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Adaptation of Bee Forage Species in Metekel Zone of Benishagul Gumuz

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Abstract— *Availability of adequate perennial and annual source of nectar and pollen is the most limiting factor in the survival, abundance and distribution of honeybees. The study was conducted to evaluate the adaptation potential of three shrub and seven herb bee forage species across different agro-ecologies. The planting materials were Tebeb (bacium grandiflorum),Trelucent (Chamecytisus proliferus),Callistemon citrinus ,Gribia (hypoestus forskaoliil), Sweet clover (miloletus alba), Phacelia tanacetifolia ,Leonurus cardiaca, Buckwheat ,Sinaps alba and Guizotia abyssinica. The species were evaluated based on days to emergence, days to flowering, number of flower head per plant, number of tiller per plant at 50% flowering, foraging intensity per minutes, duration of flower and plant height at flowering stage. Accordingly, all treatments were significantly difference in different parameters. Among seven herb bee forage species six of them (Buckweat Sweet Clover Leonurus cardiaca Gribia Guizotia Abyssinica and Sinaps Alba) are adapted in Pawe (lowland), five of them (Buckweat, Sweet Clover, Gribia, Guizotia abyssinica and Sinaps alba) are adapted in Bullen (midland) and four of them (Phacelia tanacetifolia, Buckweat, Gribia Guizotia abyssinica and Sinaps Alba) are adapted in Wombera(highland) districts. From this Buckwheat and sinaps alba were stable adaption throughout the study districts, and used for colony build up rather honey production. Becium grandiflorum (Tebeb) were adapted in all environment but the performance is lower in highland agroecology. Tebeb can flower four times if water is supplied. According to different parameters result Tebeb were selected for all study districts, whereas Gribia were selected for Pawe and Bullen and Leonurus cardiaca selected for Pawe district. To enhance the current shortage of bee forage and help for increasing honey production, highly adapted and performed bee forage species across the three study districts could be recommended. Therefore, Tebeb for three agroecology, Gribia for lowland and midland and Leonurus Cardiaca for lowland will promoted in the study area and similar environment. It requires further evaluation particularly on agronomic evaluation (seed rate and fertilizer rate) and nectar yield should be tested under different agro-ecologies of the country.*

Keywords— *Bee Forage Herbs, Shrubs, Adaptation, Flowering Period, and Foraging Intensity.*

I. INTRODUCTION

Honeybee plants are those plant species that provide food source for honeybees (Admassu *et al* 2014). About 16% of the world's flowering plant species contribute to honeybees as food sources (Adgaba et al 2017). Among the many flowering plants some of plant species supply both nectar and pollen abundantly and others provide nectar or pollen only (Shubharani *et al* 2004). The diversified agro-climatic conditions of the country created conducive environmental conditions for the growth of over 7000 species of flowering plants of which most are bee plants. The number of colonies makes the country with the highest bee density in Africa (Germew *et al*., 1998).In most parts of the country; there is enough variety of flowering plants to provide sufficient pollen and nectar to support honeybee colonies. But theses feed sources are not uniformly distributed throughout the year. The diversity of flowering plants and their flowering duration differ from one place to other depending on variation in topography, climate and other cultural and farming practices (Alemtsehay *et al* 2011). In addition, their duration of availability is also not the same all over the agro-ecologies. It could be very short for some localities and this condition can create very long dearth period for the colonies in that area.

In tropical areas, a large proportion of honey produced comes from shrubs trees and important as a sources of nectar and pollen (Munthali and Mughogho, 1992).Success in beekeeping depends on the availability of bee forage in terms of both quality and availability of nectar and pollen (Tidke and Nagarkar, 2010). Shrubs trees not only provide nectar and pollen for the honeybees but also used as animal feed, ornamental, shade tree, live fence and conservation of natural resources. Insufficient availability of natural feeds may cause the bees to leave their nest looking for new sites where feeds are available.

In Metekel zone 105 species of bee plants were identified of which 45.3% are herbs, 37.7% are trees and 17% shrubs. The densities of tree species are decreasing due to deforestation for domestic furniture. The whole burning in the area to believe good forage development for the next season, this reduced the bee flora. The zone has two major honey flow season. There is scarcity of flowering plants from December to February and July to August are occurred. This may be possible reason for absconding of bee colonies particularly during dearth period (Bilihatu, et al, 2009).Even though; scarcity of flowering plants is occurred during the honey flow seasons. Hence, to gain optimum benefit from shrubs and herb bee forage we have to collect the material and sowing for evaluating the adaptation performance with three agro-ecology. From this *Bacium grandiflorum* and *hypoestus forskaolii* that provides white honey in northern parts of the country. Therefore, the overall objective of this study were to evaluate the adaptation potential of bee forage species across different agro-ecologies and to recommended the best adapted bee forage for beekeepers.

II. MATERIALS AND METHODS

Descriptions of the study Areas

The study was conducted three potential districts Pawe (lowland), Bullen (midland) and Wonbera (highland) of

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Metekel Zone, Benishangul Gumuz Regional State, Ethiopia. It is located at a distance of 572 km North West of Addis Ababa. The area is with an elevation range from 600-2800 meters above sea level. Meteorological data of Pawe Agricultural Research Center indicate that the zone receives an annual rainfall ranging from 900 to 1450 mm with annual minimum and maximum temperature of 20 and 35°C, respectively. Metekel Zone is characterized by two common honey harvesting time; which is April to May and October to November.

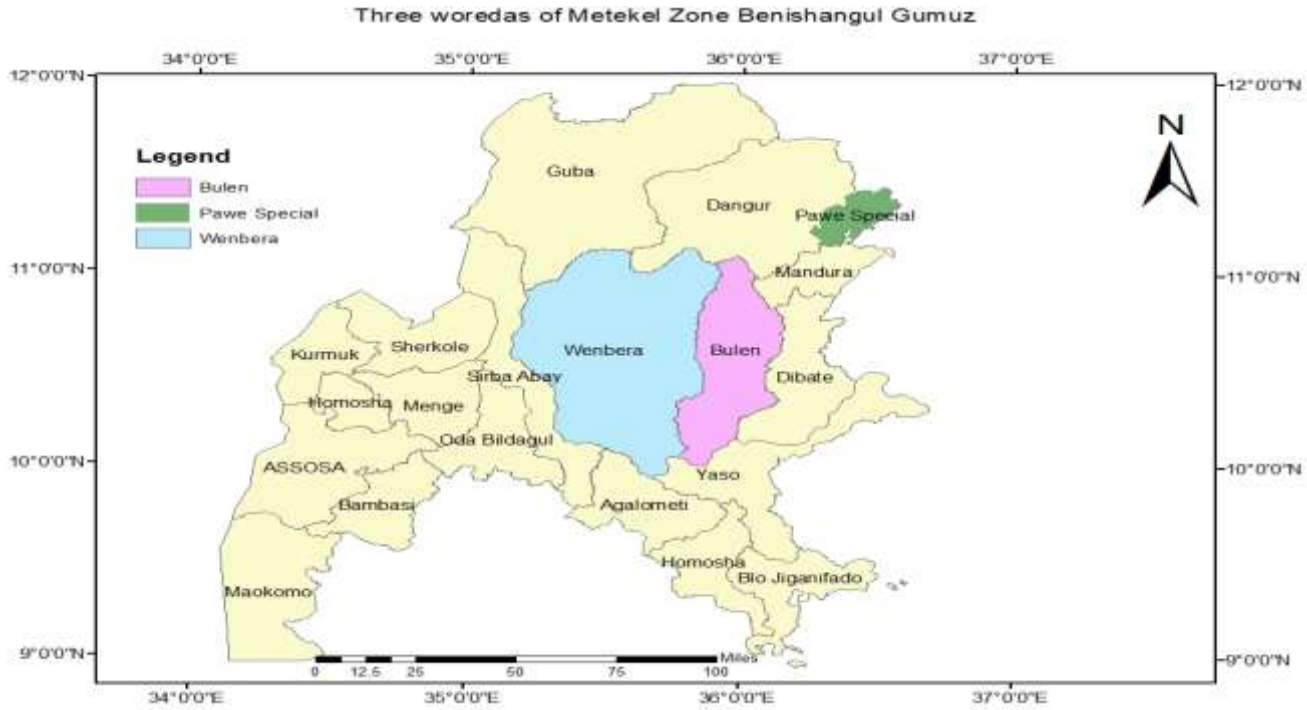

Fig:1 Study Map

Tested bee forage species:

Two groups of bee forage were tested in three locations, shrub and herb. Under shrub bee forage Tebeb (Bacium grandiflorum), Trelucent (Chamecytisus proliferus) and Callistemon citrinus and under herb bee forage Gribia (Hypoestes forskaolii), Sweet clover (miloletus alba), Phacelia tanacetifolia, *Leonurus-cardiaca*. Buckwhet(Fagophyrum-esculentum), Sinapis alba and Guizotia abyssinica(control).

Soil test

The soil sample were taken before sowing in each location. Five representative sites were selected by using X Fashion and soil sample was taken by using Auger 15 cm depth. After taking the sample make composite sample. The composite sample were dried and grind. The PH, organic carbon and organic matter parameters were analyzed.

Seed collection

For this study mature seeds of seven herbs and three shrubs were brought from Holota and Mekele Agricultural Research Center. After brought seed shrubs are prepared seedling for planting.

Experimental management and design

To evaluate the performance of selected plant materials, the land was prepared according to required standards. Seeds were sown in row on prepared plots at the plot size of 2mx2m with appropriate seed rate and to keep proper spacing and avoid nutrient competition, spacing used between rows were 30 cm for herb groups and seedling were prepared and planted 150cm between plant and row for shrub groups with 4.5m*4.5m plot size. The plots were arranged in randomized complete block design with three replications. Fertilizer 100 kg DAP per ha was used. The necessary agronomic practices weeding was done three times across all sites.

Data collection

Data collection was made on days to emergence (the number of days counted at 50% emergence) ,days to flowering (the number of days counted at 50% flower opening), number of flower head per plant(number of flower head counted at five representative sampled plants with "X" fashion), number of tiller per plant at flowering (number of tiller counted at five representative sampled plants with "X" fashion), foraging intensity per minutes (number of bees visited starting from 9am to 10am and 3pm to 4pm at active time for five consecutive days were recorded) and number of bees were recorded $4m^2$ plot based for herb group and plant based for shrub group, duration of flower(the number of days counted from the beginning of flower to the end of flower) and plant height at flowering stage (measuring five representative sampled plant height at the bottom of the ground to the tip of plant by using ¾ meter with "X" fashion). Vigor of the treatment were coded and recorded by using five scales. 1=poor, 2=fair, 3=good, 4=Very good and 5=excellent.

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Statistical Analysis and Model

The data were statistically analyzed using SAS 9.4 2019. The following General Linear Model was used during analysis of quantitative data: DTE, DTF, NFHP, NTP, FI, DF and PH.

$$Y_{ijkl} = \mu + y_i + l_j + t_k + y(l)_{ij} + l(t)_{jk} + y*t(l)_{ijk} + e_{ijkl}$$

Where:

Y_{ijkl}= the observed M variable in the i^{th} year, j^{th} location and k^{th} treatments

μ = overall mean

y_i = effect due to i^{th} year (i= 2016 and 2017)

l_j = effect due to j^{th} location (j= Pawe, Bullen and Wonbera)

t_k = effect due to k^{th} treatments (seven herb and three shrub)

$y(l)_{ij}$ = effect due to interaction between i^{th} year and j^{th} location

$l(t)_{jk}$ = effect due to interaction between j^{th} location K^{th} treatment

$y*t(l)_{ijk}$ = effect due to interaction between i^{th} year, K^{th} treatment and j^{th} location

e_{ijkl} = the effect of random error

III. Result and Discussion

Results of soil analysis

The results of soil samples from the test locations are presented in Table 1. The P^H value of each districts was slightly similar which is put under moderate acidic range according to USDA natural resource conservation service soil quality laboratory,1998. The available phosphorus, organic carbon and organic matter in Pawe is higher as compared to Bullen and Wonbera.

Mean squares for all parameters of seven bee forage species evaluated across three locations and two years

The mean square values for genotypes at three separate locations and two years for DTE, Vigor, DTF, NFHP, NTP, FI, DF and PH are presented in Table 2: The effect of year is highly significant ($p<0.01$) differences among DTE, Vigor, DTF, NTP and significant ($p<0.05$) differences on FI. The effect of location is highly significant ($p<0.01$) differences among DTE, DTF, NFHP, NTP, FI, DF and significant ($p<0.05$) differences on Vigor and PH. The effect of year*location is highly significant ($p<0.01$) differences among DTE, Vigor, DTF, NTP and significant ($p<0.05$) differences on FI. The effect of treatment is highly significant ($p<0.01$) differences among DTE, Vigor, DTF, NFHP, NTP, FI, DF and PH. The effect of location*treatment is highly significant ($p<0.01$) differences among DTE, Vigor, DTF, NFHP, NTP, FI, DF and PH and The effect of year*treatment (location) is highly significant ($p<0.01$) differences among DTE, Vigor, DTF, NTP, PH and significant ($p<0.05$) differences on FI.

TABLE 1. Soil test results of three study districts

No	location	P^H	Available phosphorus Bray II (ppm)	Organic Carbon (%)	Organic Matter (%)
1	Pawe	5.28-5.84	9.090	2.976	5.130
2	Bullen	5.3- 5.9	2.367	2.506	4.320
3	Wambra	5.3- 5.9	0.284	2.741	4.725
	Mean	5.29-5.89	3.9	2.74	4.72

Different species of bee forage photos

Bacium grandiflorum(Tebeb)

Gribia(hypoestus forskaolii)

Leonurus cardiaca

Phacelia tanacetifolia

Sinaps alba

Buckwheat

sweet clover

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TABLE 2. Combined mean squares for agronomic parameters of 7 bee forage species evaluated across three locations during 2016 and 2017 years

Source of variation	df	DTE	Vigor	df	DTF	NFHP	NTP	FI	DF	PH
Year	1	4.57**	71.62**	1	608.27**	0.77	156.91**	1174.28*	5.85	271.12
Location	2	26.64**	0.72*	2	1196.69**	3817.81**	231.63**	3591.83**	2534.93**	3356.97*
year(location)	2	3.07**	2.19**	2	481.25**	120.58	605.24**	616.99*	7.18	1731.12
Treatment	6	116.22**	5.87**	6	45387.46**	2453.58**	214.91**	15954.29**	7271.15**	39447.2**
location*treatment	12	4.21**	8.89**	6	907.94**	485.78**	123.63**	5439.12**	881.24**	4246.35**
year*treatment(location)	18	0.31**	2.58**	12	410.41**	44.28	125.61**	301.8*	28.25	2260.30**
Error	84	3.33	0.17	58	2466.67	2751.06	839	7494.83	5156	30168.87
Total	125			87						
CV%		3.45	14.19		8.25	25	31.7	33.21	15.17	22.64
LSD(0.05)		0.13	0.27		5.72	6.04	3.34	9.98	8.27	20.02
Grand mean		5.76	2.94		79.02	26.91	11.99	34.22	62.11	100.71
R2		0.99	0.95		0.99	0.91	0.88	0.95	0.94	0.91

*=significant at 5% **=highly significant at 5% DTE=days to emergency DTF=days to flowering NFHP=number of flower head per plant NTP= number of tiller per plant at flowering FI=foraging intensity per minutes DF= duration of flower and PH= plant height at flowering stage

The performance of treatment in each location

The performance of all treatments in each location are presented in Table 3 and 4. All treatments were emerge after sowing in all tested locations. The performance of Phacelia tanacetifolia was poor performance in Pawe and Bullen whereas very good in Wombera. The performance of *Leonurus cardiaca* was poor in Bullen and Wonbera whereas very good in Pawe. The performance of girbia was poor performance in Wombera whereas very good in Pawe and Bullen. The performance of sweet clover was poor performance in Wombera whereas fair in Pawe and Bullen.

The performance of each treatment presented in Table 4 showed that: in Pawe districts six bee forage species were adapted rather than Phacelia tanacetifolia, while in Bullen district five bee forage species were adapted rather than Phacelia tanacetifolia and Leonurus cardiaca. Where as in Wonbera district four bee forage species were adapted rather than girbia, sweet clover and Leonurus cardiaca. This poor adaptation potential could be environmental effect on that specific genotype.

Mean treatment performance on each location

The performance of treatments in each location were presented in Table 5. Most parameters were favored in Lowland (Pawe) and Midland(Bullen) environment as compared to Highland(Wonbera) environment. The mean value of treatments in different parameter were significant difference among tested locations. This variation could be the presence of different agroecology in the study area.

Mean performance of treatments

Days to Emergence (DTE)

The result indicated under Table 6 showed that each treatments were significance ($p<0.05$) difference among them where as there was no significance ($p>0.05$) difference between Guizotia abyssinica and Sinaps alba. Buckweat begin early emergence than other treatments, whereas Leonurus cardiaca and gribia was extended time of emergence. The result of Buckweat and Guizotia abyssinica lower than the finding of Bareke *et al*, (2014) who reported the emergence time were 5 and 8 days after sowing.

TABLE 3. The performance of treatment in each location

Locations	Treatments	N	DTE		vigor	
			Mean	SE	Mean	SE
Pawe/Lowland	Phacelia tanacetifolia	**6**	4	0	1.00	0.00
	Buckweat	**6**	3	0	2.50	0.22
	Sweet Clover	**6**	5.5	0.22	2.17	0.17
	Leonurus cardiaca	**6**	9.5	0.22	3.83	0.54
	Gribia	**6**	5.67	0.21	4.00	0.45
	Guizotia Abyssinica	**6**	3	0	4.00	0.45
	Sinaps Alba	**6**	3.33	0.33	2.67	0.61
Bullen/Midland	Phacelia tanacetifolia	**6**	5	0	1.67	0.80
	Buckweat	**6**	4	0	3.83	0.54
	Sweet Clover	**6**	6	0	2.67	0.49
	Leonurus cardiaca	**6**	10	0	1.33	0.21
	Gribia	**6**	7.5	0.22	4.00	0.63
	Guizotia Abyssinica	**6**	5	0	4.00	0.45
	Sinaps Alba	**6**	5	0	3.17	0.70
Wonbera/Highland	Phacelia tanacetifolia	**6**	4.5	0.22	4.00	0.45
	Buckweat	**6**	3.5	0.22	4.00	0.45
	Sweet Clover	**6**	5.5	0.22	1.00	0.00
	Leonurus cardiaca	**6**	12.5	0.22	1.50	0.67
	Gribia	**6**	9.5	0.22	1.00	0.00
	Guizotia Abyssinica	**6**	4.5	0.22	3.00	0.45
	Sinaps Alba	**6**	4.5	0.22	3.50	0.22

DTE=days to emergence

TABLE 4. The performance of treatment in each location

Location	Treatments	N	DTF		NFHP		NTP		FI		DF		PH	
			Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Pawe	Buckweat	**6**	24	1.34	43.93	3.12	4.53	0.49	43.25	2.31	28	2.35	67.73	16.06
	Sweet Clover	**6**	76.67	2.67	16.5	1.84	17.12	2.02	8.5	0.96	69.83	3.88	44.1	17.26
	Leonurus cardiaca	**6**	283.67	1.54	46.33	1.5	22.67	7.59	37.17	9.64	143.5	3.81	194.17	3.3
	Gribia	**6**	80	3.2	36.5	5.5	22.18	1.91	32.83	3.53	101.5	2.43	87.63	15.19
	Guizotia Abyssinica	**6**	91	0.45	73.33	6.21	21.47	1.65	80	3.6	72.83	1.7	220.66	12.99
	Sinaps Alba	**6**	73.83	6.63	21.33	2.04	11.73	1.93	5.17	0.48	79	2.9	56.62	8.3
Bullen	Buckweat	**6**	32.5	2.91	17.5	0.76	9.07	3.32	20.83	2.44	32.67	2.04	72.47	12.7
	Sweet Clover	**6**	62.5	10.51	15	1.06	13.2	3.65	9	1.63	60.33	7.56	45.6	6.32
	Gribia	**6**	115.67	2.04	26	0.58	6.67	1.63	17.17	3.24	65	1.44	122.5	10.55
	Guizotia Abyssinica	**6**	83.67	2.11	36.9	4.98	14.47	2.85	158	10.47	58.33	6.53	188.3	11.15
	Sinaps Alba	**4**	53	8.98	5.15	0.36	7.85	3.16	2.5	0.41	52.5	4.22	73.85	7.78
Wonbera	Phasilia Tantifolum	**6**	58.83	1.72	4.3	0.44	2.7	0.43	6.33	0.8	33.17	1.68	56.3	2.36
	Buckweat	**6**	21.33	1.05	18.77	1.44	5.1	0.6	28	4.38	38.83	2.07	71.83	3.03
	Guizotia Abyssinica	**6**	73.83	1.08	29.5	1.09	10.83	1.24	47	13.02	39.83	1.3	126.67	17.93
	Sinaps Alba	**6**	46.17	5.59	5.43	0.33	8.97	2.34	7	1.21	53.17	2.52	73.33	15.28

SE=standard error DTF=days to flowering NFHP=number of flower head per plant NTP= number of tiller per plant at flowering FI=foraging intensity per minutes DF= duration of flower and PH= plant height at flowering stage

TABLE 5. Mean comparisons of treatments in each location

Location	N	DTE Mean	Vigor Mean	N	DTF Mean	NFHP Mean	NTP Mean	FI Mean	DF Mean	PH Mean
Pawe	42	4.85c	2.88b	36	104.86a	39.65a	16.61a	34.48b	82.44a	111.81a
Bullen	42	6.07b	3.09a	28	70.64b	21.18b	10.42b	44.28a	53.85b	102.45b
Wombera	42	6.35a	2.85b	24	50.04c	14.5c	6.9c	22.08c	41.25c	82.03c
GM		5.76	2.94		79.02	26.91	11.99	34.22	62.11	100.71
LSD		0.08	0.18		3.45	3.65	2.01	6.02	4.99	12.08

DTE=days to emergency DTF=days to flowering NFHP=number of flower head per plant NTP= number of tiller per plant at flowering FI=foraging intensity per minutes DF= duration of flower and PH= plant height at flowering stage

Vigor

Vigor is an important parameter for knowing field performance of treatments. The overall vigor results showed that Buckwheat and Guizotia Abyssinica were no significance difference between them and perform better as compared to others, while there were no significance difference among Sinaps Alba, Gribia and Leonurus cardiaca. List performance were recorded in Sweet Clover and Phacelia tanacetifolia with compared to others.

Days to flowering (DTF)

The mean Days to flowering were significantly difference among treatments, whereas there was no significance difference observed in Phasilia Tantifolum and Sinaps Alba. Early days to flowering were observed in Buckwheat, whereas the longest period was observed in Leonurus cardiaca. The range of time taken to set flower was 25.9 to 283.6 days. The result of buckwheat and Guizotia abyssinica lower than the finding of Bareke *et al*, (2014) who reported the days to flowering were 40.3 and 103.7 days, but the result of Sinaps alba were higher than Bareke *et al*, (2014) who reported the days to flowering were 44.7 days.

Number of flower head per plant (NFHP)

The overall mean number of flower head per plant under Table 6 showed that there was a significant difference among treatments. But no significance difference observed between girbia and Buckwheat, Leonurus cardiaca and Guizotia Abyssinica and Sweet Clover and Sinaps Alba. The higher number of flower head per plant was recorded in Linorous Cardia and Guizotia Abyssinica. The medium amount of flower also recorded in girbia and Buckwheat. Whereas the list amount of flower head per plant were recorded in Phacelia tanacetifolia. Guizotia Abyssinica was higher number of flower head followed by Leonurus cardiaca and girbia. The presence of higher number of flower head per plant could provide food source for honeybees, produce honey and sustain a long period of time in the area.

Number of tiller per plant (NTP)

The current result of mean number of tiller per plant indicated that: Leonurus cardiaca was higher mean number of tiller followed by Guizotia Abyssinica, Gribia and Buckwheat. The list number of tiller recorded in Phacelia tanacetifolia, Buckweat and Sinaps Alba. The presence of higher number of tiller per plant might be higher number of flower head per plant. This enables bees can access bee flora throughout the year. More branching produces more flower heads per plant. John et al (1987) also revealed that the more vegetative growth of a plant develops to more flowers and seeds, and also plants that grow longer vegetative before flowering are typically bigger and able to support more reproductive growth

Foraging intensity (FI)

The overall mean number of bees counted in $4m^2$ land per one minute in the study locations were significance difference among treatments. Guizotia Abyssinica were recorded the higher number of bees visited in the bee flora followed by Leonurus cardiaca, Buckweat and girbia. Whereas list amount of bees was recorded in Sinaps Alba, Phacelia tanacetifolia and Sweet Clover. The variation among number of bee count in a treatments were 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. This is also in agreement with Crane (1990) the intensity of bee visit is measure of potentiality of plants for nectar and pollen production.

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Duration of flower (DF)

Flowering duration of the plant species are very important parameter for honeybees, because the production potential and sustainability of the bees depend on this. The overall mean duration of flower were significant difference among treatments. Whereas there was no significance difference among Guizotia Abyssinica, Sinaps Alba and Sweet Clover and Buckweat and Phacelia tanacetifolia. Leonurus cardiaca were recorded the higher duration of flower followed by gribia, Sweet Clover and Sinaps alba. Whereas list data was recorded in Phacelia tanacetifolia and Buckwheat. Leonurus cardiaca *and Gribia* took long days from flower opening until shedding under both condition due to different factors such as growing temperature, photoperiod and genotype which is lined with the report of Evans, (1957). 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 may be only used for bee colony buildup.

Plant height(PH)

The overall mean plant height at flowering were significant difference among treatments. Whereas there was no significance difference between Guizotia Abyssinica and Leonurus cardiaca, Sinaps Alba and Backweat and Sweet Clover and Phacelia tanacetifolia. Leonurus cardiaca were recorded the higher plant height followed by Guizotia Abyssinica and gribia.

Combined mean square of Bacium grandiflorum(Tebeb)

Among three shrub species *Trelucent and Callistemon citrinus* was not succeed in seedling, due to this reason one species of shrub were evaluated for two years in three study locations. The effect of year was highly significance ($p<0.01$) difference on PS,NTP and FI. The effect of location was highly significance ($p<0.01$) difference on DTF, NFHP, NTP and PH. The effect of interaction year(location) was highly significance ($p<0.01$) difference on NTP and significance ($p<0.05$) difference on DF as indicated Table 7.

Performance of Tebeb in two consecutive years

The overall results indicated in Table 8 showed that there was highly significance ($p<0.01$) difference on PS, NTP and FI, whereas there was no significance ($p>0.05$) difference on DTF, NFHP, DF and PH.

TABLE 6. Combined mean performance of treatments in three study districts

Treatment	N	DTE Mean	Vigor Mean	Treatment	N	DTF Mean	NFHP Mean	NTP Mean	FI Mean	DF Mean	PH Mean
Phacelia tanacetifolia	**18**	4.5d	2.55c	Phacelia tanacetifolia	**6**	58.83e	4.3d	2.7e	6.33d	33.16d	56.30cd
Buckweat	**18**	3.5f	3.44a	Buckweat	**18**	25.94f	26.73b	6.23d	30.69bc	33.16d	70.68c
Sweet Clover	**18**	5.66c	1.94d	Sweet Clover	**12**	69.58d	15.75c	15.15b	8.75d	65.08c	44.85d
Leonurus cardiaca	**18**	10.66a	2.88b	Leonurus cardiaca	**6**	283.66a	46.33a	22.66a	37.16b	143.5a	197.17a
Gribia	**18**	7.55b	3.00b	Gribia	**12**	97.83b	31.25b	14.42b	25c	83.25b	105.07b
Guizotia Abyssinica	**18**	4.16e	3.66a	Guizotia Abyssinica	**18**	82.83c	46.57a	15.58b	95a	57c	178.54a
Sinaps Alba	**18**	4.27e	3.11b	Sinaps Alba	**16**	58.25e	11.32c	9.72c	5.18d	62.68c	67.19c
GM		5.76	2.94			79.02	26.91	11.99	34.22	62.11	100.71
LSD		0.13	0.27			5.72	6.04	3.34	9.98	8.27	20.02

DTE=days to emergency DTF=days to flowering NFHP=number of flower head per plant NTP= number of tiller per plant at flowering FI=foraging intensity per minutes per $4m^2$ land DF= duration of flower and PH= plant height at flowering stage

TABLE 7. Combined mean squares for agronomic parameters of Tebeb across three locations in Metekel zones during 2016 and 2017 years

Source of Variation	df	PS	DTF	NFHP	NTP	FI	DF	PH
Year	1	200**	40.50	22.22	826.88**	249.38**	20.05	41.49
Location	2	12.5	552.7**	15041.05**	735.38**	30.72	16.72	2447.01**
Year(Location)	2	12.5	32.16	104.05	460.05**	12.05	81.05*	129.1
Error	12	4.16	16.88	229.11	23.55	25.77	15.11	81.89
Total	17							
CV%		2.18	3.77	21.28	23.74	27.28	7.46	9.43
LSD(0.05)		2.56	5.16	19	6.1	6.38	4.89	11.38
Grand mean		93.33	108.90	71.1	20.44	18.6	52.05	95.96
R2		0.83	0.85	0.91	0.92	0.52	0.54	0.84

PS=plant survivability DTF=days to flowering NFHP=number of flower head per plant NTP= number of tiller per plant at flowering FI=foraging intensity per minutes per plant DF= duration of flower and PH= plant height at flowering stage

TABLE 8. The effect of year on the performance of Tebeb

Year	N	PS	DTF	NFHP	NTP	FI	DF	PH
2016	9	90b	110.4±3.4	72.2±13.5	27.2a±5.3	14.9b±1.27	53.1±1.07	97.48±6.6
2017	9	96.6a±1.18	107.4±2.6	70±16.5	13.6b±2.9	22.3a±1.9	51±2.02	94.4±6.4
Mean		93.33±0.99	108.9±2.15	71.1±10.39	20.4±3.38	18.6±1.45	52.05±1.14	95.9±4.49
P-value		sig	NS	NS	sig	Sig	NS	NS
LSD		2.09	4.22	15.54	4.98	5.21	3.99	9.29
CV		2.18	3.77	21.3	23.7	27.3	7.4	9.4
R2		0.83	0.85	0.91	0.92	0.52	0.54	0.84

PS=plant survivability DTF=days to flowering PD=pest and disease occurrence NFHP=number of flower head per plant NTP= number of tiller per plant at flowering FI=foraging intensity per minutes per plant DF= duration of flower and PH= plant height at flowering stage

Performance of Tebebe in three study districts

The performance of Tebeb in each study districts are indicated in Table 9. PS, FI and DF was not significance difference among study districts. Whereas vigor, DTF, NFHP,NT and PH were significantly difference among study districts.

Vigor and plant survivability

The vigor of Tebeb was excellent in Pawe and Bullen but good in Wombera. This enables Tebeb can performed better in two study locations rather than Wombera. Plant survivability was higher recorded in Pawe followed by Bullen and Wombera.

Days to flowering, Number of flower head and Number of tiller per plant

Early days to flowering were recorded in Pawe followed by Bullen and Wonbera. This might be in lowland environment the plants were grow faster and ready to bloom as compared to midland and highland environment. The current days to flowering result is lower than Bareke et al, (2014) who reported 253 days to flowering. Higher number of flower head and tiller per plant were recorded in Pawe followed by Bullen and Wonbera. The presence of higher number of tiller which contribute higher number of flower head.

Foraging intensity, Duration of flower and Plant height

The number of bees counted in a plant per one minute were not significance difference among study districts. The overall mean result of duration of flower was 52 days. This result was comparable with Bareke et al, (2014) who reported that 53 days. Higher plant height were recorded in Pawe followed by Bullen and Wonbera. This due to most of the time in hot environment the growth of plant is higher as compared to midland and highland environments.

TABLE 9. The performance of Tebeb in three study districts(Mean ± SE)

Location	N	Vigor	PS(%)	DTF	NFHP	NTP	FI	DF	PH
Pawe	6	5a	95±2.23	99.67c±0.66	110.17a±6	29.67a±30	16.5±2.86	53.33±1.1	116.05a±3.9
Bullen	6	5a	92.5±1.70	108.33b±1.05	88.5b±7.3	23.5b±7.50	21±2.50	50.16±2.48	96.16b±4.19
Wonbera	6	3b	92.5±1.18	118.8a±2.95	14.67c±3.05	8.16c±1.51	18.33±2.23	52.66±2.17	75.67c±3.04
Mean		4.33	93.33±0.99	108.9±2.15	71.1±10.39	20.4±3.38	18.6±1.45	52.05±1.14	95.9±4.49
LSD		0	2.56	5.16	19	6.1	6.38	4.89	11.38
CV		0	2.18	3.77	21.3	23.7	27.3	7.4	9.4
R2		1	0.83	0.85	0.91	0.92	0.52	0.54	0.84
P-value		sig	NS	sig	sig	Sig	NS	NS	sig

PS=plant survivability DTF=days to flowering NFHP=number of flower head per plant NTP= number of tiller per plant at flowering FI=foraging intensity per minutes per plant DF= duration of flower and PH= plant height at flowering stage

IV. CONCLUSSIONS AND RECOMMENDATIONS

In conclusion this study revealed that among seven herb bee forage species six of them (Backweat Sweet Clover Leonurus cardiaca, Gribia Guizotia Abyssinica and Sinaps Alba) are adapted in Pawe(lowland), five of them (Buckweat, Sweet Clover, Gribia, Guizotia abyssinica and Sinaps alba) are adapted in Bullen(midland) and four of them (Phacelia tanacetifolia, Backweat, Gribia Guizotia abyssinica and Sinaps Alba) are adapted in Wombera (highland) districts. But the performance was different among tested locations from this Buckwheat and sinaps alba was stable adaption throughout the study districts, and used for colony build up rather honey production. In lowland environment plants were emerge early, higher number of flower head, higher number of tiller and flower stay a long period of time. The performance of Bacium grandiflorum (Tebeb) in PS, DTF, NFHP, NTP, FI, DF and PH were 93.3%, 108.9days, 71.1, 20.4, 18.6bees, 52days and 95.9cm in respective order. Tebeb were adapted more in lawland and midland agroecology than highland environment and Tebeb can flower four times if water is supplied. According to different parameters result Tebeb were selected for all study districts, whereas Gribia were selected for Pawe and Bullen and Leonurus cardiaca selected for Pawe district. To enhance the current shortage of bee forage and help for increasing honey production, highly adapted and performed bee forage species across the three study districts could be recommended. Therefore, Tebeb for three agroecology, Girbia for lowland and midland and Leonurus cardiaca for lowland will promoted in the study area and similar environment. It requires further evaluation particularly on agronomic evaluation (seed rate and fertilizer rate) and nectar yield should be tested under different agro-ecologies of the country.

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