Influence of Nitrogen Fertilizer on Growth and Calyx Yield of Roselle (*Hibiscus sabdariffa* L.) Grown under Field Conditions

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Abstract

Assessments of growth, calyx yield and nutritional composition of roselle can help farmers in Iraq to determine which cultivars are the best for commercialization. The field experiment has been done on two roselle cultivars (red and white) during summer of 2019 in a private farm that belongs to a farmer in Al-Saniyah county, Al-Diwaniyah, Al-Qadisiyah province, Iraq, to investigate the impact of applying various rates of N fertilizer (0, 30, 60, 90, and 120 kg N/ha) on some agronomic traits and calyx yield. The results exhibited that there were significant differences in the rate of Nitorgen and applying N fertilizer has increased the vegetative growth and yield. Significant differences have been also reported in different agronomic traits between the cultivars and the white cultivar showed the best. The red cultivar of roselle showed the better in yield and yield components than the white cultivar grown in Iraq. It can be concluded that applying of nitrogen fertilizer had a pronounced beneficial influenced on the red roselle cultivar.

Keywords: roselle, nitrogen fertilizer, agronomic traits, calyx yield

1. Introduction

*Hibiscus sabdariffa* L. (Roselle) is one of members of the Malvaceae family and is grown as an annual shrub in the tropical and subtropical area [1]. Roselle is cultivated in Asia, Africa, Australia, and America for its stem fibers, leaves eatable calyces, and seeds [2]. The calyces of roselle differ in color (i.e., white, green, pink, red, and dark red), and have significant levels of vitamin C and A, iron, Ca, phosphorus, and little proteins. Thus, roselle is utilized for medicinal and health purposes [3]. The seeds of roselle contain oil, which contains high lysine rate and uses in culinary; also, roselle seeds are rich in protein, calorie, fat, fiber, and micronutrients [4].

The application of nitrogen fertilizer was reported for improving the growth of plant and development of roselle. The vegetative development of roselle with using N fertilizer has been reported by many research activities. The calyx yield and plant growth of roselle must be taken into consideration in all applications of fertilizers [5, 6]. However, little works have been reported on the influence of N fertilizer on the yield and growth of this plant in Iraq. Moreover, the recommendation of N fertilizer for roselle growth and development in Iraq is lacking and farmers have tried the average of N fertilizer for okra (*Abelmoschus esculentus* L.) a crop of the same family. Thus, the objective of conducting this field study has been done to assess the influence of applying various averages of urea fertilizer on the plant growth and the calyx yield of roselle.

2. Material and methods

A field study has been done through summer season in 2019 in a private farm that belongs to a farmer in Al-Saniyah county, Al-Diwaniyah, Al-Qadisiyah province, Iraq for determining the influence of various nitrogen averages on the growth and yield of roselle. Samples of soil have been obtained to analyze the physical and chemical properties of soil traits before cultivation (Table 1). Treatments consisted of 5 rates of the fertilizer of N: 0, 30, 60, 90 and 120 kg N/ha and two cultivars; red and white, and treatments have been located in a complete randomized design (CRD) in three replicates.
Table 1. The soil chemical and physical characteristics of the study field.

| The texture of Soil          | Silt clay loam |
|------------------------------|----------------|
| The organic matters (g.kg-1) | 0.62           |
| EC (Electrical conductivity) (ds.m-1) | 2.6           |
| pH                           | 7.9            |
| Silt (g.kg-1)                | 415            |
| Sand (g.kg-1)                | 288            |
| Clay (g.kg-1)                | 189            |
| Availability of Nitrogen (mg.kg-1) | 17           |
| Availability of Phosphorus (mg.kg-1) | 26           |
| Availability of Potassium (mg.kg-1) | 254           |

Urea fertilizer was used as a resource for inorganic nitrogen fertilizer and it has been used in twice; the 1st after twenty-five days of the planting & the 2nd one after fifty days of the planting. Ten plants have been harvested from each experimental unit to measure different agronomic traits. Different agronomic traits (height of plant, branches number for each plant, and leaves number for each plant) and components of yield (fruits number for each, fresh weight of the calyx yield, and the dried weight of calyx yield) were determined. The inputs of field study were analyzed through utilizing the regression analysis, and the R software system was used to get the outputs of this field study.

3. Result and discussion

For the influence of nitrogen fertilizer on plant height (Fig 1), it was observed that as the rate of N increased, plant height increased also in linear manner especially in white roselle cultivar. The relationship was a non-linear relation for red roselle cultivar and the maximum plant height was reached at 60 kg N/ha. This result agreed with previous ones on basil and roselle [7-10].

The highest number of leaves per plant has been got in the treatment of 90 kg N/ha rate which were 49 for white roselle cultivar and 30 for red roselle cultivar when the treatment of 120 kg N/ha was applied. This result is in harmony with previous one mentioned by [7-10].

For the effect of nitrogen fertilizer on branch numbers per plant (Fig 3), it was got that as the rate of nitrogen fertilizer raised the number of branches per plant increased also in linear manner especially in red roselle cultivar and in non-linear manner in white roselle cultivar. The result agreed with previous one mentioned by [7-11].

It is clear from Figure 4 that fruit numbers responded significantly to application of nitrogen fertilizer in both roselle cultivars. The number of fruits per plant increased with increased N rate and reached 123 for red roselle cultivar and 78 for white roselle cultivar. Also, this result agreed with previous one mentioned by [8, 9].
Figure 1. Influence of usage various average of nitrogen fertilizer on the plant height of different roselle cultivars.

Figure 2. Influence of usage various rates of nitrogen fertilizer on leaf numbers per plant of different roselle cultivars.
Figure 3. Influence of usage various rates of fertilizer of nitrogen on branch numbers per plant of different roselle cultivars.

Figure 4. Influence of usage various rates of fertilizer of on fruit numbers per plant of different roselle cultivars.

The fresh weight of calyx increased dramatically as nitrogen rate increased especially in red roselle cultivar which shown a non-linear relationship (Fig 5). The highest fresh weight of calyx yield was got in treatment of 90 kg N/ha rate which were 4.42 (t/ha) for red roselle cultivar and 2.73 (t/ha) for white roselle cultivar when the treatment of 120 kg N/ha was applied. This result is in harmony with previous one mentioned by [6, 7].
Figure 5. Influence of applying different averages of fertilizer of nitrogen on fresh weight of calyx yield of different roselle cultivars.

For the influence of fertilizer of nitrogen on dry weight of calyx yield (Fig 6), it was observed that as the rate of nitrogen fertilizer increased, the calyces dry weight starts from 230 (kg/ha) for red roselle cultivar and 170 (kg/ha) for white roselle cultivar for control treatment and reached 960 and 520 (kg/ha) for the both cultivars at the highest average of N fertilizer. Also, regression analysis exhibited the positive linear correlation between the calyx dry weight and nitrogen rate for red roselle cultivar. However, the relationship between the calyx dry weight and nitrogen rates was non-linear for white roselle cultivar. Also, this result agreed with previous one mentioned by [6,7,9,12].

Figure 6. Impact of applying different averages of N fertilizer on dry weight of the calyx yield of different roselle cultivars.

Conclusion

According to the results of the current field study, the calyx yield and growth of roselle were influenced by applying N fertilizer, rate, and cultivars. The most agronomic traits studied done well at 90 kg N ha\(^{-1}\) for white roselle cultivar, while the yield and yield components were better at 90 kg N ha\(^{-1}\) for red roselle cultivar. The main differences was from the cultivars where red roselle cultivar out yielded white roselle cultivar. In Iraq, applying N fertilizer is recommended for increasing the calyx yield and growth of this plant. Moreover, the red roselle cultivar is recommended for the commercial production.
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