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Influence of Harvesting Age and Genotype on Growth Parameters and Herbage Yield of Sweet Basil (*Ocimum basilicum* L.) at Wondo Genet, Southern Ethiopia

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Abstract

The field experiment was carried out at Wondo Genet Agricultural Research Center (WGARC) in 2017 under irrigation condition to determine the effects of genotypes and harvesting ages on herbage yield of sweet basil. The experiment consisted of four harvesting ages (40, 60, 80 and 100 days after transplanting (DAT)) and three genotypes (B01, B04, and B05). A 3 × 4 factorial experiment arranged in randomized complete block design (RCBD) with three replications was used. The analysis of variance revealed that the interaction effect of genotype and harvesting age was not significant for plant height, primary and secondary branches of sweet basil. However, all other tested parameters were significantly affected by the interaction of genotype and harvesting ages. The highest leaf area and leaf weight/plant were obtained from genotype B01 harvested at 80 DAT. The maximum aboveground biomass was recorded from genotype B04 harvested at 100 DAT. Genotype B01 harvested at 80 DAT produced the highest fresh herbage yield/ha (16.00 t/ha), which however, was not statistically different from genotype B04 harvested at 100 DAT. On the other hand, the highest dry herbage yield (3.10 t/ha) was produced from genotype B04 harvested at 100 DAT followed by genotype B01 harvested at 80 DAT (2.78 t/ha) and 100 DAT (2.72 t/ha). Therefore, genotype B04 harvested at 100 DAT can be recommended for maximum herbage yield of basil at Wondo Genet area. Since the present experiment was conducted under irrigation condition, further study is suggested to assess the effect of season on herbage yield of this plant under Wondo Genet condition.

Keywords: Essential oil content; Genetic variation; Herbage; Maturity; Plant age

Introduction

Sweet basil or common basil (*Ocimum basilicum L.)* is an annual herbaceous aromatic, spice and medicinal plant belonging to the Lamiaceae family [1]. The name basil is derived from the Greek word *basileus* which means "king" [2]. Basil consists of more than 150 species distributed in the tropics and subtropics of the world. The most widely cultivated species in the world are *O. basilicum* , *O. gratissimum* , *O. xcitriodorum* , O. *americanum* L., *O. minimo* L., and *O. tenui lorum* L. They are grown widely throughout temperate and tropical regions of the world for their essential oil product [3]. Sweet basil (*O. basilicum* L.) is most widely used due to its high economical value, popularity and demands among the economically important species of basil [4]. Basil originated from tropical and warm areas, such as India, Africa and southern Asia [5] and widely cultivated in India, Iran, Japan, China and Turkey.

Sweet basil is known by different names depending on the location. In the English language, it is called basil, common basil or sweet basil. In India, speci ically in Hindi and Bengali, it is called babui tulsi. Other common names of basil are basilica (in French), basilikum or basilienkraut (in German), basilico (in Italian), and albahaca (in Spanish). In Arabic, it is known as hebak as well as rihan. In Ethiopia, different ethtnic group has different names for sweet basil. For instance, it is locally known as besobila in Amharic, Sikakibe or Duguno in Afan oromo, seseg in Tigrigna, Gimenja in Hadiya, qantalama in sidamigna, Kepowa in Wolayita [6]. There are more than 160 named cultivars of basil in existence today. Popular examples include *O. basilicum* 'Cinnamon', *O. basilicum* 'Dark Opal' and holy basil (the species *O. tenui lorum* L., previously known as *O. sanctum* L.). Scents and lavors can range from cinnamon, liquorice and lemon to anise. Probably the most familiar basil is sweet basil (*O. basilicum*); however, this has a large number of cultivars, varying in lavour, scent and uses. Most of the regular varieties of basil are considered as annuals; however, in warm tropical regions many perennial varieties exist, e.g., *O. tenui lorum* [4,7]. Their wide range of forms, colors and sizes have elevated the ornamental importance of basil and have increased the economic value globally [8].

Basil is used in food, perfumery and pharmaceutical industries. Jansen [9] explained that both dried and fresh inflorescences and leaves of basil are used as flavoring agent in the preparation of all kinds of wät. Dried ground basil is also used to flavor butter and is sometimes sprinkled in tea or coffee to add flavor. Farrell [10] also wrote that the herb complements meat, vegetables, cheese, and egg dishes. Etana [11] and Mesfin et al. [12] also noted the spice use of *O. basilicum*.

Yield of *Ocimum* species were influenced by interaction between the genotype and environment, method of distillation, kind of storage, crop age, spacing, diseases and insects, time of harvest and season [5,13-15]. Among the various factors, which affect the production of this plant, harvesting age is important. Yield of fresh and dried herbage

yields were strongly dependent on developmental stage of the plant (ontogeny), and therefore harvesting age is one of the most important factors influencing basil oil [5]. Therefore, the extraction of essential oil at an appropriate age of plant makes it possible to obtain the highest herbage yield of sweet basil.

Farmers of Ethiopia conventionally cultivate and use sweet basil for house consumption and provide for local market. Demand of basil for international market is high due to its multipurpose nature, and is being exported to different countries to fetch foreign currency. According to Yimer [16], export of sweet basil herb is mainly destined to Sudan with 91.4% share of total export value of basil herb from Ethiopia, and the rest of export goes to Israel (7.4%) and USA (1.2%). Ethiopia earned a total of 60,162.20 US dollar total income from export of sweet basil herb in 2010 year. Even though research undertaking on basil in Ethiopia is very minimal, so far, preliminary and national variety trials of basil were done at Wondo Genet Agricultural Research Center (WARC) and promising genotypes have been identified. Moreover, a research on those identified sweet basil genotype with different plant spacing was done by Alemu [17]. However, little research has been conducted to determine at what age the herbage should be harvested or the age at which the plant can produce the highest herbage yield [18-22]. Thus, it is necessary to identify the right harvesting age that could give maximum herbage yield of this economically important plant. Therefore, this study was undertaken with the following objectives:

General objective

To examine the effects of genotypes and harvesting ages on herbage yield of sweet basil at Wondo Genet condition.

Specific objectives

To determine optimum harvesting age for maximum herbage yield of selected genotypes of sweet basil.

To determine a possible interaction effect of harvesting age and genotype on herbage yield of sweet basil.

Materials and Methods

Description of the experimental site

Field experiment was conducted at Wondo Genet Agricultural Research Center (WGARC) in 2017 under irrigation condition. The center is situated at about 264 km south of the capital, Addis Ababa. Geographically it is located at 07°19' North latitude, 38°38' East longitude and an altitude of 1876 m.a.s.l. According to the records from 1997 to 2017, the site receives mean annual rainfall of 1182 mm with an average minimum and maximum temperature of 9.86 and 28.28°C, respectively. The soil textural class of the experimental area is sandy clay loam (Nitosol) with pH of 6.4 [23].

Treatments and experimental design

The experiment consisted of four levels of harvesting ages (40, 60, 80 and 100 days after transplanting (DAT)) with three genotypes (B01, B04, and B05). A 3 × 4 factorial experiment was laid out in randomized complete block design (RCBD) with three replications. Thus, there were 12 treatment combinations in triplicates as shown in the Appendix Table 1. The treatments were randomly allotted to each plot. The experimental plot had an area of 7.2 m^2 (3 m width × 2.4 m length). The space between replications and plots was 1 m. The seedlings were planted at spacing of 60 cm and 40 cm between rows and plants respectively. Plants in the three middle rows out of the five rows per plot constituted the net plot used as the sampling unit. Randomly five plants from the middle rows were taken for sampling and data collection.

Cultural practices

Two-month old fresh soft-wood cuttings, having 10-15 cm length, were taken from the top parts of disease-free plants. The cuttings were planted in 10 cm polyethylene bags filled with fine mixtures of top soil, sand and compost (3:1:2 ratio), respectively at the nursery site of WGARC. The rooted cuttings were allowed to grow at the nursery for about 30 days. The experimental field was ploughed and harrowed to provide a fine and pulverized soil. Then, uniformly grown rooted cuttings were selected, hardened and transplanted to the experimental field at a spacing of 60 cm × 40 cm between rows and plants respectively. All appropriate agronomic practices such as weeding, watering and hoeing were applied uniformly both at the nursery and experimental field.

Data collected

Growth parameters: The following growth parameters were collected from five randomly sampled plants of each plot at the respective harvesting ages (40, 60, 80 and 100 DAT).

Plant height (cm): Plant height was measured from the base of the plant to tip of the main stem and was expressed in centimeter. It was taken from five randomly sampled plants using a ruler and the sum total divided by number of sampled plants was made to get mean plant height per plant. The mean value was used for data analysis.

Number of primary branches per plant: Primary branches are emerged from the main stem of sampled plants. The sum of primary branch number of all sampled plants was divided by the number of sampled plants to work out the mean of primary branches per plant, which was used for data analysis.

Number of secondary branches: Secondary branches emerged from primary branches, were counted from the middle two rows of five plants. The mean values were taken as the representative of the plot, and were used for data analysis.

Leaf area per plant (cm^2): Leaf area per plant (cm^2) was measured according to Bazaz et al. model:

$$LA=0.209(L^2+W^2)+0.25$$

Where, LA=Leaf area; L=Leaf length from the tip of the leaf to petiole attachment; W=Leaf width from the widest lamina or middle part of the leaf 0.209 and 0.25 are fitted coefficient and constant.

Hence, three leaves taken from the top, middle and bottom of five plants from the middle three rows were selected and length (from the tip of leaf to petiole attached) and width (from the widest part) were measured and expressed in centimeter. Therefore, the average leaf area of each plant from the plot, was multiplied by the average leaf number of each plant and mean value was calculated.

Yield and yield component parameters:

Fresh leaf weight/plant (g): The average fresh leaf weight of the randomly sampled plants was immediately recorded after the leaves were separated from stem. All leaves and top tender parts of the plants

were weighed by using sensitive balance (Model No. yt-1002 and reading scale 0.01).

Dry leaf weight/plant (g): Leaf dry weights per plant was estimated by taking 100 g of leaf and top tender parts of the plants from each sampled plant and were dried in hot oven at 100°c for 24 hours until constant weight was reached. Then, dried sample was weighed by sensitive balance (Model No. yt-1002 and reading scale 0.01). Finally, the sum of dry leaf weight of sampled plant was divided by the number of sampled plants to work out the mean; and was expressed in gram per plant.

Fresh aboveground biomass (t/ha): All plants in the central three rows of each plot were harvested and weighed by sensitive balance (Model No. yt-1002 and reading scale 0.01). Then fresh aboveground biomass per net plot was estimated, and converted to ton per hectare.

Dry aboveground biomass (t/ha): All plants in the central three rows of each plot were harvested and drying of harvested biomass was made in the hot oven. Then, dry aboveground biomass was weighed by sensitive balance using (Model No. yt-1002 and reading scale 0.01). Finally, dry aboveground biomass per hectare was determined, and converted to ton per hectare.

Fresh herbage yield (t/ha): All plants in the central rows of each plot were harvested and fresh herbage yield per net plot was weighed using sensitive balance model no. yt-1002 and reading scale 0.01, and it was converted to ton per hectare.

Dry herbage yield (t/ha): All plants in the central rows of each plot were harvested and dry herbage yield per plot was estimated by taking composite sample of leaves and dried in oven. Then dry herbage yield per hectare was estimated using the following formula and expressed as ton per hectare.

Yield per hectare (t)=[Dry yield per net plot (kg) × 10,000 (m^2)/Net area of the plot (m^2)] × 1000

Data analysis: The data collected for parameters studied were subjected to analysis of variance (ANOVA) for RCBD and mean separation procedure was also undertaken. The ANOVA model used for the analysis was:

$$Yikj=\mu+Gi+HAj+(GHA)ij+Rk+\varepsilon ijk$$

Where, Yikj=the mean value of the response variable of the ith genotype at the jth harvesting ages in kth blocks, μ=the overall mean, Gi=effect of genotypes, HAj=effect of harvesting ages, (GHA)ij=interaction effect of genotypes and harvesting ages, Rk=effect of block and εijk is a random error term due to those uncontrolled factors. After fitting analysis of variance (ANOVA) model for those significant interactions or main effects a mean separation procedure using LSD (Least significance difference) mean methods were done at required levels of probability (5%). Simple correlation analysis between different characters was also computed to observe associations between characters. All the statistical analysis was carried out using Statistical Analysis System (SAS) version 9.3 (SAS, 2012).

Results and Discussion

Growth parameters of sweet basil

Plant height: he difference in plant height at different treatment combination of genotypes and harvesting ages were not significant (p=0.19) (Appendix Table 2). However, genotypes exerted significant (p=0.0001) effect on plant height. he tallest plant height (46.84 cm) was recorded from sweet basil genotype B01, followed by genotypes B04 (40.92 cm) and B05 (39.32 cm), both of which were statistically on par (Table 1). he difference in plant height might be due to the presence of genetic variation among tested genotypes having different growth habit. he present study is in line with the work of Runyoro et al. [24], Svecova and Neugebauerova [8], and Fikadu et al. [25] who reported significant variations among different genotypes of basil with regard to plant height and other morphological characteristics. Similarly, Patel et al. [26] and Saran et al. [27] have also observed significant variations in height of plants obtained from different *Ocimum species* based on their distinct morphological characters. Kassahun et al. [28] also reported significant differences among spearmint genotypes with plant height and other morphological characters.

Similarly, harvesting age had significant (p=0.0001) influence on plant height of sweet basil plant (Appendix Table 2). Higher plant height (52.79 cm) was recorded at harvesting age of 100 days after transplanting (DAT). On the other hand, the lowest plant height (31.05 cm) was recorded at 40 DAT (Table 1). When harvesting age of sweet basil was delayed from 40 to 100 DAT, plant height was increased significantly. his increase in plant height might be due to conductive growth condition and extended duration of harvesting age. In harmony with the present result, Motsa [29] and Blank et al. [30] reported increase in plant height of rose-scented geranium due to delayed harvesting. Likewise, Galanopulou-Sendouca et al. and Damtew et al. [31] in Artemisia annua, Zigene et al. [32] in rosemary and Kumar and Kumar in kalmegh also reported increase in plant height with increasing harvesting age of the respective plants. Avci and Giachino [33] also found plant height increase in lemon balm with increase harvesting ages.

Treatments	Plant Height (cm)	Primary Branches/ Plant	Secondary Branches/Plant
Genotypes			
B01	46.84^a	9.67^a	130.23^a
B04	40.92^b	7.90^b	107.47^b
B05	39.32^b	7.68^b	93.30^c
LSD(0.05)	2.52	0.65	8.32
Harvesting Ages (DAT)			
40	31.05^d	4.64^c	34.00^d
60	38.18^c	6.58^b	86.24^c
80	47.42^b	11.11^a	147.27^b
100	52.79^a	11.33^a	173.82^a
LSD(0.05)	2.92	0.75	9.61
CV (%)	7.04	9.1	8.9

Table 1: Main effect of genotypes and harvesting ages on plant height, number of primary and secondary branches of sweet basil at Wondo Gent in 2017. Means followed by the same letter in the same column are not significantly different at 5% level of probability. DAT=Days after transplanting, LSD=Least significant difference, CV=Coefficient of variation.

Primary and Secondary branches: he present study revealed that the interaction effect of genotypes and harvesting ages was not significant (p=0.082) and (p=0.068) on primary and secondary branches respectively. However, the main effects of genotypes and harvesting age showed a highly significant (p=0.0001) effect on both primary and secondary branches of sweet basil (Appendix Table 2). Genotype B01 gave the highest number of both primary (9.67) and secondary (130.23) branches, which were statistically different from B04 (107.47) and B05 (93.30) genotypes. he minimum primary branch (7.68) was recorded from genotype B05 which was not statistically different from genotype B04 (7.90) and minimum secondary branches (93.30) was recorded from genotype B05 (Table 1). Generally, the significant differences in primary and secondary branches among the studied genotypes of basil could be attributed to the substantial genetic variability among genotypes [34-40]. Similar results were observed in earlier studies involving sixteen different genotypes of *Ocimum* species to assess the variability of qualitative and quantitative morphological characters among genotypes [41]. he authors observed that there was a variation among different genotypes of *Ocimum* species for branch number. In addition, Kassahun et al.[28] also reported morphological character differences amongst spearmint genotypes with respect to branch number. Fikadu et al. [25] also observed significant differences among Ethiopian sweet basil accessions for number of branches per plant.

he main effect of harvesting age also showed a significant (p=0.0005) effect on both primary and secondary branches (Appendix Table 2). Primary branches increased with increasing harvesting age and the highest primary branches (11.33) was obtained at harvesting age of 100 DAT, which, however, did not statistically differ from the same genotype harvested at earlier harvesting age of 80 DAT (Table 1). In addition, the maximum secondary branches (173.82) were recorded at harvesting age of 100 DAT but the minimum primary and secondary branches were obtained when the plant harvested at 40 DAT. In harmony with the present study, Nassar et al. [42] reported increased primary and secondary branches of basil as plant age increased.

Leaf area per plant: he main effects of genotype and harvesting age and their interaction had a significant (p=0.0048) effect on leaf area per plant (Appendix Table 2). he highest leaf area per plant (5232.84 cm^2) was recorded from genotype B01 when harvested at 80 DAT while the lowest leaf area per plant was obtained from genotype B04 (758.85 cm^2) and B05 (661.38 cm^2) with harvesting age of 40 DAT (Table 2). he variation in leaf area per plant might be due to the age of leaves, which resulted in plants to have lower leaf area at early and older growth ages and highest leaf area at bud initiation stage containing matured leaves. For genotype B01, the leaf area per plant was increased as harvesting age was increased up to 80 DAT and then declined when delaying to 100 DAT but for genotypes B04 and B05 leaf area being increased as the crop age increased even though there was no a statistically significant difference when the plant reached to 80 DAT and 100 DAT. Consistent to the present study, Nassar et al. [42] reported that total leaf area had a significant difference with plant ages of basil. he authors observed that the maximum leaf area per plant was recorded at 14 week old after planting which did not show a significant difference with leaf area obtained at 16 weeks old. Gebremeskle [43] also reported that harvesting age had a significant effect on leaf area per plant in rose scented geranium.

Genotypes	Harvesting ages (DAT)			
	40	60	80	100
B01	1056.92^{h}	3553.02^{e}	5232.84^{a}	5051.22^{b}
B04	758.85^{i}	3012.03^{f}	4498.71^{c}	4588.98^{c}
B05	661.38^{i}	2487.56^{g}	3903.72^{d}	4026.52^{d}
LSD (0.05)=131.19		CV (%)=2.39		

Table 2: Interaction effect of genotype and harvesting age on leaf area/plant (cm2) of sweet basil at Wondo Genet in 2017. Means followed by the same letter in the same column and row are not significantly different at 5% level of probability. LSD=Least significant difference, CV=Coefficient of variation, DAT=Days after transplanting.

Herbage and yield component characters

Fresh and dry leaf weight/plant: Both the main effects of genotype and harvesting age, and their interaction significantly (p=0.0001) influenced fresh leaf weight/plant of sweet basil (Appendix Table 3). he maximum fresh leaf weight per plant (384.02 g) was obtained at treatment combination of B01 with harvesting age of 80 DAT, which was statistically similar with that of genotype B04 harvested at 100 DAT [44-49]. On the other hand, the minimum fresh leaf weight was obtained from genotypes B05 (45.79 g/plant) and B04 (46.58 g/plant) when both harvested at 40 DAT (Table 3). Fresh herb yield increased significantly with increase in crop age (delay in harvesting) for all tested genotypes. his might be due to better growth of plants in terms of plant height and number of branches per plant, which might have resulted due to longer growth period. In agreement with this, Kassahun et al. [50] reported that fresh leaf yield per plant was increased with harvesting age in peppermint. Contrary to this finding, Solomon and Beemnet [51] reported a decrease in fresh leaf weight with delaying of harvesting age in Japanese mint.

Similarly, dry leaf weight of sweet basil was significantly (p=0.0004) affected by interaction of genotypes and harvesting ages (Appendix Table 3). he highest dry leaf weight per plant (74.42 g) was recorded from genotype B04 harvested at 100 DAT, followed by genotype B01 harvested at 80 DAT (67.14 g) and 100 DAT (65.25 g) respectively while the lowest dry leaf weight per plant was obtained from all genotypes with harvesting age of 40 DAT. he dry leaf weight was increased when harvesting was delayed for all genotypes. his might be due to reduction of moisture content in the leaves of the plant associated with prolonged age. In agreement with the present study, Zigene et al. [32] observed that there was an increment of dry leaf weight per plant with increase in harvesting age of rosemary. Contrary, Damtew et al. [31] reported a decrease in dry leaf yield per plant with delaying of harvesting time in Artemisia.

Genotypes	Harvesting ages (DAT)	Fresh leaf weight/plant (g)	Dry leaf weight/plant (g)
B01	40	87.88^{g}	11.27^{h}

	60	247.55^{d}	38.26^{ef}
	80	384.02^{a}	67.14^{b}
	100	294.38^{c}	65.25^{b}
B04	40	46.58^{h}	6.30^{h}
	60	207.51^{e}	32.63^{f}
	80	295.20^{c}	46.61^{d}
	100	380.41^{a}	74.42^{a}
B05	40	45.79^{h}	5.72^{h}
	60	157.90^{f}	23.75^{g}
	80	326.56^{b}	44.73^{de}
	100	324.65^{b}	57.15^{c}
LSD(0.05)		26.49	2.07
CV (%)		6.71	10.6

Table 3: Interaction effect of genotypes and harvesting age on fresh and dry leaf weight of sweet basil at Wondo Genet in 2017. Means followed by the same letter in the same column are not significantly different at 5% level of probability. LSD=Least significant difference, CV=Coefficient of variation, DAT=Days after transplanting.

Fresh and dry aboveground biomass/plant: Fresh and dry aboveground biomass per plant was highly significantly (p=0.0006) influenced by both the main effects of genotype and harvesting age, and their interaction (Appendix Table 3). he highest fresh aboveground biomass per plant was recorded from genotype B04 (592.81 g) harvested at 100 DAT, followed by B01 (542.17 g) genotype harvested at 80 DAT (Table 4). Similarly, the highest dry aboveground biomass per plant (127.65 g) was also recorded from genotype B04 harvested at 100 DAT followed by genotypes B05 and B01 harvested at 100 and 80 DAT respectively. On the other hand, the lowest values of fresh (84.04 g) and dry weight (3.50 g) were obtained from genotype B04 when harvested at 40 DAT, which was statistically similar with the value obtained from genotype B05 (5.72 g) harvested at 40 DAT. Contrary to the present study, Solomon and Beemnet [51] reported that fresh biomass weight was decreased with increasing crop age in Japanese mint.

Genotypes	Harvesting Ages	FABPP (g)	DABPP (g)
B01	40	115.84^{i}	13.74^{g}
	60	377.52^{f}	57.71^{e}
	80	542.17^{b}	106.73^{b}
	100	430.67^{e}	109.26^{b}
B04	40	84.04^{j}	9.80^{g}
	60	336.21^{g}	55.04^{e}
	80	473.94^{d}	82.61^{c}
	100	592.81^{a}	127.65^{a}
B05	40	95.23^{ij}	10.05^{g}
	60	284.10^{h}	37.26^{f}
	80	491.40^{cd}	73.14^{d}
	100	511.95^{c}	105.37^{b}
LSD(0.05)		26.54	7.2
CV (%)		4.34	6.48

Table 4: Interaction effect of genotypes and harvesting age on fresh and dry aboveground biomass per plant of sweet basil at Wondo Genet in 2017. Note: Means followed by the same letter in the same column are not significantly different at 5% level of probability. LSD=Least significant difference, CV=Coefficient of variation, FABPP=Fresh aboveground biomass per plant, DABPP=Dry aboveground biomass per plant.

Fresh and dry aboveground biomass/ha: he ANOVA table showed that both the main effects and their interaction had a significant (p=0.0001) effect on fresh aboveground biomass/ha (Appendix Table 4). he maximum fresh aboveground biomass (24.70 t/ha) was recorded from genotype B04 harvested at 100 DAT followed by genotype B01 (22.59 t/ha) and B05 (21.33 t/ha) with harvesting ages of 80 and 100 DAT respectively, while the lowest fresh aboveground biomass was obtained from all tested genotypes with harvesting age of 40 DAT (Table 3). For genotypes B04 and B05, fresh aboveground biomass/ha was increased with their ages which could be because the plants have a good opportunity to attain their maximum overall growth components. Jimayu and Gebre [52] also reported that delaying of harvesting age in lemongrass had a contribution for obtaining highest fresh aboveground biomass yield.

he analysis of variance showed that both the main effects and their interaction had a significant (p=0.0003) effect on dry aboveground biomass/ha (Appendix Table 4). he maximum dry aboveground biomass (5.32 t/ha) was recorded from genotype B04 harvested at 100

DAT and the lowest dry aboveground biomass was obtained from all tested genotypes with harvesting age of 40 DAT (Table 5). This indicated that dry aboveground biomass was increased with increasing of the age of sweet basil [53-58]. This might be due to the increasing of other contributing characters like plant height and dry leaf weight with harvesting age. Moreover, the loss of moisture with the ages of the plant also contributed for the increasing of dry aboveground biomass per hectare.

Genotypes	Harvesting ages	FABPH (t/ha)	DABPH (t/ha)
B01	40	4.83^{i}	0.57^{g}
	60	15.73^{f}	2.40^{e}
	80	22.59^{b}	4.45^{b}
	100	17.94^{e}	4.55^{b}
B04	40	3.50^{j}	0.41^{g}
	60	14.01^{g}	2.29^{e}
	80	19.75^{d}	3.44^{c}
	100	24.70^{a}	5.32^{a}
B05	40	3.97^{ij}	0.42^{g}
	60	11.84^{h}	1.55^{f}
	80	20.47^{cd}	3.05^{d}
	100	21.33^{c}	4.39^{b}
LSD(0.05)		1.11	0.3
CV (%)		5.64	7.22

Table 5: Effect of genotypes and harvesting ages on fresh and dry aboveground biomass/ha at Wondo Genet in 2017. Note: Means followed by the same letter in the same column are not significantly different at 5% level of probability. LSD=Least significant difference, CV=Coefficient of variation, FABPHA=Fresh aboveground biomass per hectare, DABPHA=Dry aboveground biomass per hectare.

Fresh and dry herbage yield/ha: Fresh herbage yield/ha was significantly (p=0.0011) influenced by the interaction effect of genotype and harvesting age (Appendix Table 5). he highest fresh herbage yield (16.00 t/ha) was produced from genotype B01 when harvesting was done at 80 DAT, which was statistically similar with genotype B04 harvested at 100 days after transplanting (Table 4). he lowest fresh herbage yield/ha was recorded from genotype B04 and B05 when both harvested at 40 DAT. Generally, the herbage yield was increased for both genotypes (B01 and B05) until they reached to 80 days old after transplanting and eventually the yield became decreased for genotype B01. his yield reduction after 80 DAT might be due to senescence of older leaves as observed in the field. In agreement with the present investigation, Kassahun et al. [50] also found that fresh and dry leaf yield of peppermint increased with increase in harvesting ages up to 120 DAT, there after decreased with plant age, which was consistent with the result reported by Bekele [59] in lemongrass. In addition, Kizil and Tocer [60] reported that the highest yield in terms of fresh herbage and dry herbage in spearmint was obtained as plant age increased.

Similarly, genotypes and harvesting ages had a significant (p=0.0032) interaction effect on dry herbage yield/ha (Appendix Table 5). he highest dry herbage yield (3.10 t/ha) was produced from genotype B04 harvested at 100 DAT (B04*100 DAT) followed by genotype B01 when harvesting was done at 80 DAT (2.78 t/ha) and 100 DAT (2.72 t/ha) respectively. he lowest dry herbage yield (0.24 t/ha) was obtained from genotype B05 harvested at 40 DAT, which was not statistically different from the yield produced from genotypes B04 and B01 when both harvested at 40 DAT (Table 6). Generally, dry leaf yield/ha was increased for all tested genotypes with delaying of harvesting age. his may be because the moisture content of the herb is decreased when the plants get older [61-69]. his result is in line with that of Leal et al. [70-75] who reported that dry matter production was increased with plant age. Bekele [59,76-79] also reported that dry herbage yield per hectare was affected by the interaction between varieties and harvesting age in lemongrass. Moreover, Jimayu and Gebre [52] also found that fresh and dry herbage yield of lemongrass were affected by various growth ages [80-85]. Moreover, Avci and Giachino [33] found that the highest fresh herbage yield and dry herbage yield of lemon balm were recorded with increasing harvesting ages [86-89].

Genotypes	Harvesting Ages (DAT)	Fresh Herbage Yield (t/ha)	Dry Herbage Yield (t/ha)
B01	40	3.66^{g}	0.47^{h}
	60	10.31^{d}	1.59^{ef}
	80	16.00^{a}	2.80^{b}
	100	12.27^{c}	2.72^{b}
B04	40	1.94^{h}	0.26^{h}
	60	8.65^{e}	1.36^{f}
	80	12.30^{c}	1.94^{d}
	100	15.85^{a}	3.10^{a}
B05	40	1.91^{h}	0.24^{h}
	60	6.58^{f}	0.99^{g}
	80	13.61^{b}	1.86^{de}
	100	13.53^{b}	2.38^{c}
LSD(0.05)		1.1	0.29
CV (%)		5.25	11.81

Table 6: Interaction effect of genotypes and harvesting age on fresh and dry herbage yield of sweet basil at Wondo Genet in 2017. Note: Means followed by the same letter in the same column are not significantly different at 5% level of probability. LSD=Least significant difference, CV=Coefficient of variation, DAT=Days after transplanting.

Summary and Conclusion

Sweet basil (*Ocimum basilicum L.)* is an annual aromatic and medicinal crop, which widely grown as home garden plant throughout the world for its multipurpose use such as medicinal value, flavoring food, spice and blended with different spices for local consumption. The growth, biomass and oil yield of sweet basil plant is known to be affected by numerous factors, which are difficult to separate from each

other; among these climatic conditions, genetic variation, and cultural practices such as harvesting time, harvesting age, plant spacing (population density), postharvest drying and storage are the most important ones. Even though the plant has diverse advantages, its production has not been supported by research work in the country/Ethiopia especially on variation of genotypes responses for different harvesting age. The field experiment was conducted at Wondo Genet Agricultural Research Center (WGARC) to determine the effects of genotypes and harvesting ages on herbage yield of sweet basil.

Growth parameters of plant height, number of primary and secondary branches were not significantly affected by the interaction effect of genotypes and harvesting ages. However, leaf area /plant, fresh leaf weight/plant, dry leaf weight /plant, fresh aboveground biomass/plant, dry aboveground biomass/plant, fresh aboveground biomass/ha, dry aboveground biomass/ha, fresh herbage yield/ha, dry herbage yield/ha were significantly influenced by the interaction effect of genotypes and harvesting age. The highest leaf area per plant (5232.84 cm^2) was recorded from genotype B01 when harvested at 80 DAT. The highest fresh yield per plant was recorded from genotype B01 (384.02 g) at harvesting age of 80 DAT, which was statistically similar with genotype B04 harvested at 100 DAT.

The highest values of fresh and dry aboveground biomass/plant were recorded from genotype B04 harvested at 100 DAT, followed by genotype B01 at harvesting age of 80 DAT. The aboveground biomass yield was increased up to 80 and 100 DAT for genotype B01 and genotypes (B04 and B05) respectively. This indicated that, aboveground biomass yield was increased with their ages, which could be due to the plants having a good opportunity to attain their maximum overall growth components. The highest fresh leaf yield (16.00 t/ha) was produced from genotype B01 harvested at 80 DAT, which was statistically similar with genotype B04 when harvested at 100 DAT. On the other hand, the highest dry herbage yield (3.10 t/ha) was produced from genotype B04 harvested at 100 DAT followed by genotype B01 when harvesting was done at 80 DAT (2.78 t/ha) and 100 DAT (2.72 t/ha) respectively. Generally, dry leaf yield/ha was increased for all tested genotypes with delaying of harvesting age.

It can be concluded that, interaction of genotypes and harvesting age significantly influenced herbage yield of sweet basil. Therefore, genotype B04 harvested at 80 DAT can be recommended for maximum herbage yield of basil at Wondo Genet area. Since other factors, such as location and season affect herbage yield, further study is suggested for assessing the effect of season on herbage yield of sweet basil under Wondo Genet condition.

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