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Original Article

Effect of Spacing on the Performance of native honeybee forage, *Becium grandiflorum at* Remeda station, Sidama National Regional State, Ethiopia

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ABSTRACT

This study was carried out to compare and analyze how spacing influenced the performance of Becium grandiflorum bee forage plant in Remeda site intending to find the most appropriate spacing for optimum flower production. The effect of four spacing viz: 0.1m×1m, 1m×1m, 1.5m×1m, and 2m×1m was evaluated. The experiment was laid out with a Randomized Complete Block Design (RCBD) replicated three times. Data were taken on four parameters viz: plant height, branch number, flower number, and canopy cover. The result shows that spacing has a great effect on the performance of Becium grandiflorum. Spacing (S1), (2×1m) gave the highest flower number (510±30.39 cm), branch number (23±2.27cm), and canopy cover (201.3±8.17cm). There was a significant difference in the canopy cover per plant between spacing (S_1) with the mean value of (201.3±8.17cm) and spacing (S_4) with the mean value of (128.3±1.02cm). Based on the findings of the study, the 2x1m spacing was recommended for local farmers for maximum flora production.

Keywords: Bee forage, Flower number, Becium grandiflorum

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INTRODUCTION

Beekeeping has been and still is widely spread, an economically important and integral part of the life of the farming communities of Ethiopia (Verma, 1990; Fichtl and Admasu, 1994). Production of honey and other products depends on the availability of floral resources (bee forage) which is a very important field for most beekeepers in the world (Rucker *et al.,* 2002).

The flowering plants known in Ethiopia are composed of between six to seven thousand species spread across diverse agro-ecological zones. This makes the country highly suitable for bee and beekeeping. Apiculture is the keeping and management of honeybees for various products: honey, beeswax, royal jelly, propels, bee pollen, and brood, as well as for pollinating flowers in field or tree crops (Debbissa Lemessa, 2007). The variation in topography, climate, and other cultural and farming practices contributes to the differences in the diversity of flowering plants and their flowering duration (Alemtsehay, 2011).

Becium grandiflorum is an endemic plant to Ethiopia and grows in the highlands and midlands of the country (Fichtl and Admassu, 1994). *Becium grandiflorum* is a medium-sized, aromatic woody shrub that belongs to the family of Lamiaceae. It is locally known as Tebeb (Tigrigna) or Mentesie (Amharic). The species grows on eroded soils, particularly in rocky slopes and sandy soil, in mountain bushland and pastures. The species spans over altitude ranges from 1600 m to 3100 m asl. The plant gives flowers directly after short rain and gives flowers up to four times per year if there is a continuous water supply (Haftom and Kibebew, 2013).

Becium grandiflorum is valued for various purposes. The numerous pale pink flowers, together with their violet veins and fragrance, are very attractive to honeybees. Thus, honey bees visit flowers of the plant for collecting the pollen and/or nectar. The color of the honey is creamy white and it granulates rapidly. Because of its attractive color and also light taste, honey is preferred by many consumers. As a result, honey from this species fetches premium prices both in the local and international markets (Taddele and Nejdan, 2008). Hence, the plant ranked as the best honeybee forage by beekeepers (Fichtl and Admassu, 1994; Guinad and Dechassa , 2001; Haftom *et al*, 2011; Alemtsehay, 2011). The study conducted by Tura B and Admassu , (2018) indicated that the meantime is taken to set flower after flowering was higher in *Becium grandiflorum* (171 days) than *Fagophyrum esculentum*(38 days).

Even though *Becium grandiflorum* is one of the most attractive honey source plants in Ethiopia, its population is becoming declining due to population pressure and farmland expansion. Moreover, increased demand as fuelwood leads to its loss from the natural habitat. The study conducted by (Haftom and Kebebew, 2013) revealed that *Becium grandiflorum* could be propagated using different techniques including plant cutting, seed sowing, seedling transplanting, splitting/dividing the main branch of the mother plant air layering, and ground layering. *B.grandiflorum* gave the highest and least number of flowers through its propagation by cutting and sowing respectively. Despite the above studies, there is a lack of information about the effect of spacing on the performance of *Becium grandiflorum* in the country and this study has been conducted focusing on the following objectives.

- To determine the effects of spacing on canopy cover and flower number of *Becium grandiflorum*
- To establish productive annual bee forage species in the study area
- To recommend the best spacing of *Becium grandiflorum.*

MATERIALS AND METHOD

Description of the experimental site

The study was carried out at Hawassa Agricultural Research Center, Remeda site. The study site (Remeda), is located at 6°50′N and 38°30′E in the northern part of Sidama National Regional state at a distance of 15 km from Hawassa city. The altitude of the station is 1680 m asl, representing the midland agro-ecology.

Treatments and experimental design

The treatments were laid out in a randomized complete block design (RCBD). The treatments were four inter-row spacing of 0.5m, 1m, 1.5m, and 2m by a constant intra-row spacing of 1m replicated three times (4×3) making a total of twelve plots with one meter between each plot. The spacing for the treatments was assigned to be S_1, S_2, S_3, and S_4 with a plot of 2m×1m, 1.5m×1m, 1m×1m, and 0.5m×1m, respectively.

Observations and Data Collection

Plant Height

Three randomly selected plants from the plot were taken and the height of the plant was measured from the ground to the top end of the longest branch using a measuring tape. All the required data were taken from the three plants and the mean height of the plants was calculated by dividing the total by 3.

Number of flowers per plant

The number of flowers per plant was also assessed by counting the number of opened flowers from three randomly selected plants within the plot, and the mean number of a flower was taken by dividing the total by 3.

Number of branches per plant

The number of branches per plant like the number of flowers was obtained by counting the number of main branches from three randomly selected plants within the plot, and the mean number of branches was taken by dividing the total number of branches in each plant by 3.

Canopy cover

The canopy cover was determined by measuring the diameter of the plants towards East-West and North-South; then the mean canopy cover of the plant was calculated by dividing by two. Canopy cover was calculated as;

$$\mathbf{C.C = (D_1 + D_2)/2}$$

Where,

D_1- is the diameter of the plant in the larger coverage direction,

D2- is the diameter of the plant in the smaller coverage direction and

C.C – is canopy cover of the plant in cm

The canopy cover of the plant was expressed in terms of the average diameter in cm

Statistical Analysis

The data collected and measured at the study site was properly recorded and arranged using excel. One-way ANOVA was used to analyze the data, and correlation analysis was applied for specific variables using SPSS Version 23.

RESULT AND DISCUSSION

Effect of inter-row spacing on number of branches and flowers of *Becium grandiflorum*

Plant spacing had a significant effect on the number of branches and flowers per plant. As depicted in table 1, the spacing (S_1) with a 2m×1m plot had the highest number of branches (23±2.27) whereas the spacing (S_4) with 0.5m*1m plot had the smallest number of branches per plant (10.3±1.20). The variation in the number of branches per plant among the spacing is likely to be plant population with competition for space and growth factors among the plants. Futuless *et al.,* (2010) revealed that in general, the large the plant spacing; the higher is the number of branches and flowers of a plant. Stronger closeness encourages greater etiolating which results in the lowest number of branches per plant. The wider spacing between plants results in flower numbers which help in reducing competition for the growth factors such as light, water, and soil nutrients. Besides, the higher number of branches with increasing intra-row spacing indicates that wider plant spacing encouraged lateral growth (branching) but not apical growth and vice versa.

Similarly, the treatments show a difference in the number of flowers per plant. The spacing (S_1) with a 2m×1m plot had the highest number of flowers per plant (510±30.39) whereas the spacing (S_4) with 0.5m×1m plot had the smallest number of flowers per plant (210.3±35.31) (Table 1). This might be due to the higher number of branches at wider spacing benefiting for better flower development.

Rajesh (2010) demonstrated that the flowering performance of a plant is considered to be the sum of all branches and morphological traits of a specific plant.

Table 1:Effect of inter-row spacing on number of branches and flowers of *Becium grandiflorum*

Parameters	Treatment Spacing(m×m)	Mean± Std. Error	95% Confidence	
			Lower Bound	Upper Bound
Number of Branches	S_4 (0.5×1)	10.3±1.20[a]	5.16	15.50
	S_3 (1×1)	13.97±1.02[a]	9.59	18.34
	S_2 (1.5×1)	16.7±0.94[a]	12.69	20.77
	S_1 (2×1)	23±2.27[b]	13.30	32.83
Number of Flowers	S_4 (0.5×1)	210.3±35.31[a]	158.41	262.26
	S_3 (1×1)	292.5±7.51[a]	255.71	329.29
	S_2 (1.5×1)	302.16±18.48[a]	288.16	316.17
	S_1 (2×1)	510±30.39[b]	326.62	693.38

In both trials mean differences were significant at $P< 0.05$ level

Effect of inter-row spacing on canopy cover and plant height of *Becium grandiflorum*

The treatments show a difference in the canopy cover per plant. The spacing (S_1) with a 2m×1m plot showed the greatest canopy cover (201.3±8.17) cm whereas the spacing (S_4) had the smallest canopy cover (128.3±12.02) cm (Table 2). There was no significant difference in canopy cover per plant between spacing(S_1) and spacing (S_2) at ($p<0.05$). There was a significant difference in the canopy cover per plant between spacing(S_1) and spacing (S_4) at ($p>0.05$). The plant spacing within a 2×1m, 1.5×1m, 1×1m and 0.5m×1m plot had a canopy cover (201.3±8.17) cm, (178.7±6.61)cm, (141.7±7.26)cm and (128.3±12.02)cm, respectively (Table 2).

Similarly, the spacing in *Becium grandiflorum* showed a difference in plant height. The spacing (S_1) with 2m×1m recorded the highest plant height (192±4.36) cm whereas the spacing (S_4) with a 0.5m×1m showed the smallest plant height (136.6±14.24)cm (Table 2). This difference in plant height is likely due to some environmental factors such as nutrient competition between the plants because of their population arrangement.

The correlation between branch number, flower number, canopy cover, and plant height

The relationship between branch numbers, flower number, canopy cover, and plant height were investigated using a simple correlation coefficient. There was a strong positive correlation between the number of branches and flowers per plant ($r = + 0.88$) and canopy cover ($r = + 0.83$) per plant. However, the number of flower and canopy cover per plant had no significant correlation ($r = -0.26$) with plant height. This might be due to an increase in the number of branches associated with a high number of flowers reflecting in shorter plants. Haftom Gebremedhn and Kibebew Wakijira (2013) reported that the spacing per plant had a significant positive correlation with the number of flowers and number of branches.

Table 2 : Effect of inter-row spacing on canopy cover and plant height of *Becium grandiflorum*

Parameters	Treatment Spacing(m×m)	Mean± Std. Error	95% Confidence	
			Lower Bound	Upper Bound
Canopy Cover (average diameter in cm)	S_4 (0.5×1)	128.3±1.02^a	91.62	165.04
	S_3 (1×1)	141.7±7.26^a	110.41	172.92
	S_2 (1.5×1)	178.7±6.61^b	173.54	187.79
	S_1 (2×1)	201.3±8.17^b	187.10	212.23
Plant Height (cm)	S_4 (0.5×1)	136.6±14.24^a	121.40	152.94
	S_3 (1×1)	164.6±3.76^a	152.50	171.83
	S_2 (1.5×1)	177.3±2.89^b	173.58	182.42
	S_1 (2×1)	194.1±4.36^b	177.25	210.75

In both trials, mean differences were significant at $P< 0.05$ level

Table 3.Correlation coefficient (r) among branch number, flower number, canopy cover, and plant height

Measures	Branch Number	Flower Number	Canopy cover	Plant height
Branch	1			
Flower	0.88**	1		
Canopy cover	0.83**	0.33*	1	
Plant height	-0.26	-0.09	-0.21	1

**. Correlation is significant at $P< 0.05$

CONCLUSION AND RECOMMENDATION

The study revealed that *Becium grandiflorum* can be planted in different spacing arrangements. These different spacings showed a significant difference in the mean values of the various morphological attributes which include the number of branches, number of flowers, canopy cover, and plant height per plant.

Based on the results, *Becium grandiflorum* performed better in terms of flower and branch number at a spacing (S_1) with 2mx1m having mean values of 510±30.39 and 23±2.27 respectively. Similarly, the highest number of canopy cover and plant height per plant was measured at spacing (S_1) with the mean value of 201.3±8.17 and 194.1±4.36 respectively. On the contrary, the smallest values in canopy cover and plant height per plant were observed at spacing S_4 (0.5m×1 m) with 128.3.3±1.02 and 136.6±14.2 respectively. Therefore, for better flower production and canopy cover, planting *Becium grandiflorum* at a spacing (S_1) with 2m×1m is more recommended.

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