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Screening of Potential Shrubs for Bee Forage Development

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Abstract: Availability of adequate honeybee forage plants is very important for honey production. The study was therefore conducted to screen the best performing bee forages from five plant species with a view to selecting for honey production for high and mid land agro-ecologies. The planting materials were *Vernonia amygdalina, Buddleja polystachya, Callistemon citrinus, Dovyalis caffra* and *Chamecytisus proliferus*. The species were evaluated based on the number of flower heads per plants, foraging intensity of honeybees, flowering length and amount of pollen. *C. citrinus, C. proliferus* and *V. amygdalina* were set flower with the ranges of two to three and half years while *B. polystachya*, and *D. caffra* didn't reach to set flower up to the end of five years. *V. amygdalina and C. proliferus* provides significantly higher pollen compared to *C. citrinus*. Average number of flower heads per plant were highest for *C. proliferus* and it was significantly different ($p<0.05$) from the rest. The flowering time of *C. citrinus, C. proliferus and V. amygdalina* are almost during the dearth period at which only a few bee forage plant species in flower around the area. *V. amygdalina* and *C. citrinus* was highly foraged by honeybees from 10:00am-12:00 am, while *C. proliferus* 10:00 am -2:00pm. *C. citrinus* has the highest flowering time with duration up to six months in a blooming state having lots of flower heads and the rest months with few flowers. Generally, the study revealed that *C. citrinus, C. proliferus* and *V. amygdalina* were selected as major bee forage plants. However, it requires further evaluation particularly on nectar volume and sugar concentration for these plants and their integration with watershed development is recommended. Since they were flowered in dearth period and their further multiplication is recommended to increase honey production.

Keywords: Shrubs, Flowering Period, Foraging Intensity, Set Flower, Bee Forage

1. Introduction

Beekeeping is an incentive for planting trees and protecting existing trees, because trees are very important for bees and therefore for beekeepers as well [7]. On top of this honeybees serve as pollinating agents for numerous species of plants and contribute to their survival, genetic prosperity and play a crucial role in the maintenance of ecosystem services [7, 8, 15]. On the other side, honey bees can benefit from plants in different ways: some plants can be utilized by honey bees as food sources (pollen and nectar); honey bees visit certain plants to gather propolis beside their ability to recycle previously collected propolis [1]; some plant cavities and branches can be used by honey bees as permanent or tentative nests, respectively. Beside these benefits, some plant extracts have been used as treatment for honey bee parasites including; neem oil [14] and thymol powder [10].

The success of beekeeping depends not only on honeybee strains and its management but also on the abundance and availability of bee floral plants around bee farming area [14]. Bee forage management is important for increasing the beekeeping potential of an area. Without proper bee forage management, it is difficult to maintain an apiary of strong and healthy bee colonies. Poor management of bee forage, especially during dearth periods, results in weak colonies which are susceptible to various diseases and infections. Bee forage potential and therefore, beekeeping carrying capacity can be increased by establishing beekeeping oriented plantations. Managing honey plant resources is necessary for improving the beekeeping potential of an area [9].

Attention is not given to maintain the existing bee flora and multiplication of multipurpose plant species in order to make beekeeping sustainable. Inadequate information on bee forage resources are a major obstacle to improve the

production and productivity of honeybees in mixed crop farming of Ethiopia. It is also important to screen suitable bee forage species that have compatibility with existing farming systems, high nutritive value, fast growth, easy to manage and resistance to diseases and pests [2].

Bee forage trees/shrubs provide bees with ample of food source (nectar and pollen) due to their relatively large canopy spread, and long flowering duration. Bee forage shrubs/trees not only provide nectar and pollen for the honeybees but also used as food, ornamental, shade tree and live fence for the beekeepers [17]. Hence, to gain optimum benefit from honeybee forage shrubs screening and adapting of the well performing multipurpose species is essential to increase honey production. Therefore, the objective of the study was to evaluate and screen well performing shrubs bee plants and recommend best performing for the users.

2. Methods

Description of Study Areas

The study was carried-out at Holeta Bee Research Center. The site is located at an elevation of 2400 m.a.s.l, at 09°03.5'N latitude and 038° 30.367'E longitudes. The predominant soil type in the study area is red soil.

Candidate Bee Forage Plant Selection

Potential shrubs were identified through interview of farmers, observation of foraging bees on each flower of candidate shrubs during different flowering seasons (Sep/Oct, Dec/ Jan, April/May and Jun/July) and literature review. Accordingly 5 shrub bee forages were put under investigation (table 1)

Table 1. *Identified candidate bee forage and their range of distribution.*

No	Botanical name	Common name	Growing Agroecological zone
1	*Vernonia amygdalina*	Eebicha(Or), Girawa(Am)	500-2800 m.a.s.l.
2	*Buddleja polystachya*	Anfara(Or)	1000-3300 m.a.s.l.
3	*Callistemon citrinus*	Bottle brush (Eng)	1250-2500 m.a.s.l.
4	*Dovyalis caffra*	Koshim (Amh)	1500-2600 m.a.s.l.
5	*Chamecytisus proliferus*	Tagasaste	up to 3200 m.a.s.l.

Source: [9]

Seed Collection

Matured seeds of *Vernonia amygdalina*, *Buddleja polystachya*, *Callistemon citrinus*, *Dovyalis caffra* and *Chamecytisus proliferus* were collected from respective mature plant species. Immediately after collection, seeds were packed and allowed to dry for one and half week at room temperature. The packages were maintained at room temperature until day of sowing.

Nursery Establishment and Experimental Setup

Seed was sown and seedlings of the species were raised in nursery bed. The seedlings were transplanted to plots size 4mx5m, with 0.5 m spacing between plants and 1m between rows. Completely randomized block design was used with three replications. All necessary data such as, flowering date, number of flowers heads per plant, pollen grain and foraging intensity of honeybees were recorded on a note book until the end of data collection. At 50% flowering, number of flower heads/plant was counted randomly from three plants. Foraging bee intensity on flowers was counted starting from 6: 00 a.m. to 6: 00 p.m. for ten minutes at every 2 hour interval. Finally, the collected data were statistically analyzed using descriptive statistics and ANOVA.

3. Results

Time required giving flower: The mean time required to give flower was significantly different at ($p<0.05$) among the bloomed species. *V. amygdalina* has shorter time to give flower compared to C. *proliferus* and *C. citrinus* (Table 2). However, under similar condition *B. polystachya and D. caffra* did not flower until the end of five years of the study period.

Average number of flower heads per plant: Average number of flower heads per plant was highest for *C. proliferus* as compared to *C. citrinus and V. amygdalina* and it was significantly different ($p<0.05$) from the rest (Table 2).

Pollen yield: the mean amount of pollen yield of C. *Citrinus* was significantly the lowest at ($p<0.05$) compared to C. *proliferus and V. amygdalina* which has similar pollen yield (Table 2).

Time from blooming to shedding: The mean flowering length of C. *citrinus* was the highest which stayed up to six months with a lot of flowers and some flower throughout the year. Whereas, *C. proliferus* and *V. amygdalina* stayed almost for three and two months, respectively. Statistically they were significantly different ($p<0.05$) from each other (Table 2).

Table 2. *Mean number of flower heads per plants (MNFHP), Mean time to give flower (MTGF), Pollen yield (PY) and Time from blooming to shedding (TBSH) ± Standard Deviation (SD) of Chamecytisus proliferus, Callistemon citrinus and Vernonia amygdalina.*

Plant species	MNFHP ± SD	MTGF ± SD	PY ± SD	TBSH ± SD
Chamecytisus proliferus	1247.8 ± 349.1a	3.00 ± 0.2b	0.14 ± 0.05a	80.9 ± 3.8b
Callistemon citrinus	151.2 ± 31.0 b	3.29 ± 0.4a	0.09 ± 0.03b	189.1 ± 6.2a
Vernonia amygdalina	72.6 ± 9.2 c	2.53 ± 0.3c	0.13 ± 0.03a	55.4 ± 2.6c

Different letters shows significant difference

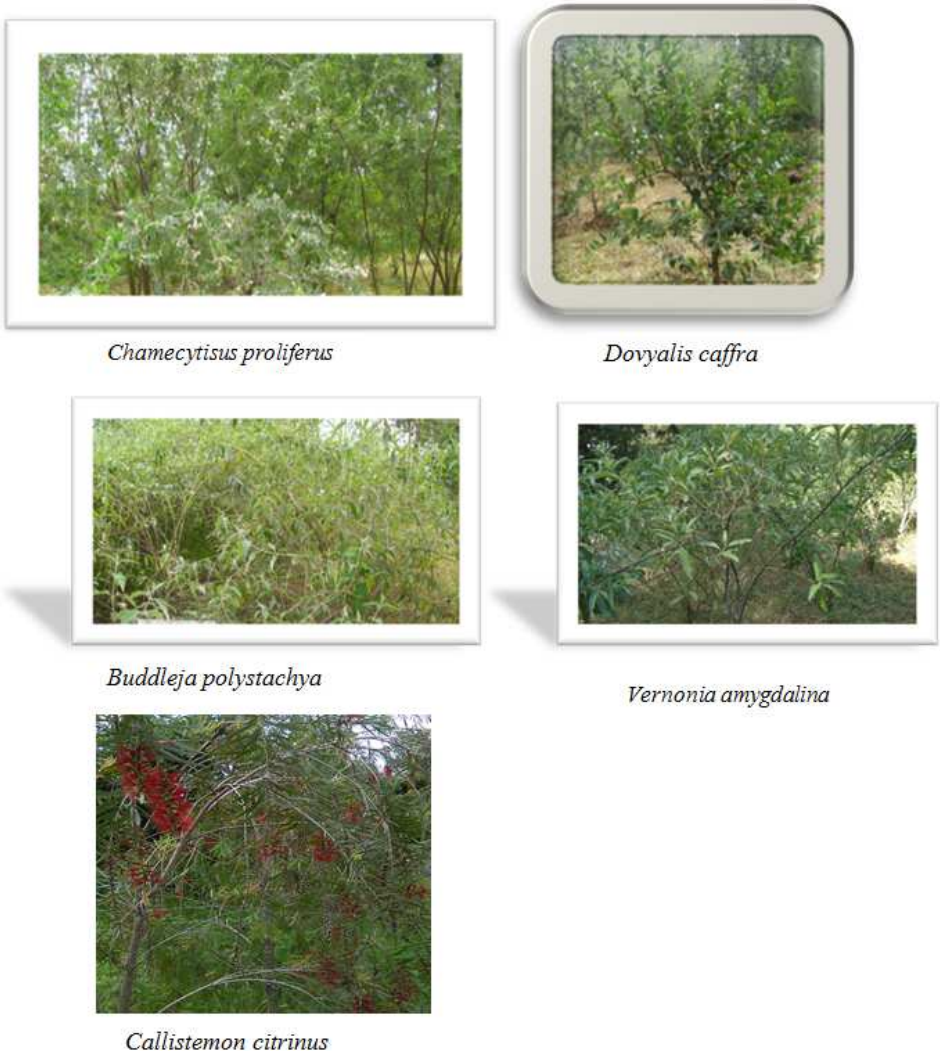

Figure 1. *Performance of planted plants.*

Foraging Intensity of Bees

Vernonia amygdalina was highly visited by bees from 10am-12 am followed by *Callistemon citrinus*. Almost at 6am and 6pm the number of bees visited the plant species were null. *C. proliferus* has long peak foraging time in a day than *V. amygdalina* and *C. citrinus*. Because *C. proliferus* flowered during rainy season and cold weather condition (Figure 2).

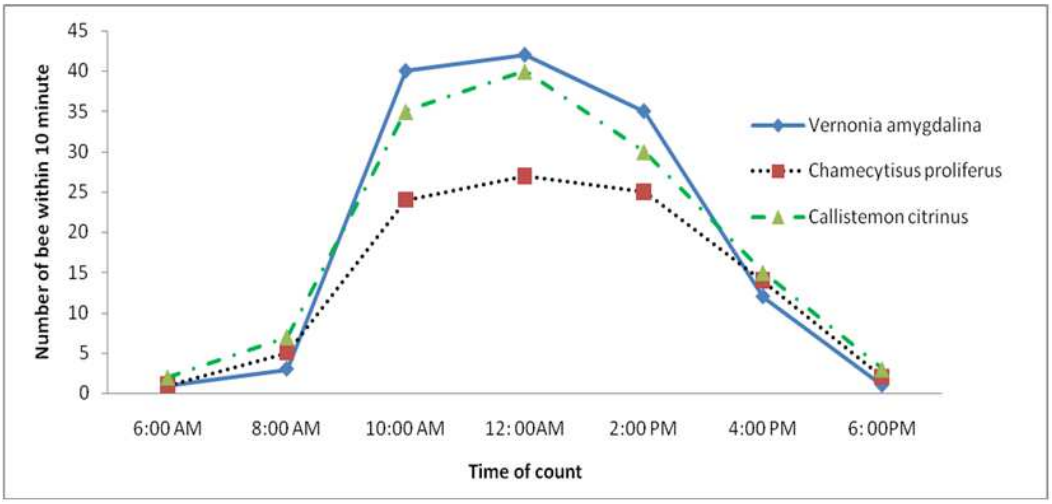

Figure 2. *Foraging intensity of bees on the three different plant species.*

4. Discussions

A number of flower heads per plant were the highest for *Chamecytisus proliferus*. This is due to their growing habit and crown size. Plant with more branching produces more flower heads per plant [16]. [11] also revealed that plants with more vegetative growth produce more flowers. Bee forage plants which take a long time from blooming to shedding are very important for honey production whereas those have short flower shedding time is used for bee colony buildup.

The foraging time of honeybees has varied from bee forage plant species to species, and the peak foraging time ranged from 12 p.m-2p.m. The observations recorded on the foraging intensity of the honeybees showed that visiting bees were few in the early morning and late in the evening due the cold weather condition. *V. amygdalina* and *C. citrinus* was highly foraged by bees 10:00am-12:00 am, while *C. proliferus* from 10:00 am -2:00pm. The foraging time of honeybee is varying from plant species to species based on nectar secretion time and pollen potentiality of plants. *V. amygdalina* is flowered from December-February in the area depending on the rainfall, and honeybees collect pollen and nectar from the flowers frequently. In these months herbaceous bee forage plants dried and there is only a few bee forage plant species in flower around the area [9]. *C. proliferus* flowered from June to August in the area. This is the summer season in the area, in which the high rainfall dropped. This time is also considered as dearth period in view of beekeeping because only a few bee forage plant species in flower, the weather condition is very cold and difficult for honeybees to get food in the area. *Callistemon citrinus* flowered throughout the year. It flowered mostly during the dry season, some trees but may be found with flowers any time of the year under good rain conditions. It starts blooming from the branches close to the stems and goes to the end of the branches. When the first bloomed flower gives seeds and the flower at the end of branches have flowered and vice versa. *Callistemon citrinus* is used and cultivated for ornamental purposes it is to some extent salt tolerant and can grow on very poor dry soils. *Callistemon citrinus* provides sufficient quantities of nectar and pollen for honeybees. Therefore, it assists indirectly with honey production by stimulating brood rearing and strengthening bee colonies, particularly when other plants are not flowering and the flowered plant species have no diversity in the area [9].

Foraging is essential to a honeybee colony's survival. To forage successfully, a bee has to learn and remember not only the color and shape of the flowers that contain nectar and pollen, but also how to get to them [5, 13]. Honeybees are able to remember the period of the day when the resources are higher [12]. They can quickly identify unrewarding patches and might leave them if the amount of resources gained does not compensate for the energy spent collecting it [18]. The variation of number of bee count is associated with different factors such as attractiveness of the flower, number of flower heads per plants, nectar and pollen yield of plants and weather condition [16]. This is also in agreement with [6] the intensity of bee visit is measure of potentiality of plants for nectar and pollen production. Generally, from beekeeping point of view it is economical to select plant species with high bee foraging intensity (showed the quality of pollen and or nectar), more flower heads, and longer flowering period which provides continuous food source for the honeybee colonies [16].

5. Conclusion

In conclusion this study revealed that all plant species included in the study showed good vegetation growth performances. However, *C. citrinus, C. proliferus and V. amygdalina* were given flower with the ranges of 2-3.5 years while *B. polystachya, and D. caffra* are not flowered up to the end of five years. All bee forages plants bloomed were visited by honeybees well. Because the flowering time of *C. citrinus, C. proliferus and V. amygdalina* are almost during the dearth period and only a few bee forage plant species in flower around the area. They provide a good amount of nectar and pollen for honeybees. The time spent by bees for foraging on the flowers depends on the amount of nectar and pollen present in the flower. The peak foraging time is associated with nectar and pollen potentiality and floral preference of honeybees. Even though *C. citrinus, C. proliferus and V. amygdalina* selected as major bee forages plants in this trial, however, it requires further evaluation particularly on nectar volume and sugar concentration for these plants and their integration with watershed development is recommended because they are fast growth plants.

Since *C. citrinus, C. proliferus and V. amygdalina* were flowered in dearth period and their planting is recommended *to* increase honey production.

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