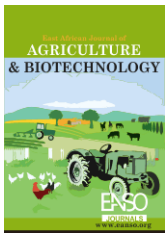

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*Original Article*

# Herbaceous Bee Forage Adaptation Trail in Lowlands of Borana Zone Southern Oromia

*Wayema Amano*[1*], *Olyad Daniel*[1] *& Siraj Kelil*[1]

[1] Yabello Pastoral and Dryland Agriculture Research Center, P. O. Box 085, Yabello, Ethiopia.
* Author for Correspondence ORCID ID: https://orcid.org/0009-0005-5860-1073; Email: wyemano@gmail.com

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## ABSTRACT

To mitigate the shortage of bee forage and help increase honey production, the use of cultivated perennial and annual nectar and pollen sources is highly important in beekeeping development. The study was conducted with the objective of evaluating and identifying adaptable honey bee forage species for beekeeping development. The planting materials were *Aschynomene uniflorum*, *Miloletus alba*, *Fagopyrum esculentum*, *Sinaps alba*, and *Vicia sativa*. The species were evaluated based on germination date, time to set flower, days to 50% flowering, number of flower heads per plant (at 50% flowering of the plant), flowering length (blooming duration), maturity date, and plant height at the flowering stage. Among the five evaluated herbaceous bee forage species, three of them, *Aschynomene uniflorum*, *Fagopyrum esculentum*, and *Sinaps alba*, are adapted and perform well in the most important agronomic parameters. Therefore, the selected bee forage species can be promoted, and beekeepers in the study areas and other areas with similar agroecology can utilise the forage species for beekeeping development. Moreover, evaluation of other agronomic parameters such as seeding rate, fertiliser rate, nectar and/or pollen yield, foraging intensity, and others over different locations of the Borana zone is recommended.

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## INTRODUCTION

Ethiopia is endowed with wide agroclimatic conditions and diverse and unique flowering plants, thus making it highly suitable for sustaining large numbers of bee colonies, and the country is known for its long practices of beekeeping (Fitchel & Admasu, 1994).

In the world today, there are 250,000 species of flowering plants, and many produce nectar, pollen, or both, which are accessible to honey bees. About 40,000 species are reported to be the source of world honey (Crane, 1990). Flowering plants and bees are interdependent; one cannot exist without the other. As bees visit flowers, they collect food, and their pollination activities ensure future generations of food plants are available for future generations of bees and for people too.

The diversified agro-climatic conditions of the country create environmental conditions conducive to the growth of 6000 to 7000 plants (Fitchel & Admasu, 1994), and most are bee plants (Nuru, 2002). However, nowadays, a shortage of bee forage is reported as a constraint to beekeeping in different parts of the country, including the Borana Zone (Tamirat et al., 2013). This may be due to human population growth, agrochemicals, and drought. Generally, the effort to conserve and manage bee flora to maintain the sustainability of beekeeping is poor in the country as well as in the zone.

In order to survive, prosper, and be productive, honeybee colonies must have a supply of both perennial and annual nectar and pollen sources in adequate quantities. Moreover, the use of cultivated bee flower plants will ensure the continuous availability of bee forage by bridging floral gaps.

A shortage of bee forage leads to a devastating problem that retards the production and productivity of honey bee colonies, especially during the dearth period (Malede, Selomon, & Zebene, 2015). The introduction of improved bee forages is paramount to beekeeping development in the Borana zone. There is also demand for improved honey bee forage from different sectors, like government, nongovernment, and beekeeper farmers. However, so far, no adaptation trials have been conducted on potential bee forage species in the lowlands of the Borana zone.

Therefore, the study was conducted to screen the best-performing herbaceous bee forage species from six improved forage species with a view to selecting for honey production in Borana zones.

### Objectives

- To evaluate and identify adaptable honey bee forage species
- To select and recommend the best bee forage source for beekeeping development

## MATERIALS AND METHODS

### Study Areas

The study was conducted in Borana zone, Southern Oromia. Borana zone is characterised by its arid to semi-arid climate, with an annual mean temperature ranging from 19 $^{o}$C to 24 $^{o}$C (Coppock, 1994; Kamara et al., 2005). The rainfall pattern is bimodal, with 60% occurring in the long rainy season (Ganna), which occurs from March to May, and the short rainy season (Hagaya), which extends from September to November (Coppock, 1994). Generally, the average annual rainfall ranges between 350 and 900 mm. On the other hand, the long dry season (Bona) occurs from December to February, and the short dry season (Adolessa) occurs from June to August (Coppock, 1994).

The predominant soil types in the area include red soil, black soil, white or grey soil, and sandy soil. In most cases, the soil is a well-drained red sandy loam type (Coppock, 1994). Plant communities on flat and hilly plains of central Borana Plateau consist of diverse mixture of woody and herbaceous vegetation (Coppock, 1994). Nowadays, it has been reported that these vegetation has been declining from time to time due to many factors. This leads to the shortage of honeybee forages in the area which is one of constraints of beekeeping in the zone.

 

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### Acquisition of Bee Forages

Seeds of honeybee forage species, including Buckwheat (*Fagophyrum esculentum*), Sweet clover (*Melilotus alba*), *Sinaps alba*, *Vicia sativa*, and *Aschynomene uniflorum* were collected from Adami Tullu Agricultural Research Center (ATARC) and Bako Agricultural Research Center (BARC). The plant species were selected on the basis of agroecological adaptation (growing from lowland to highland areas), literature for their importance as bee forages, similarity of their growth habits (herbaceous), and ease of propagation from seeds.

### Experimental Management

To evaluate the performance of the selected plant materials, a 2 m x 2 m plot was prepared for each of the bee forage species by digging the ground and smoothing the field. RCBD with three replications was employed for all bee forage species. Sowing seed was carried out on prepared plots with the spacing of 20cm, 1m and 1.5m between rows, plots and blocks respectively, in the main rainy season to avoid nutrient competition. Then, each plot was covered with a thin layer of soil, and weeding was performed manually. The data collection on germination date (the number of days counted at 50% emergency), days to flowering (the number of days counted at 50% flowering), number of flower heads per plant (number of flower head counted at five randomly selected sampled plant), flowering length (the number of days counted from flowering to shading), Date of maturity (the number of days counted from sowing date to maturity, and Plant height (measuring five representative sampled plant height at bottom of the ground to the tip of the plant using measuring tape) were recorded.

**Figure 1: Plot preparation and sowing seeds**

### Data Analysis

Data was analysed using SAS version 9.0 software and descriptive statistics was used. Mean differences were analysed by using LSD test.

 

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## RESULTS AND DISCUSSION

In this study the mean value of investigated traits for *Aschynomene uniflorum*, Buckwheat (*Fagophyrum esculentum*) *and Sinaps alba* bee forage species were indicated in *Table 1* and *2*. While the other two forges did not reach to germination at both years of study periods.

**Table 1: Agronomic parameters of forage species**

| Forage species | Parameters | Years =2019/20 | | | Years=2020/21 | | | Pooled |
|---|---|---|---|---|---|---|---|---|
| | | Mean ±SD | Min | Max | Mean ±SD | Min | Max | |
| *Aschynomene uniflorum* | DTE | 5.00±0 | 5 | 5 | 6.00±0 | 6 | 6 | 5.5 |
| | DTF | 66.00±0 | 66 | 66 | 64.00±0 | 64 | 64 | 65 |
| | NFHP | 9.53±1.5 | 8 | 11 | 15.00±7 | 10 | 23 | 12.3 |
| | DF | 29.67±1.15 | 29 | 31 | 29.00±0 | 29 | 29 | 29 |
| | DM | 103.67±0.58 | 103 | 104 | 98.00±0 | 98 | 98 | 100.8 |
| | PH | 81.63±12.22 | 68.3 | 92.3 | 77.88±6.57 | 70.33 | 82.3 | 79.75 |
| Buckwheat (*Fagophyrum esculentum)* | DTE | 5.33±0.58 | 5 | 6 | 6.00±0 | 6 | 6 | 5.6 |
| | DTF | 26.00±0 | 26 | 26 | 29.00±0 | 29 | 29 | 27 |
| | NFHP | 16.20±3.12 | 12.6 | 18.2 | 12.57±3.01 | 9.2 | 15 | 14.4 |
| | DF | 30.00±0 | 30 | 30 | 24.00±0 | 24 | 24 | 27 |
| | DM | 66.00±0 | 66 | 66 | 64.00±0 | 64 | 64 | 65 |
| | PH | 62.53±8.44 | 56.6 | 72.2 | 55.53±2.84 | 53 | 58.6 | 59 |
| Sinaps alba | DTE | 5.33±0.58 | 5 | 6 | 5.00±0 | 5 | 5 | 5.2 |
| | DTF | 44.33±3.06 | 41 | 47 | 46.00±0 | 46 | 46 | 45 |
| | NFHP | 6.1±2.85 | 3.3 | 9 | 3.83±0.29 | 3.5 | 4 | 4.7 |
| | DF | 33.67±4.73 | 30 | 39 | 21.00±0 | 21 | 21 | 27 |
| | DM | 80.00±0 | 80 | 80 | 75.00±0 | 75 | 75 | 77.5 |
| | PH | 75.53±5.61 | 72 | 82 | 41.00±1 | 40 | 42 | 58.3 |

***DTE**= Date to emergency, **DTF**= Days to flowering, **NFHP** = Number of flower head per plant, **DF**= Duration of flowering, **PH**= plant height at flowering stage, **DM**= Maturity date*

**Table 2: Performance of three various bee forage species across planting years**

| Forage Species | Planting year | Parameters | | | | | |
|---|---|---|---|---|---|---|---|
| | | DTE | DTF | NFHP | DF | DM | PH (cm) |
| *Aschynomene uniflorum* | 2019/20 | 5.00b | 66.00a | 9.53a | 29.67a | 103.67a | 81.63a |
| | 2020/21 | 6.00a | 64.00b | 15.00a | 29.00a | 98.00b | 77.88a |
| Backwheat (*Fagophyrum esculentum)* | 2019/20 | 5.33a | 26.00b | 16.20a | 30.00a | 66.00a | 62.53a |
| | 2020/21 | 6.00a | 29.00a | 12.57a | 24.00b | 64.00b | 55.53a |
| *Sinaps alba* | 2019/20 | 5.33a | 44.33a | 6.10a | 33.67a | 80.00a | 75.53a |
| | 2020/21 | 5.00a | 46.00a | 3.83a | 21.00b | 75.00b | 41.00b |

**Means under similar Forage Species and columns with the same superscript letter are not significantly different p>0.05*

***DTE**= Date to emergency, **DTF**= Days to flowering, **NFHP**= Number of flower head per plant, **DF**= Duration of flowering, **PH**= plant height at flowering stage, **DM**= Maturity date.*

### Date to emergency (DTE)

The result shows that the mean emergency dates of selected forages were 5.5, 5.6, and 5.2 days for *Aschynomene uniflorum*, Buckwheat (*Fagophyrum esculentum*), and *Sinaps alba*, respectively. The result of Buckwheat (*Fagopyrum esculentum*) is similar to the findings of Tura, Kibebew & Admassu, (2014); Tusa & Amaslu, (2017); and Ofijan, (2017). But according to Habtie et al (2020) the emergency dates of Buckwheat (*Fagopyrum esculentum*) is 3 days, which is lower than the current finding. *Sinaps alba* (5.5 days) is also within the ranges of previous findings, which are 6.16 and 4.27 days, by Ofijan (2017) and Habtie et al (2020), respectively. The result shows only *Fagophyrum esculentum* has a significant difference (P<0.05)

 

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in days to germination across planting years (*see Table 2*).

**Days to Flowering (DTF)**

The current finding in days to flowering of selected forages is 66 for *Aschynomene uniflorum*, 27 for Buckwheat (*Fagophyrum esculentum*), and 45 for *Sinaps alba*. The result is within the range of previous reports in other areas. Accordingly, Buckwheat (*Fagophyrum esculentum*) takes 40.3 days (Tura, Kibebew & Admassu, 2014); 38 days (Tura & Admasu, 2018); 25.94 days (Habtie et al., 2020); 26.95 days (Tusa and Amsalu, 2017); and 29.50 days (Ofijan, 2017) to flower. *Sinaps alba* also takes 44.7 days (Tura, Kibebew & Admassu, (2014); 35.83 days (Ofijan, 2017), 58.25 days (Habtie et al, 2020). Both *Aschynomene uniflorum* and *Fagophyrum esculentum* showed significant differences ($P<0.05$) in days to flower across planting years.

**Duration to Flowering (DF)**

The result shows that the mean flowering duration for the selected forages was 29, 27, and 27 days for *Aschynomene uniflorum*, Buckwheat (*Fagopyrum esculentum*), and *Sinaps alba*, respectively. In the study area all bee forages have long flowering period which ranges to one month. The previous findings by Habtie et al (2020), 33.16 days; Tusa and Amsalu (2017) 31 days reported the duration of flowering of Buckwheat. Besides, Tura & Admasu, (2018) also reported that Buckwheat has short flowering period. Girma et al (2014) reported that *Aschynomene uniflorum* has a long blooming duration. Bee forage plants, which have a long flowering period from blooming to shedding, are very important for honey production.

**Days to Maturity (DM)**

The current finding on days to maturity of selected forages 103.6 for *Aschynomene uniflorum*, 66 for Buckwheat (*Fagopyrum esculentum*), and 80 for *Sinaps alba*, respectively is within the range of previous findings. The result shows each forage has a significant difference ($P<0.05$) in days to maturity across planting years (see *Table 2*). Buckwheat (*Fagopyrum esculentum*) is fast growing crop and mature faster than any other grain crop, making it particularly well suited to regions with short growing seasons. The current days to maturity result of Buckwheat (*Fagopyrum esculentum*) is within the rage of previous finding of Tusa and Amaslu (2017) who reported 65.8 to 88 depending on sowing date of the plant.

**Plant Height (PH cm)**

Plant height is a good indicator of the growth rate and adaptation of bee forages to the environment. The mean performance of tested bee forage species' plant heights was 79.75 cm, 59 cm, and 58.3 cm for *Aschynomene uniflorum*, Buckwheat (*Fagopyrum esculentum*), and *Sinaps alba*, respectively. The result shows only *Sinaps alba* has a significant difference ($P<0.05$) in plant height across planting years. The current plant height result of Buckwheat (*Fagopyrum esculentum*) is lower than Habtie et al (2020) who reported 67.73 cm, but higher for *Sinaps alba*, 56.62 cm in the lowland areas (Pawe) of Metekel Zone, Benishagul Gumuz.

## CONCLUSIONS AND RECOMMENDATIONS

In conclusion, this study reveals that among five evaluated herbaceous bee forage species, three of them: Buckwheat (*Fagopyrum esculentum*), *Aschynomene uniflorum*, and *Sinaps alba* were adapted and performed well in the most important agronomic parameters in the study area. The performance of each forage species was significantly ($P<0.05$) different across planting years. This might be due to moisture content differences over the years. Thus, it is important to further evaluate them for nectar and pollen production potential in different agro-pastoral areas of the zone as it is the base for honey production and thus demonstrate them to the end users. Thus, Beekeepers in Southern Oromia and areas with similar agroecology can utilise the forage species for beekeeping development.

Moreover, evaluation of other agronomic parameters such as seeding rate, fertiliser rate,

 

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nectar/pollen yield, and others over different locations of the Borana Zone is recommended.

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