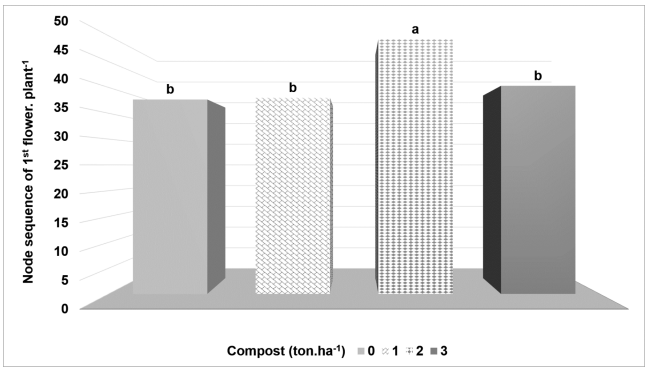

Fig. 4: Effect of compost on node sequence of 1st flower. plant-1 of *Hibiscus sabdariffa* L.

*Columns with the same letters of each date are not significantly different from each other according to Duncan's Multiple Range test at 0.05 level.

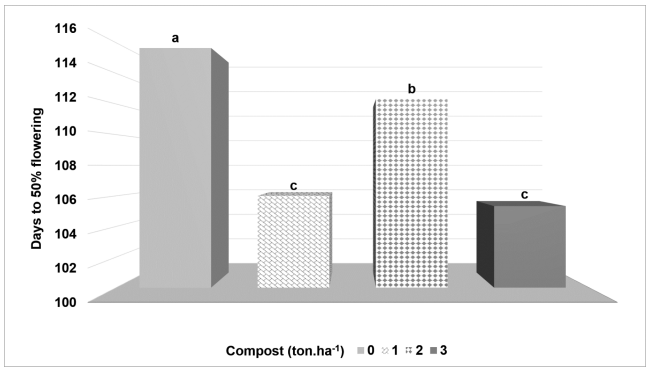

Fig. 5: Effect of compost on days to 50% flowering of *Hibiscus sabdariffa* L.

*Columns with the same letters of each date are not significantly different from each other according to Duncan's Multiple Range test at 0.05 level.

among compost (Fig. 5). The maximum numbers of days to reach 50% flowering (115.66) was recorded from control but the minimum numbers of days of 50% flowering (105.33) was recorded from the treatment (3 tons. ha^{-1}) compost which had most benefit effect for obtaining fruits in earlier time to harvest before the first rain falling in November in the location of this study (Table 2).

Flower diameter

It is clear from Fig. 6 that flower diameter was not significantly influenced by compost treatments at 16 and 20 weeks after sowing date. These results are harmony with those obtained by (Gupta *et al.,* 2014) in Marigold.

Yield and yield components

Results in table 4 shows the effects of compost on fruit diameter (mm), fruit length (mm), number of fruits. plant^{-1}, fresh and dry weight of fruits. plant^{-1} and fresh and dry weight of calyxes. plant^{-1}. The analysis of variance showed that the highest fruit diameter was from control (23.87 mm) which was not different significantly with compost treatments of (1 and 3 tons. ha^{-1}). The longest fruit (30.80 mm) was obtained from compost level (1 ton. ha^{-1}) and there was no significant difference between it and (2 tons. ha^{-1}) however there were significant. The shortest fruit (22.64 mm) was attained from control. The highest number of fruits. plant^{-1} (66.00) was obtained from (3 tons. ha^{-1}) compost and the lowest number of fruits. plant^{-1} (25.00) was obtained from the control. The same mentioned table 4.3 shows that there were significant differences among compost levels. The highest fresh and dry weight of fruits. plant^{-1} and fresh and dry weights of calyxes. plant^{-1} was (210.57 and 31.82 g) and (152.75 and 25.09 g), respectively recorded when (3 tons. ha^{-1}) compost was used.

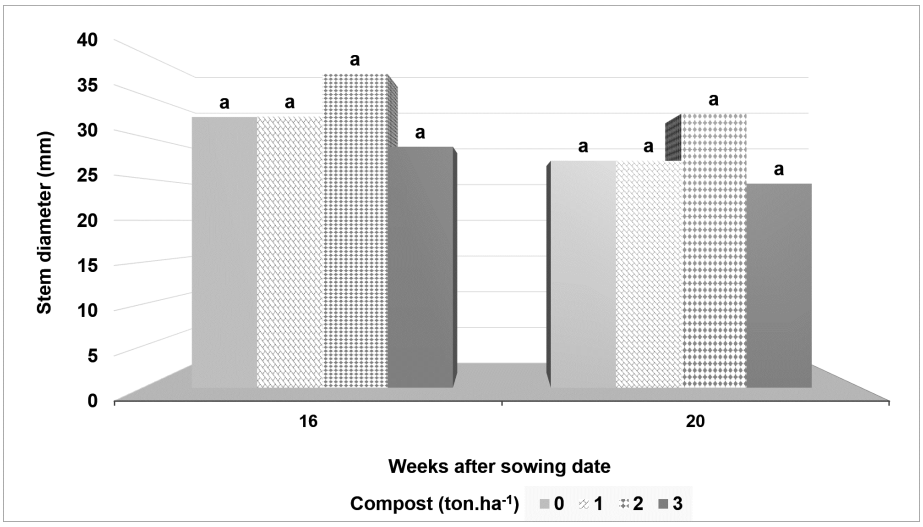

Fig. 6: Effect of compost on flower diameter of *Hibiscus sabdariffa* L.

*Columns with the same letters of each date are not significantly different from each other according to Duncan's Multiple Range test at 0.05 level.

Dry weight of 100 seeds

The effect of compost on 100 seeds weight. plant^{-1} presented in Fig. 7. It is clear from this Fig. that application of compost had negative significant effect on 100 seeds dry weight of roselle, the control treatment gave the highest value (3.53 g). The present results could be supported by previous related work of (Yagoub *et al.,* 2012) on soybean.

The findings of the reproductive parameters analysed revealed that the compost had a stimulating effect on plant growth

Table 4: Effect of compost on yield and yield components of *Hibiscus sabdariffa* L.

Compost (ton.ha^{-1})	Fruit diameter (mm)	Fruit length (mm)	No. of fruits. plant^{-1}	weights of fruits. plant^{-1} (g)		weights of calyxes. plant^{-1} (g)	
				fresh	dry	fresh	dry
0							
1							
2							
3							

* Values within each column followed with the same letters are not significantly different from each other according to Duncan's Multiple Range Test at the (0.05) level.

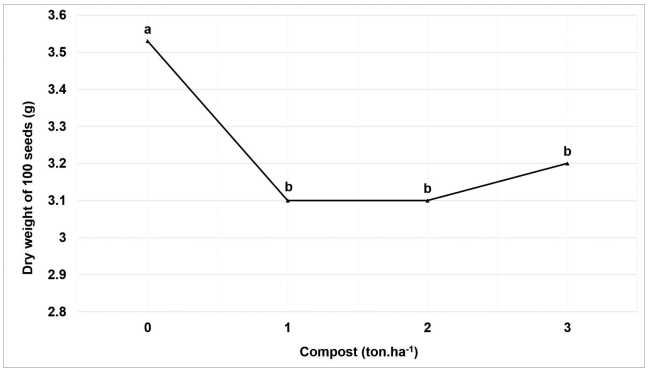

Fig. 7: Effect of sowing dates on dry weight of 100 seeds of *Hibiscus sabdariffa* L.

*Bars of the same letters are not significantly different from each other according to Duncan's Multiple Range test at 0.05 level.

and residence in order to increase its economic productivity. This beneficial effect can be attributed to the higher nutritional value of the compost (Table 3). The present results could be supported by relevant work of (Abdel-Seoud *et al.,* 1997; Atiyeh *et al.,* 2000 in tomato; El-Sherif and Sarwat, 2007 in roselle; Mohamed-Fahmy (2012) in melon and cucumber; Hewidy *et al*. 2018; Shuhaimi *et al.,* 2019 and Yusuf *et al.,* 2019) in roselle.

Conclusion

It can be argued that the use of organic fertilizers has led to an improvement in soil physical requirements including better aeration, better water keeping efficiency, better nutrient supply and good nutrient quality in the soil solution and increased soil nutrient and ion exchange (Rady *et al.,* 2016).

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