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Full Length Research Paper

Effect of mineral and organic fertilizers on the growth and calyx yield of roselle (*Hibiscus sabdariffa* L.)

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Yield study was carried out during the 2006 summer season in the field of Research Institute, University of Zabol at Sistan (latitude 30°54' N and longitude 61°41'E). The goal of the study was to evaluate the reaction of roselle cultivar to different chemical fertilizers alone or in combination with organic manure. Ten fertilization treatments were used for this study (mineral fertilizer, hen manure, cattle manure, ostrich manure, mineral fertilizer plus hen manure, mineral fertilizer plus cattle manure, mineral fertilizer plus ostrich manure, hen manure plus cattle manure, hen manure plus ostrich manure and ostrich manure plus cattle manure). Rates of NPK fertilizers were 300, 200 and 200 Kg ha^{-1}, respectively and organic manure included cattle, hen and ostrich manures with combination of others. This study was done in a randomized complete block design (RCBD) arrangement with three replications. Application of ostrich in addition to hen manure significantly (P<0.05) increased plant height, branch number/plant, weight of dry stem and calyx yield compared with other treatments but did not show significant difference in number of pods of roselle. Calyx yield of 1.6 t/ha was significantly different (P<0.05) compared to other manure. The highest of calyx yield was obtained by using ostrich plus hen manure compared to other organic manures. Results of this study indicate that maximum calyx yield of roselle is grown when ostrich plus hen manure is used.

Key words: Roselle, mineral and organic fertilizer, growth, calyx yield.

INTRODUCTION

Roselle (*Hibiscus sabdariffa*. L) belongs to the Malvaceae family, and is an annual or biennial plant cultivated in tropical and subtropical regions for its stem fibers, eatable calyces, leaves and grains. Cultivation of the plant has been reported throughout Indian subcontinent, part of Asia, America and Australia and Africa (Cobley, 1968). Roselle that common people call "Yakuwa" (Hausa) and 'Isapa' (Yoruba), is adapted to a spread range of soil conditions. It is often grown on relatively infertile soils but economic yields are only obtained on soils which are well supplied with organic material and essential nutrients. Roselle is resistant to relatively high temperatures throughout the growing and fruiting times (Tomes, 1990).

Nutritionally, the calyces, as reported by FAO, have significant amounts of vitamins A, C, phosphorous, Iron and calcium but tiny protein (FAO, 2004). The juvenile leaves are also known to be rich in assimilation protein, the oil content of roselle seeds may vary from 25 to 30% and it has similar qualities with cotton seed oil. The plant is, however most proper in tropical climate. It is an important crop in many forms. The leaves are used for making soup, while the fleshy calyces are used for making syrups, jelly and alcoholic drink. It has been reported (Rao, 1996) that the plant is grown in some areas for obtaining fiber from its stem. Nearly 17% of edible oil is derived from the seed, which is also used as hen's feed. Roselle is a short day crop with a critical photoperiod of 12 to 12.5 h, and progresses best in hot, dry regions with a high humidity and temperature of about 25 to 35°C (Hacket and Carolene, 1982). High productive potential has been reported for roselle grown under rainfed, and through various agronomic training such as weeding (Babatunde and Zechariah, 2001);

Abbreviation: RCBD, Randomized complete block design.

intercropping, sowing dates and nitrogen fertilizer (Babatunde, 2003). To increase the quality of crops especially medicinal and aromatic crops, organic fertilization is better than mineral fertilizers. Organic agriculture is a quality standard to be matched well by small farmers (Abou El-Fadl et al., 1990). It is suggested that there should be completely or partial substitution of mineral fertilization (NPK) by using of organic and bio-fertilizers which are sure and economical to farmers. Many investigators have pointed out the influence of organic manure by increasing the growth, yield and essential oil production of celery (Mahajan et al., 1977), Achilla (Sayed, 1993), groundnut (Mehta et al., 1995), roselle (Ezz-Eldin and Abd-Elmoaz, 1998), Anise (Safwat et al., 2001), Cumin (Safwat and Badran, 2002) and Fennel (Badran and Safwat, 2004). According to Fagbayide (1997), the full yield and nutritional quality of the crop should be taken into consideration, in any fertilizer programmed. Sadly, little has been reported on the effects of mineral fertilizers on the yield and quality of the economic portion of roselle especially in the arid region. Other researchers believed that the application of nitrogen sources to roselle in the rainforest zone of nitrogen is almost a front for optimum growth and yield of roselle (Ginginyu et al., 1999).

Egharevba and Law-Ogbomo (2007) showed that yield of roselle was more influenced by NPK compared to urea at 100 kg ha^{-1}. Other researchers reported that both nitrogen and phosphorus are notable for the growth and yield of the roselle plant, just as with most crop plants (Okosun et al., 2006).

This study is guidance for studying the effect of mineral fertilizer and organic manure alone or in combination on vegetative aspects, sepal yield–and yield components of roselle plant.

MATERIALS AND METHODS

The present study was carried out at the Research Farm, Faculty of Agriculture, University of Zabol, during 2006 to study the influence of mineral fertilizers and organic manures on growth, calyx yield and yield component. The study farm is located at 30° 54′N, 61° 41′E at an altitude of 483 m above sea level in Sistan Region. Sistan zone is located in Southeast of Iran and has arid type of climate. Organic manure (cattle, hen and ostrich manure) was provided from the animal production farm of Faculty of Agriculture, University of Zabol. Seeds were sown on December 15. The experimental plot was 2 × 4 m in row to row, which was 50 cm apart; each plot contained four rows (20 cm apart) and each row contained two hills. Four weeks from planting, plants were thinned to one plant per hill. The experimental treatments were laid out in a randomized complete block design with three replicates. All agricultural practices were performed as usual.

The 10 treatments are as follows: T_1, NPK recommended fertilizer [300, 200 and 200 Kg ha^{-1}, N (Urea), P (super phosphate), K (potassium sulfate), respectively]. T_2, Cattle manure (40 t ha^{-1}). T_3, Hen manure (40 t ha^{-1}). T_4, Ostrich manure (40 t ha^{-1}). T_5, NPK recommended (150, 100 and 100 kg ha^{-1}, NPK, respectively) + cattle manure (20 t ha^{-1}). T_6, NPK recommended (150, 100 and 100 kg ha^{-1}, NPK, respectively) + hen manure (20 t ha^{-1}). T_7, NPK recommended (150, 100 and 100 kg ha^{-1}, NPK, respectively) + ostrich manure (20 t ha^{-1}). T_8, Cattle manure (20 t ha^{-1}) + hen manure (20 t ha^{-1}). T_9, Cattle manure (20 t ha^{-1}) + ostrich manure(20 t ha^{-1}). T_{10}, Hen manure (20 t ha^{-1}) + ostrich manure (20 t ha^{-1}).

Data recorded

The following data were recorded: Average of plant heights, branch number/plant, stem dry weight kg ha^{-1} and number of pods/plant and calyx yield kg ha^{-1}.

Analysis of mineral nutrient of manures

Nitrogen was determined by Kjeldahl procedure. Potassium was measured by flame photometer (Corning 405). Phosphorus was determined spectrophotometrically (Olsen methods UV). The physical and chemical characteristics of the soil used are presented in Table 1 and the chemical analysis of the organic manure is shown in Table 2.

Statistical analysis

Data were statistically analyzed according to Steel and Torrie (1980) and means were compared between treatments by least significant range (LSR) at P≤ 0.05.

RESULTS AND DISCUSSION

Vegetative growth

Plant height (cm)

Data presented in Table 3 shows that the effect of NPK and organic manure fertilizers separately or in combination on plant height of roselle plants was statistically significant. From the obtained results, it is revealed that T_{10} (hen manure (20 t ha^{-1}) + ostrich manure (20 t ha^{-1}) significantly accelerated the plant height compared to other organic manure and mineral fertilizer. Fertilizing roselle plants with hen manure (20 t ha^{-1}) + ostrich manure (20 t ha^{-1}) treatment gave the tallest plants compared to other combination treatments. There were no significant differences between T10 and T7. The beneficial effect of NPK and organic manure on plant height was insistence by other investigators (Mohamed and Ahmed, 2003; Swaefy et al., 2007) on mint plant.

Branch number/plant

Branch number of roselle plants had significant effect by using NPK and organic manure. It seems that T10 and T7 treatments led to a significant increase in number of branches/plant in comparison with other treatments. Treating roselle plants with hen manure (20 t ha^{-1}) + ostrich manure (20 t ha^{-1}) or NPK recommended (150,

Table 1. Physical and chemical characteristics of the soil.

Texture	Sand (%)	Silt (%)	Clay (%)	pH	EC (ds/m)	N (%)	P (ppm)	K (ppm)
Sandy loam	66	23	11	7.4	1.5	0.06	14	110

Table 2. Chemical analysis of organic manure used in the research farm.

Manure	Macro element		
	N (%)	P (%)	K (%)
Cattle manure	1.2	0.51	0.34
Hen manure	1.25	1.43	0.78
Ostrich manure	1.37	1.80	0.36

Table 3. Effect of chemical and organic manure on vegetative growth characters of roselle plants during 2006/2007 season.

Treatment	Plant height (cm)	Branch number/plant	Stem dry wieght (t ha^{-1})	Calyx yield (kg ha^{-1})	Pods number/plant (ns)
T1	138.3^{c}	1.66^{b}	9.5^{ab}	891^{b}	29.6
T2	165.3^{b}	2.66^{ab}	7.83^{b}	890^{b}	39.6
T3	175.0^{ab}	3.33^{ab}	16.1^{ab}	915^{b}	41.3
T4	163.7^{b}	3.33^{ab}	12.1^{ab}	958^{b}	34.3
T5	168.3^{b}	2.33^{ab}	6.66^{b}	886^{b}	37.0
T6	150.3^{b}	3.66^{ab}	7.83^{b}	974^{b}	20.3
T7	194.3^{a}	4.66^{a}	15.33^{ab}	1150^{b}	48.0
T8	142.7^{c}	4.00^{ab}	10.87^{ab}	1160^{b}	38.3
T9	162.7^{b}	2.66^{ab}	8.83^{b}	911^{b}	26.6
T10	207.0^{a}	4.66^{a}	22.00^{a}	1606^{a}	43.3

*Means followed by the same letter (s) within a column are not statistically different at the p = 0.05% level. ns, Non significantly different.

100 and 100 kg ha^{-1}, NPK, respectively) + ostrich manure (20 t ha^{-1}) recorded high branch number compared to other treatments. The efficiency of NPK and organic manure was mentioned by many authors such as Abou-Aly and Gomaa (2002) on coriander plant and Shaalan (2005) on *Nigella sativa* L. plant.

Stem dry weight

Table 3 shows that stem dry weight of roselle plant was significantly affected when the plans were fertilized with mineral and organic manure. From the obtained data it could be drawn that T10 significantly increased stem dry weight compared to other treatments. The lowest of stem dry weight (6.6 t.ha^{-1}) was obtained at T5 (NPK recommended; 150, 100 and 100 kg ha^{-1}, respectively + cattle manure (20 t ha^{-1}).

The yield parameters

Number of pods/plants

Data recorded in Table 3 points out that the effect of NPK and organic manure treatments on the number of the pods of roselle plant was not significant. The affirmative effect of NPK and organic manure was declared by Yuonis et al. (2004) on *Ammi visnaga* L. and Salem and Awad (2005) on coriander plant.

Calyx yield

The effect of NPK and organic manure on calyx yield (kg/ha) was statistically significant. The data reveals that receiving roselle plants with the high level of organic manure treatment produced the highest values of calyx in comparison with mineral treatments. The highest value of

calyx yield was obtained by T_{10} (hen manure (20 t ha^{-1}) + ostrich manure (20 t ha^{-1}) with 1606 kg ha^{-1} (dry weight), but the lowest value was obtained with T5 (NPK recommended; 150, 100 and 100 kg ha^{-1} + cattle manure; 20 t ha^{-1}) having 886 kg ha^{-1} (dry weight). The stimulating effect of NPK and organic manure treatments was investigated by Radwan and Farahat (2002) oncoriander plant.

Conclusion

According to the results obtained, all the manure used in this study can be used to improve agricultural soils and ameliorate soil properties, because they consist of notable organic matter. However, among all the manure, hen manure plus ostrich manure showed the highest values of parameters for the growth of roselle. The maximum yield of roselle was under hen manure plus ostrich manure found to be about 16060 kg ha^{-1} of dry calyx per hectare. Ostrich manure and hen manure have the highest value of N, P, K compared to cattle manure. Application of mineral fertilizers to roselle is also important.

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