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# Demonstration of Local Honeybee Flora "Mentesie" (*Becium grandflorum*) Propagation Techniques in Wag - Himra Zone, Ethiopia

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## Abstract

The demonstration of local honeybee flora "Mentesie" (*Becium grandiflorum*) propagation techniques was carried out over two rainy seasons in the Gazgibla district, Debreweyla watershed closure area of the Northeastern Amhara region. The shrub has numerous benefits for the community, including honey production, fuel use, and soil and water conservation. However, it has been gradually declining. To preserve these valuable shrubs, various propagation techniques were tested. The objectives of the experiment were to demonstrate the propagation techniques of *Becium grandiflorum* to beekeepers and to generate wider demand for its plantation among beekeepers and extension workers. The experiment compared two selected propagation techniques with local farmers' traditional planting practices, under the guidance of forestry researchers. The treatments included seeds and cuttings. Seeds were collected from mature fruits, and cuttings were taken early in the morning from natural, mature, young, and healthy mother plants at a height of 40 cm during 2020/21. These materials were packed in perforated polyethylene bags. The average mean of flower numbers, branch numbers, and canopy cover for the enhanced propagation techniques (seedlings with pots) were 4107, 21.81, and 92.5, respectively. These values were higher than those for the comparative propagation technique, which had flower numbers of 2462, branch numbers of 19.4, and a canopy cover of 92.5. There were significant differences ($p<0.05$) among the propagation techniques in terms of canopy cover, height, number of flowers, and branches per plant. Farmers recognized the higher flower biomass, canopy cover, and potential for greater plant height of the enhanced techniques, which are beneficial for bee forage and soil and water conservation. Therefore, planting seedlings using pots were found to be the best method for the wider production of *B. grandiflorum* in its natural growing areas.

## Keywords

*B. grandflorum*, Propagation, Seedling, Cutting, Farmer's Preference

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# 1. Introduction

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) [1]. The shrub is the most important source of honeybee forage in terms of preference by honeybees, abundantly available more visit flowers of the plant for collecting pollen and nectar [2]. In order to gather pollen and nectar, honeybees had visited flowers of the plant and the color of the honey is creamy white and granulates rapidly because of its attractive color and also light to taste with preferred by many consumers in the country [3]. The nectar produced from these shrubs is an aqueous solution of sugars, mainly glucose, fructose, and sucrose, with traces of minerals and amino acids [4]. It serves as a floral reward to the pollinator, and hence is a plant's adaptation to promote out-crossing, plants vary widely in the quality and quantity of nectar produced, and consequently in their economic value for honey production [4].

According to the scholars of, [1, 5] the shrubs characterizeby, a drought tolerant, the most flower carrier for nectar and pollen source, aromatic shrub and grows in highlands and mid altitude areas and indigenous or endemic perennial plant to the highlands of Ethiopia and Eritrea [6]. The honeys produced from these shrubs are creamy white color granules and high viscosity, however currently honeybees exposed to a serious of bee flora shortage that is mainly consequence by colony absconding [4]. Due to population pressures and expansion in the agricultural area, as well as use for a variety of crops, it is possible that there are some other factors contributing to the decreasing populations of various bee flora types in this region [7]. The shrubs were the dominant honeybee plants followed by trees, herbs, and domesticated crops, respectively [8].

On top of this, increased demand for fuel wood has led to intensified extraction of mature plants from their natural habitats. As a result, natural regeneration of the species from seeds has become very difficult due to widespread human interference and also due to climate change (Ayalew *et al* 2020). Loss of honeybee forage plants has negative implications for beekeepers which mean loss of bee forge, loss of nesting sites for bees, loss of places to keep hives and low honey production [6]. Thus, further plantation is needed to this favorable plant with appropriate propagation technique. Therefore, this activity was initiated.

1. To demonstrate the best propagation techniques of B. grandflorum.
2. Select the best method for wider invention of the plant in Wag-Himra zone.

# 2. Material and Methods

This study was conducted at Gazgibla district, which is one of potential naturally vegetated bee forage plants dominated by mentese growing area from Wag-Lasta eastern Amara region (Figure 1). Gazgibla district have a total population of 84,969 and categorized into highlands with a total area of 1,037 $km^2$. Regarding the topography of the study area, it is located at an elevation between 1500 and 3500 m.a.s.l. and the annual rainfall distribution varies between 500 to 700 mm, which is an erratic type of rainfall. Its temperature ranges from 27 ℃. In the area, there is a huge potential of beekeeping [9].

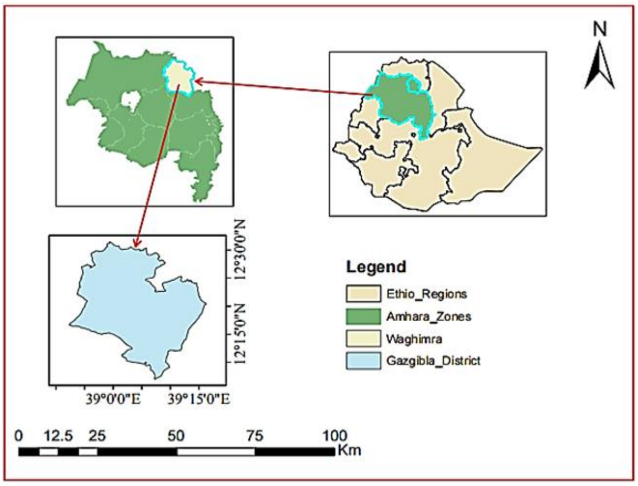


***Figure 1.*** *Map of study area.*

## 2.1. Experimental Evaluation of Propagation Techniques

Evaluation of propagation technique was conducted at Jnkaba apiculture research site to select the best propagation technique(s) of B. grandflorum. Therefore Six (6) propagation techniques were applied within the appropriate planting techniques consulted by forestry researchers. Among these, propagated through seedling with pot and cutting with pot had the uppermost canopy coverage, flower biomass and the highest number of branches per plant. Hence both techniques had the probability of the plant to have meaningful branch, canopy coverage and flower biomass and based on the recommendation those were to habitual more demonstration for extension.

## 2.2. Seed Collection

For seedling technique, were collected from mother plants by selecting mature fruits from September to November 2020/21, packed in perforated polyethylene bags, and allowed to dry for one month at room temperature [1]. Then seeds were takeout of these packages and sewed on the ready plastic pots. Plastic sleeves (diameter, 8; length, 15cm) were prepared at the Woleh nursery site. Dried grass cover over the ordered plastic sleeves to be done to conserve water loss. Watering was applied regularly for about 45 day's period which was the end of nursery age of the seedlings

(Figure 2). In the ratio of 20:2:5, those sleeves contained a mixture of soil consisting of silt, sand and manure. Plastic sleeves filled with the soil mixtures were arranged in the open air and were watered with tap water.

***Figure 2.*** *Vegitation stage at woleh nursery site.*

## 2.3. Cutting Material Collection

Cuttings with a height of 40cm were collected early in the morning from natural matured young and healthy mother plants [10]. Young and healthy branches were collected from mother plants (Figure 3). For the avoidance of variation between treatments caused by these characteristics, the cuttings were uniform in size and age. In the nursery a plastic sleeves were prepared for planting each cutting size. Plastic sleeves were 15cms long and 12 cm wide. Plastic sleeves filled with the soil mixtures were arranged in the open air and were watered with tap water. Then after, cuttings were inserted in plastics sleeves (diameter, 12; length, 15cm) and well managed for 55 days in nursery to avoid the direct entrance of water during planting and growing period, the cuttings were prepared in such a way as the top ends have a slant surface (angle of 45°) vertically, and contain a minimum of two nodes.

***Figure 3.*** *Cutting with pot at woleh nursery site.*

## 2.4. Sampling Area and Farmers Participation

Comparative evaluation and demonstration of *B. grandflorum* propagation practices was conducted in 2020/21 and 2020/22 rain season in participatory approach at Gazgibla district Debreweyla watershed closer area. Gazgibla district was one of the potential *B. grandflorum* locally (mentesie) growing area from Wag-Lasta eastern Amhara region and it was purposely selected to illuminate the mid altitude recommendation domain for bee forage plants. Beekeepers and non-bee keepers research and extension group (FREG) to be organized in each site consisting fifteen members to enhance participatory evaluation. The group members were select based on area delineation and conservation groups, in consultation with key informants familiar with the area, to represent different social segments of the community (including a diverse spectrum of age, sex, and wealth status). The groups had a chairman to facilitate the FREG tasks, as well as an action plan and meeting schedule to evaluate the experiments following the physiological growth stages, the advantages of the plant, conservation-based issues, and the use of B. grandiflorum as a source of honey. Four subjective beekeepers from each group on top of five farmers' training centers (FTCs) were select to attend all members.

## 2.5. Data Collection and Analysis

To evaluate the performance of the newly propagated plant materials, shaded areas were selected and prepared. Planting was done in rows on prepared land holes relative to the plot size. The B. grandiflorum plants were spaced 1.5 meters apart to ensure proper spacing and avoid nutrient competition [9]. Planting was conducted during the rainy season, and irrigation supplements were used to maintain their natural growing conditions. The quantitative data on survival rate, blooming time, number of flowers per plant, foraging intensity of honeybees, canopy cover, number of flowers per plant, and number of branches per plant, plant height, and conservation area was made on plot basis. Flower blooming to shedding time was also recorded for each treatment plant. Farmers' preference to shrubs captured as a group through assigning literate farmers to lead the discussion. Therefore, easily propagated, abundantly available, easily controlling of erosion, early flowering, flower duration and production of quality honey were identified as preference parameters of *B. grandflorum*.

Finally, the data were statistically analyzed using descriptive statistics and the social parts were analyzed using SPSS version 9.0. The quantitative data (survival rate, blooming time, number of flowers per plant, foraging intensity of honeybees, canopy cover, number of flowers per plant, and number of branches per plant, plant height,) were analyzed in descriptive statistics like mean, frequency and percentages. A weighted ranking table matrix was created after the calculation and weighting of identified parameters pairwise. Beekeepers in each group were asked to compare and contrast treatment each other and then to give values based on identified parameters. Counting the values provided for each treatment, finally to put scores. The scores given by farmers to each treatment under each criterion was summed (least sum was ranked 1st), then the obtained rank was multiplied by the respective weight for treatments. Finally, the products were aggregated for each propagation techniques for final selection (high sum was ranked 1st) reciprocal with the correlation coefficient is defined as

$$Rs = 1 - (\sum d\ 2 / n\ (n^{2} - 1)$$

Where;

R= Correlation coefficient.

D = Difference in the ranks assigned to the same phenomenon.

N = Number of phenomena ranked (Mihiretu & Assefa, 2019).

Finally, extension activities like field days and indicative visits were accepted to create awareness about the propagation techniques in general.

## 3. Result and Discussion

### 3.1. Biological Results

The experiment examines the effects of two treatments, “Seedling with Pot” and “Cutting with Pot,” on various plant growth parameters (Table 1). The analysis includes mean values, t-values, P-values, and coefficients of variation (CV %) for plant height, branch number, canopy coverage, root collar diameter, fruit number, and survival rate. The slight difference in plant height between Seedling with Pot and Cutting with pot treatments is not statistically significant. This suggests that both treatments have a comparable effect on plant height. The moderate variability (CV = 17.4%) indicates consistent measurements within each treatment group. The lack of significant difference could be due to the similar nutrient composition or environmental conditions provided by both treatments. The significantly higher branch number in the SP treatment indicates that SP is more effective in promoting branching. This could be attributed to the specific nutrients or growth regulators in the SP treatment that encourage lateral growth such as nitrogen and phospheres. The high variability (CV = 23.5%) suggests that individual plant responses to the treatments varied, which could be influenced by genetic factors or micro-environmental conditions. The significantly greater canopy coverage in the SP treatment suggests that SP promotes better overall plant spread and leaf area, which can enhance photosynthetic efficiency. The relatively low variability (CV = 14.7%) indicates consistent improvements in canopy coverage with SP treatment across the sample population. This consistency suggests that the SP treatment could be reliably used to enhance canopy development in similar plant species.

***Table 1.*** *Growth and flower biomass comparison of Becium grandflorum propagation technique.*

| Treatment | | | Parameter | | | | |
|---|---|---|---|---|---|---|---|
| | N | PH. (cm) | BN | CC (cm) | RCD (cm) | FN | S. rate% |
| SP | 60 | 91.3±10.6 | 21.81±3.3 | 92.5±1 | 1.86±0.4 | 4107.6±1999 | 83.2 |
| CP | 60 | 90±17.3 | 19.4±2.0 | 82.2±1 | 1.72±0.5 | 2462.7±643 | 71.6 |
| Over all mean | | 82.2±17.5 | 18.12±13.4 | 87.38±13.8 | 1.79±0.5 | 3285.2±1692 | 77.4 |
| t-value | | 6.73 | 0.93 | 0.78 | 1.24 | 0.49 | 0.48 |
| P-value (0.05) | | Ns | ** | ** | Ns | ** *** | *** |
| CV (%) | | 17.4 | 23.5 | 14.7 | 27.2 | 37.3 | 23 |

Note: SP=seed with pot. CP=cutting with pot. PH. =plant height. BN= branch number. CC canopy cover. RCD = root caller diameter. FN= flower number. S. rate =survival rate. Plant height, canopy cover, and root collar diameter parameters were measured in cm while survival rate is the percentage of survived seedlings and cuttings after 2 years from initially planted.

The root collar diameter is slightly larger in the SP treatment, but the difference is not statistically significant. This suggests that both treatments have a similar impact on root collar development. The high variability (CV = 27.2%) indicates substantial differences among individual plants, which could be due to inherent genetic diversity or soil heterogeneity. The lack of significant difference might also suggest that factors other than the treatments, such as soil compaction or water availability, play a more crucial role in determining root collar diameter. The SP treatment results in a significantly higher fruit number compared to CP, indicating that SP is more effective in enhancing fruit production (Table 1). This could be due to specific nutrients or growth hormones in the SP treatment that promote flowering and fruit set. The very high variability (CV = 37.3%) suggests that fruit production is highly variable among individual plants, which could be due to differences in pollination efficiency, microclimatic conditions, or plant health. The significantly higher survival rate in the SP treatment suggests that SP provides better conditions for plant survival. This could be due to improved nutrient availability, disease resistance, or environmental stress tolerance provided by the SP treatment. The moderate variability (CV = 23%) indicates that while there is some variation in survival rates, the overall trend is that SP enhances survival. This makes SP a potentially more reliable treatment for improving plant establishment and longevity.

Seedling with pot was also a weighty ($p<0.001$) difference in the number of flowers (4107.6±1999) from cutting with pot (Table 1). Which is calculated T.N.F = N.F.H *N.F Where T.N, F = total number of flowers per plant, N.F.H= Number of Flower Head per plant and N.F=Number of flowers per head of flower. This is due to the fact that, more branches and canopy cover orient parallel to the ground rather than growing upward, resulting in a large number of flower biomass per plant. A similar study by [10] reported that plants propagated through seedlings had the highest number of flowers per plant (4427.8) due to a strong positive correlation with the number of branches and canopy cover.

## 3.2. Correlation between Branch Number, Canopy Cover and Flower Number

The relationship between branch numbers, canopy cover and flower number were explored using a simple correlation coefficient. There was a strong positive correlation between the number of branches and canopy cover, number of branches and number of flowers per plant, canopy cover and number of flowers per plant (r = +.6), (r = +.6), (r = +.89) (r = +0.65) respectively (Table 2). This was supported with the scholar of [8] research results in correlation coefficient of branch number and canopy cover with number of flowers was highly positively correlated. This is due to the fact, that more branches and canopy cover orient straight line than growing upward.

***Table 2.*** *Correlation between plant height, branch number, canopy cover and flower number.*

| | Branch number | Canopy cover | Flower number |
|---|---|---|---|
| Branch number | 1 | +0.6 | +0.89 |
| Canopy cover | | 1 | +0.65 |
| Flower number | | | 1 |

## 3.3. Beekeepers Alternative

Based on their observation and consulted with designed questionnaire 88% of participated beekeepers respond *B. grandflorum* propagated through seedling had the best, easy and more appropriate techniques. The selection results from the beekeepers showed that the shrubs planted through seedlings with pots rated first-class in terms of survival rate, number of branches, conservation role, flower production, and appropriate flowering time. Based on their selection index and the load simplicity parameters from the planting techniques, (Table 3). The seedling method was the top choice. Considering factors such as workload, time consumption, labor intensiveness, flower production, and conservation role, they concluded that seedlings with pots have the most advantageous propagation technique.

## 3.4. Beekeepers Preference

Based on their observation and consulted with designed questionnaire 88% of participated beekeepers respond *B. grandflorum* propagated through seedling had the best, easy and more appropriate techniques. The selection result of bee keeper showed that the shrubs planted through seedling with pot were first-class rate in terms:-Survival rate, branched number, conservation role and more flower production, appropriate flowering time. Based on their selection index the load simplicity parameters from the planting techniques, as shown (Table 3). The seedling method were the first one chose. Based on the workload, time consuming, labor intensiveness, more flower production and more conservation role they Saied seedling with pot has the better advantageous propagation techniques (Table 3).

***Table 3.*** *Beekeepers first choose on B. grandflorum propagated technique through time consuming.*

| Parameter | Seedling index | Cutting index |
|---|---|---|
| Easily to propagated | 0.9 | 0.1 |
| Less labor consumption | 0.5 | 0.5 |
| More survival rate | 0.7 | 0.3 |
| More branched | 0.8 | 0.2 |
| More conservation role | 0.5 | 0.5 |
| More time consuming | 0.6 | 0.4 |
| Total simplest score | 4.0 | 2.0 |
| Simplest rank | 1 | 2 |

In addition to easily propagated, they said the shrubs are abundantly available, preferred by bees; more flower production, appropriate flowering time, and B. grandflorum were first-class rate (Table 4). However, 12% of participant farmers disagreed about the first- class rate of bee stayed *B. grandflorum*. They said that acacia spp. Was the first rate bee to attract flora. In total preference of *B. grandflorum* were associated with different factors such as attractiveness of the flower, number of flower heads per plant, nectar sugar concentration, yield and nutritive value pollen of plants and weather condition of the area. The same result was exercised in different parts of the country [7]

*Table 4. Farmers' Pre-investigation Apiculture value of B. grandflorum*

| Parameter | Frequency | % |
|---|---|---|
| Easily to propagated | 10 | 75 |
| Abundantly available | 20 | 80 |
| Flowering duration | 7 | 46.6 |
| Preferred by bees | 11 | 86.1 |
| Honey quality | 12 | 89.6 |
| Appropriate flowering time | 8 | 53.4 |

### 3.5. Farmers Experience, Preference Parameter and Ranking to PropagationTechniques

There were designed questionnaires about the propagation of bee forage plants on the beekeeper's knowledge and attitude towards the Apiculture exercise. According to the respondents, More than 50% of participated farmers said that other horticultural activity was planting but not purposively bee forage because of less knowledge related to bee forage plants. The parameters elite were valued and weighted to their importance for comparison. The results from the weighted ranking matrix show that the practice with the highest percentage of the total weight was selected as the optimal choice. Therefore, farmers preferred canopy cover, flower biomass, survival rate, and ease of implementation, propagation efficiency, growth efficiency, and low labor consumption as the best parameters (Table 5). Participants had a comparable primary preference for flower biomass, canopy cover, survival rate, and greater root collar diameter. Because, the study locations were known for beekeeping and are categorized by a shortage of bee forage. Flowers provide ample nectar and pollen for bee forage, some at times when other foraging options are limited. Combining apiculture and forest management provides forage and protection for honeybees, while ensuring thorough pollination of the tree flowers, and assuring flower biomass and survival rate had higher glory as parameter in the districts; because of the farmers require greater nectar and pollen source plant in order to solve shortage of bee flora forage [2]. The outcome was supported reported the plants propagated through seedling had the highest number of flowers per plant (4427.8) and canopy coverage of seedlings was the highest (121.2cm) that of other propagation techniques.

*Table 5. Beekeepers preference selection and ranking to propagate B. grandiflorum.*

| Preference parameter | % | Index score | Rank |
|---|---|---|---|
| Canopy cover | 7 | 0.07 | 6 |
| Flower biomass | 34 | 0.04 | 1 |
| Survival rate | 18 | 0.18 | 2 |
| Easy to implement | 4 | 0.34 | 7 |
| Propagation efficiency | 15 | 0.15 | 3 |
| Growth efficiency | 12 | 0.12 | 4 |

*Table 6. Summary of farmers' preference ranking for seedling and cutting propagation techniques of B. grandiflorum.*

| Propagation technique | Standards | Farmers Weighted parameter | | | | | | | ∑score (rank*weight) | Rank |
|---|---|---|---|---|---|---|---|---|---|---|
| | | *CC* | *FB* | *SR* | *EE* | *PE* | *GE* | *LC* | | |
| | Score | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | |
| Seedling with. Pot | Weight | 6 | 7 | 2 | 1 | 3 | 4 | 5 | 28 | 1 |
| | Score* Weight | 6 | 7 | 2 | 1 | 3 | 4 | 5 | | |
| | Score | 2 | 2 | 2 | 2 | 2 | 2 | 2 | | |
| Cutting with pot | Weight | 6 | 7 | 2 | 1 | 3 | 4 | 5 | 56 | 2 |
| | Score* Weight | 12 | 14 | 4 | 2 | 6 | 8 | 10 | | |

Note: CP = cutting with pot, SP =seedling with pot, CC=canopy cover, FB= flower biomass, SR= survival rate, EE= easy to implement, PE=propagation efficiency, GE= growth efficiency, and LC= labor consumption.

## 4. Conclusion and Recommendation

In these parameters seedling with pot was highly advantageous than cutting with pot. Based on the outcomes in the study area and the previous result as well as farmer's preference for their bee forage availability, easy to implement, more survive to the area, and other connected advantages, seedling with pot had the first-class rate. Participants had comparable primary choice to flower biomass, canopy cover, survival rate and more root collar diameter.

In line with the outcomes in the study area and the previous result as well as farmer's preference for their bee forage availability, easy to implement, more survive to the area, and other connected advantage, seedling with pot had the first-class rate in similar agro ecology.

Therefore, it's safe to recommend *B. grandflorum* propagated through seedling with pot had an advantageous for further dissemination in the respective agro ecology.

## Abbreviations

| | |
|---|---|
| SP | Seedling with Pot |
| Cp | Cutting with Pot |
| o.mean | Overall Mean |

## Author Contributions

**Ertiban Desale:** Data curation, Formal Analysis, Methodology, Software, Validation, Writing – original draft Writing – review & editing

**Agazhe Tsegaye:** Conceptualization, Investigation, Methodology, Project administration, Supervision

**Meressa Lemma:** Data curation, Investigation, Methodology, Resources, Supervision

**Ayalew Grmay:** Investigation, Project administration, Supervision

**Yesuf Ibrahim:** Conceptualization, Methodology, Resources, Software

**Alemu Tsegaye:** Conceptualization, Data curation, Validation, Writing – review & editing

**Adisu Bihonegn:** Conceptualization, Data curation, Visualization

## Conflicts of Interest

The authors declare no conflict of interest.

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