



## Appropriate Chemical Fertilizer Application Rates on Yield and Yield Components of Red Roselle, Cultivar: Surin

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**Abstract** The experiment of appropriate chemical fertilizer application rates on yield, yield components, dry calyx acid and seed oil contents in red roselle (*Hibiscus sabdariffa*) cultivar: Surin with 4 chemical fertilizer rates (16-16-16: 0, 25, 50 and 75 kg/rai; 1 rai = 1,600 m<sup>2</sup>) was conducted at Faculty of Agricultural Technology; Rajamangala University of Technology Thanyaburi; Pathumtani province, during late July to December 2010 by RCB design 4 replications. The results indicated that some agronomic characteristics, yield and yield components of all red roselles with applied in any rate of the chemical fertilizer were higher than the non-applied one. The rate of 75 kg/rai brought red roselle not only got better in growth of vegetative parts (192.2 centimeters of plant height, 10 main branches), faster in 50% first flower blooming date (only 100 days after planting), longer periods of flowering and maturation of the first fruit (22 and 23 days after the first bloom flower) but also gave greater in yield components (38.8 fresh fruits, 179.2 and 24.1 grams fresh and dry calyx, 31.1 grams of seeds/plant), these supported the roselle to get the highest yield (764.8, 103.0 and 132.8 kg/rai of fresh calyx, dry calyx and seed weight respectively). Nevertheless when considering to the harvest index, the highest rate of fertilizer applied roselle plot was equal to that non-applied plot (0.36). Regarding to the analysis of dry calyx acid and seed oil contents in red roselle, all treatments by average contained 13-16% of acid and 20-21% of seed oil.

**Keywords** red roselle, chemical fertilizer rates, yield, yield components, dry calyx acid, seed oil contents

### INTRODUCTION

Roselle (*Hibiscus sabdariffa*), a member of Malvaceae family, is a tropical crop which has the various uses, started from home consumption to medicinal and industrial uses. Red calyxes are utilized as reagent for jelly, jam, beverages, sauces and food preserves (Abo-Baker and Mostada, 2011). Fresh calyxes are filled with greater amount of ascorbic acid and also rich in riboflavin, niacin, carotene, calcium and iron while dry calyxes presents antimicrobial as well as antioxidant activities due to its phenolic compounds: flavanoids, gossypetine, hibiscetine and saddaretine. Seeds of roselle have been found to be a good of protein (Anokwuru et al., 2011 and Qi et al., 2005). Furthermore, the calyx extraction had a great therapeutic action for curing heart and nerve diseases and high blood pressure (Hassan, 2009).

Roselle is one of the target medicinal herbs that Thai government desired to push their products to share in the international markets. Thailand used to be the outstanding exporter of high quality dry roselle calyxes before the occurrence of economic crisis. From the analytic report of roselle production, market and processing, OAE (2007) had concluded that despite roselle products have a big chance for markets but there are some obstructions: in part of production, most plantations are in small scale (only 5-6 rai/grower) with using the local growing practices, lacking of good varieties and agricultural practicing, then led to low productive efficiency. Indeed, systematic cultivation of this medicinal plant needs specific cultural, management practices and agronomical recommendations. Fertilizer is a major factor affecting crop production, to search for

optimum rate of application being one important cultural practice needs to be standardized. Unfortunately, until now there is very few of available research papers that could be supported the roselle production in commercial scale.

## **OBJECTIVE**

This investigation was aimed to find the response of red roselle to 4 chemical fertilizer rates (16-16-16 : 0, 25, 50 and 75 kg/rai; 1 rai = 1,600 m<sup>2</sup>) on yield, yield components, acid content in dry calyxes and oil content in seeds.

## **METHODOLOGY**

Field trial was carried out at the Agronomic field of Agricultural Technology Faculty, RMUTT, during late July to December 2010. Before planting, the soil sample from field was taken and sent to Soil and Plant Laboratory of Rice Department of Thailand for properties analysis (the results were Sandy clay loam texture, pH 6.3, Organic matter 2.23%, Total N 0.11%, P<sub>2</sub>O<sub>5</sub> 123 ppm, K<sub>2</sub>O 241 ppm, CEC 9.76 meq/100g). Simultaneously the compost and manure samples were brought to analyse for NPK contents in Soil and Plant Laboratory at Kasetsart University (compost: 1.12%N; 0.46% P<sub>2</sub>O<sub>5</sub> and 1.03% K<sub>2</sub>O, manure: 1.49%N; 0.57% P<sub>2</sub>O<sub>5</sub> and 1.30% K<sub>2</sub>O). At the land preparation time or two weeks before planting, one tons of farmyard manure mixed with one ton of compost per rai were uniform applied to all plots as basal application.

The experiment was arranged in RCB design with 4 replications and 4 level of chemical fertilizer application rates (formula 16-16-16: 0, 25, 50 and 75 kg/rai) which were applied at 3 weeks after planting. Two-three seeds/hill were sown (two weeks later thinned to one plant/stand) at 75x50 centimeters, 5 rows in 21 square meters of plot size. Ten sample plants in the middle rows of each plot were observed for agronomic characteristics: plant height, number of main branches, 50 % of 1st flower blooming date, flowering periods and 1st fruit maturation date. At maturity, dark red fresh fruit of ten sample plants in each plot were harvested for collecting yield and yield components data : number of fresh fruits/plant, fresh calyx weight/plant, dry calyx weight/plant, seed weight/plant, 1000 seeds weight, fresh and dry calyxes yield, seed yield and harvest index. The 200 g of dry calyxes and seeds of each treatment were taken to Agricultural and Agro-Industrial Product Improvement Institute at Kasetsart University for analysed the contents of dry calyx acid and seed oil.

## **RESULTS AND DISCUSSION**

### **Some Agronomic Characteristics**

Highly significant increase in plant height and number of main branches/plant was observed with chemical fertilizer application by the 120 days after planting when compare with the control treatment (2 tons of compost mixed with manure only). The plant height varied from 145.9 cm in non fertilized plants to 191.2 cm in plant that received the highest rate of chemical fertilizer (75 kg/rai). In case of number of main branches/plant, it seems that all fertilized plants progressively increased their number of main branches/plant from 3 branches of control treatment to 8-10 branches/plant. Generally, fertilized plants would perform better than non fertilized one. (Akanbi et al., 2009)

When considering to the data analysis of 50 % of 1<sup>st</sup> flower blooming date, flowering periods and 1<sup>st</sup> fruit maturation date, it showed that the highest rate of application plant took shortest time to reach 50% of 1<sup>st</sup> flower blooming, equal to 3-11 days faster when compared with the lower rates and control treatments. Moreover, it spent a little longer period of flowering (since the first to last flower blooming) and 1<sup>st</sup> fruit maturation (duration between flower blooming and mature fruit). Plants in higher fertilizer rate flowered earlier might be because of the vigorous and rapid growth

of plants which brought them to attain the competent stage of flowering. Oyewole and Mera (2010) reported that manure application promoted vegetative growth in roselle, while nitrogen had elongated the juvenile stage in plant, thus delaying crop maturity.

**Table 1 Some agronomic characteristics of red roselle “Surin” at different rates of chemical fertilizer**

Fertilizer (16-16-16) (kg/rai)	Plant height at 120 day after planting (cm)	No. of main branches/plant	50 % of 1 <sup>st</sup> flower blooming date (days)	Flowering periods (days)	1 <sup>st</sup> fruit maturation date (days)
Control	145.9b	2.8c	111.0a	19.3b	21.8c
25	186.9a	8.3b	104.2b	20.8ab	22.6b
50	186.4a	9.3ab	103.0b	22.3a	22.7b
75	191.2a	9.8a	100.2c	21.8a	23.3a
F test	**	**	**	**	**
CV.(%)	6.44	9.75	1.24	4.59	1.19

Means followed by the same letter at the same column were not significantly different by LSD

\*, \*\* significant at  $P < 0.05$  and  $0.01$ , respectively and ns not significant

### Yield and Yield Components

Different chemical fertilizer rates had significant effect on yield and yield components of deep red roselle “Surin”. Application of 75 kg/rai plots gave the highest number of fresh fruits, fresh and dry calyxes weight/plant/rai, seed weight/plant and seed yield/rai. Meanwhile the application in 50 kg/rai plants had all components and yield which were at par with the 25 kg/rai ones. Nevertheless, both got in higher values than control treatment equal to 1.3-1.4 times. However, increased in application of the chemical fertilizer rates did not show the significant affect on the 1000 seed weight. Okosun (2006) reported that the 20 kgN/ha did enhance the number of fruits and seed/fruit. Furthermore, Haruna et al. (2011) found that the application of 60 kg/ha of nitrogen fertilizer and 5 tons/ha of poultry manure significantly increase calyx yield and profitability of roselle. Oyewole and Mera (2010) observed that for the calyx, pod and seed production, the application of manure at 7.5 tons/ha or nitrogen at 75 kgN/ha gave the best yield. Anyinkeng and Mih (2011) concluded that 20 tons of poultry manure significantly increase growth, biomass and economic yield of roselle. In case of the harvest index (calyx plus seed yield), it was found the significant effect on. The increased fertilizer rate from control to 50 kg/rai had reduced the harvest index value. However, when topped up to 75 kg/rai, the value was speed up but not over the control. Atta et al. (2010) also discovered that the supplying 50-100 kgN/ha significantly decreased seed and calyx harvest indexes relative to control (0 kgN/ha).

**Table 2 Yield components of red roselle “Surin” at different rates of chemical fertilizer**

Fertilizer(16-16-16) (kg/rai)	No.of fresh fruits/plant	Fresh calyx weight/plant (g)	Dry calyx weight/plant (g)	Seed weight/plant (g)	1000 seeds weight (g)
Control	10.8c	47.5c	8.2c	10.3c	37.5
25	27.9b	126.1b	16.8b	22.5b	37.8
50	28.5b	133.5b	18.4b	23.1b	37.5
75	38.8a	179.2a	24.1a	31.1a	37.5
F test	**	**	**	**	ns
CV.(%)	11.62	14.88	13.5	10.66	3.31

Means followed by the same letter at the same column were not significantly different by LSD

\*, \*\* significant at  $P < 0.05$  and  $0.01$ , respectively and ns not significant

Data from Table 4 revealed that the pH of dry roselle calyxes were decreased after applied higher chemical fertilizer rates which would be correlated with the gradually increased of acid content (titratable acidity percentage) that ranged from 13.21-16.06%. This is in accordance with that obtained by Abo-Baker and Mostada (2011). Nevertheless, at any rates of fertilizer did not

affect to the oil content in roselle seeds, the approximate value of seed oil content was equal to 20-21%.

**Table 3 Yield of red roselle “Surin” at different rates of chemical fertilizer**

Fertilizer (16-16-16) (kg/rai)	Yield of fresh calyx (kg/rai)	Yield of dry calyx (kg/rai)	Seed yield (kg/rai)	Harvest Index
Control	202.6c	35.2c	44.0c	0.36a
25	495.6b	68.6b	96.0b	0.32b
50	555.5b	78.1b	98.6b	0.32b
75	764.8a	103.0a	132.8a	0.36a
F test	**	**	**	*
CV.(%)	12.99	12.28	10.67	6.51

Means followed by the same letter at the same column were not significantly different by LSD

\*, \*\* significant at  $P < 0.05$  and  $0.01$ , respectively and ns not significant

**Table 4 pH, dry calyx acid content and seed oil content of red roselle “Surin” at different rates of chemical fertilizer**

Fertilizer (16-16-16) (kg/rai)	pH	Dry calyx acid content (%)	Seed oil content (%)
Control	2.96 ± 0.02	13.21 ± 0.29	19.71±0.18
25	2.96 ± 0.01	14.16 ± 0.41	21.43±0.04
50	2.93 ± 0.01	14.01 ± 0.20	19.95±0.49
75	2.82 ± 0.02	16.06 ± 0.13	19.83±0.90

## CONCLUSION

For producing roselle to reach better yield and yield components, two tons of organic fertilizer (compost mix with farmyard manure) as basal application and 75 kg/rai of chemical fertilizer application formula 16-16-16 are recommended.

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