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Effect of harvesting age and plant spacing on growth, yield and yield component of Lavender (*Lavandula angustifolia* L.) under Rainfed condition at Hawassa, Southern Ethiopia

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Abstract: *The experiment was carried out at Hawassa, Southern Ethiopia during 2017 and 2018 cropping season under rainfed condition to investigate the optimum harvesting age and plant spacing for growth, yield and yield component of lavender under rainfed condition. The experiment consisted of four levels of intra-row spacing (45, 60, 75 and 90 cm) with inter-row spacing of 60 cm and three levels of harvesting ages after transplanting (9, 10 and 11 MAT). The experiment laid out in Randomized Complete Block Design (RCBD) with three replications as factorial arrangement. The results of combined analysis of variance revealed that, spacing had a significant influence on number of branches per plant, fresh leaves and flower weight/plant, fresh leaves and flower yield/ha and essential oil yield/ha. The highest number of branches/plant (180.7) and fresh leaves and flower weight/plant (755.39 g) was obtained at spacing of 60*90 cm; fresh leaves and flower yield/ha (21.12 t) and essential oil yield/ha (119.2 kg) was obtained at a spacing of 60*45cm. Whereas, harvesting age exerted a significant influence on essential oil content and essential oil yield in kg/ha, but not on the other traits. The highest essential oil content (0.67 %) and essential oil yield/ha (115.5 kg) were obtained at 11 MAT. Moreover, the interaction effect did not significantly influence all the tested parameters. Therefore, it was concluded that further investigation is needy by adding additional levels of harvesting age above 11MAT to investigate at which age the essential oil yield/ha will be declined. But, for the time being until another investigation obtained, at Hawassa and a place where having similar agroecology, it is highly recommended to plant Lavender at a spacing of 60*45 cm and harvest it at 11 MAT to get the highest essential oil yield/ha.*

Keywords: *Essential oil content, Essential oil yield, Harvesting age, Plant spacing*

1. INTRODUCTION

Lavender (*Lavandula angustifolia* L.) is a perennial shrub which belongs to the mint family *Lamiaceae*. It is native to southern Europe and the Mediterranean area and is commercially cultivated in France, Spain, Portugal, Hungary, the UK, Bulgaria, Australia, China and the USA (Shawl and kumar, 2000). It is cultivated for its aromatic inflorescence from which the essential oil is isolated, although its fresh and dried flowers are also marketed (Renaud *et al*., 2001).

The essential oil of this species is commonly used in aromatherapy and massage. Its major clinical benefits are on the central nervous system (Chu and Kemper, 2001). The essential oil is also known for its excellent aroma and is extensively used in the perfumery, flavor and cosmetic industries. The oil is known to possess sedative, carminative, anti-depressive and anti-inflammatory properties (Cavanagh and Wilkinson, 2005). Chu and Kemper (2001) also stated that, Lavender extracts have traditionally been prescribed to treat infertility,infection, anxiety and fever, and have been used as antidepressants, antispasmodics, anti-flatulent agents, antiemetic remedies and diuretics. Its essential oil has gained a strong reputation in aromatherapy and as holistic relaxant to treat stress, anxiety, depression, fatigue or insomnia (Chu and Kemper, 2001). Studies suggest that lavender aroma during recesses prevents deterioration of work performance (Sakamoto *et al*., 2005) and might improve memory and cognition in Alzheimer's patients (Adsersen *et al*., 2005).

The growth, yield and yield components of plants are determined by a series of factors including plant genetic (Shafie *et al*., 2009), climate, edaphic, elevation, topography and also an interaction of various factors (Rahimmalek *et al*., 2009). Among these factors crop management practices such as harvesting age and plant spacing are included. Plant spacing and harvesting age had an effect on growth, biomass and oil yield of Artemisia (Zewdinesh *et al*., 2011) and Rose-scented geranium

(Haileslassie and Kebede, 2015). Harvesting age had an effect on yield and yield related traits of lemongrass (Jimayu *et al*., 2016; Lulie and Chala, 2016; Jimayu and Gebre, 2017).

Even if it has many uses, there is a limited finding regarding to the agronomic management practices of lavender cultivating under rainfed condition in worldwide including Ethiopia. This would result cultivation of the crop without knowing its appropriate management practices. This leads to reduction of the production and productivity of lavender. Though, research is useful to minimize the reduction of growth, yield and yield components of lavender. Therefore, the objective of this paper was to investigate optimum harvesting age and plant spacing for growth, yield and yield component of *Lavandula angustifolia* L. under rainfed condition.

2. MATERIALS AND METHODS

2.1. Description of the Study Area

The study was conducted at Hawassa Agricultural Research Center experimental field, Southern Ethiopia during 2017 and 2018 cropping seasons under rainfed condition. The center is located at latitude 7°05'N and longitude39°29' E with an altitude of 1700 meters above sea level (m.a.s.l.). The area receives mean annual rainfall of 964 mm with mean maximum and minimum temperatures of 27.34^{0}C and 12.94^{0}C, respectively. The soil textural class of the study area is sandy loam with pH of 7.2.These environmental conditions are conducive for lavender cultivation.

2.2. Plant Materials, Experimental Design and Field Management

Lavender (Variety WG-Lavender-II) was planted at different intra spaced (45, 60, 75 and 90 cm) with inter-raw spacing of 60 cm at Hawassa in South Ethiopia were harvested at three different months after transplant (9, 10 and 11 MAT) used for the study. The experiment was laid by using randomized complete block design with three replications as factorial arrangement. The gross plot size of each treatment was 3.6m x 3.6m. The distance between plots and replications was 1 m and 2 m, respectively. Healthy and uniform seedlings were transplanted from the nursery to the open field condition after two months of establishment. Transplanting of seedlings was taken place at the commencement of main rainy season after the land prepared well. Proper hoeing, watering and weeding were carried out as required.

2.3. Data Collection

During the study the following data were collected. The characters that manifested for data collection are:

Plant height: It was measured in centimeter from the base of the randomly selected plants to tip of the main stem by using tape meter; then the average height was determined.

Number of branches per plant:The total numbers of branches arising from the main stem were counted manually and average value was determined.

Fresh leaf and flower weight/plant (g)*:* The average fresh leaf and flower weight of the randomly selected plants was immediately recorded after the leaves and flowers were separated from stem.

Fresh leaves and flower yield (t/ha)*:* All plants from the central rows of each plot were harvested and fresh leaf and flower yield per net plot was estimated and then converted in to tones per hectare.

Essential oil content (%)*:* Essential oil content was obtained by hydro-distillation, according to the procedure described by Daniel *et al*. (2009).The fresh leaves and flower of lavender were placed in round bottom flask and subjected to hydro-distillation in a Clevenger apparatus. Then, harvested plants were separated into leaf, flower and stem,fresh leaves and flowers having biomass of 300 gcomposite sample was charged in the Clevenger apparatus along with 700 ml of water and trapped for 3 hours. Water was poured in to the flask until the plant part submersed completely. The flask was placed on the heating mantle and the water and plant sample could boil for 3 hours and the essential oil were collected and measured by using pipette reading. The percentage of essential oil content was determined by the following formula.

$$Essential\ oil\ content\ \left(\%\frac{w}{w} fresh\ basis\right) = Weight\ of\ oil\ X\ 100/Weight\ of\ sample$$

Essential oil yield (kg/ha):The volume of essential oil collected in the collecting tube of the apparatus dehydrated, measured and expressed on weight by weight (%w/w) fresh basis. Then the essential oil yield/ha was determined by the following formula.

$$Essential\ oil\ yield\ \left(\frac{kg}{ha}\right) = Fresh\ leaves\ and\ flower\ yield\ \left(\frac{kg}{ha}\right)$$

$$X\ Essential\ oil\ content\ (\%\ w/w)/100$$

2.4. Data Analysis

The collected data were subjected to analysis of variance (ANOVA) using SAS version 9.0 (SAS, 2000) statistical software packages. Means were separated using the Least Significant Difference (LSD) procedure at the 5% and 1% level of significance.

The following meteorological data were collected from Hawassa during 2017 to 2018 (Table 1).

Table1. *Mean monthly maximum and minimum temperature (^oC);and Mean monthly rainfall (mm) at Hawassa trial site during2017 and 2018 cropping seasons*

Month	Mean monthly temperature (^{o}C)				Mean monthly rainfall (mm)	
	2017		2018			
	Max.	Min.	Max.	Min.	2017	2018
January	29.00	9.75	29.18	11.43	0.00	0.14
February	29.90	14.49	30.23	13.28	3.16	2.19
March	31.56	14.49	28.34	13.93	2.94	4.22
April	31.60	14.78	26.65	15.63	2.95	9.20
May	28.40	15.82	27.76	15.65	7.78	3.55
June	27.73	15.49	25.12	15.50	1.95	6.30
July	26.10	16.03	34.16	15.16	5.49	7.59
August	26.61	15.53	34.08	15.20	3.84	5.41
September	26.34	15.56	25.68	14.34	6.01	2.20
October	27.94	15.12	27.75	13.86	4.29	1.68
November	28.49	11.69	27.50	13.04	0.21	4.99
December	28.32	9.43	28.29	11.65	0.00	0.22

*(**Source**: NMA Hawassa Branch)*

3. RESULT AND DISCUSSION

3.1. Plant Height (cm)

Plant height was significantly ($p<0.05$) affected by plant spacing in 2017 cropping season .In 2017 cropping season, the highest (85.11 cm) and least (77.33 cm) plant height was obtained at 60*75 cm and 60*45 cm, respectively (Table 2). Whereas, it didn`t significantly ($p>0.05$) affected by plant spacing in 2018 cropping season and combined result (Table 2).Supporting result obtained by ElNaim *et al*. (2012) who showed that crop density had no significant effect on plant height of roselle. Contrasting result was reported by Zewdinesh *et al*. (2011) on Artemisia and Degu and Tesfaye (2015) on Roselle who showed that an increase in planting population markedly would increase plant height.

Harvesting age did not significantly ($p>0.05$) affect plant height (Table 2). Contrasting result was reported by Zewdinesh *et al*. (2011) on Artemisia and Haileslassie and Kebede (2015) on rose-scented geranium. This could be due to the consistence of plant height at each level of harvesting age.

The interaction of plant spacing and harvesting age had a significant ($p<0.05$) effect on plant height in 2018 cropping season (Table 2). The highest (79.8 cm) plant height was obtained when lavender was planted at plant spacing of 60*90 cm and harvested at 10 MAT; while, the least (65.73 cm) was obtained when it was planted at plant spacing of 60*90 cm and harvested at 11 MAT (Table 5).Based on the combined result, the interaction effect did not significantly ($p>0.05$) affect plant height (Table 2). Similar result was reported by Haileslassie and Kebede (2015) on rose-scented geranium

Table2. *Effect of plant spacing and harvest age on plant height (cm) and number of branches per plant of L. angustifolia L. at Hawassa during 2017 and 2018*

Treatment & Statistics	Plant height (cm)			Number of branches per plant		
	2017	2018	Combined mean	2017	2018	Combined mean
Plant spacing (cm)						
60*45	77.33[b]	72.04	74.69	97.64	174.5[b]	136.09[c]
60*60	78.40[b]	73.22	75.81	107	210.76[a]	158.88[b]
60*75	85.11[a]	71.42	78.27	113	221.51[a]	167.26[ab]
60*90	82.31[ab]	71.44	76.88	120.2	241.2[a]	180.7[a]
LSD (0.05)	**5.65**	**5.6**	**4.74**	**16.29**	**32.39**	**20.41**
Significance	*	**NS**	**NS**	**NS**	**	**
Harvest age (MAT)						
9	78.22	71.02	74.62	104.60	220.28	162.44
10	83.75	72.72	78.23	113.02	222.80	167.91
11	80.4	72.37	76.38	110.77	192.92	151.84
LSD (0.05)	**4.89**	**4.85**	**4.1**	**14.11**	**28.05**	**17.67**
Significance	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Spa*HA	**NS**	*	**NS**	**NS**	**NS**	**NS**
CV (%)	**7.15**	**7.95**	**6.34**	**15.22**	**15.63**	**12.99**

Means with the same letter at the same column are not significantly different.

Where, MAT = Months after transplanting, LSD = Least significance difference, CV = Coefficient of variation, Spa = Spacing, HA= Harvesting age, NS = Nonsignificant at $p<0.05$, * = Significant at $p<0.05$ and ** =Significant at $p<0.01$ probability level.

Number of Branches per plant

Number of branches per plant didn`t significantly ($p>0.05$) affected by plant spacing in 2017 cropping season; whereas, it was significantly ($p<0.01$) affected by plant spacing in 2018 cropping season and combined result (Table 2). Based on the combined result, the highest (180.7) and least (136.09) number of branches per plant was obtained at 60*90 cm and 60*45 cm plant spacing, respectively (Table 2). At the widest spacing, there is reduced competition of plants for light, water and nutrients as compared to the closest spacing. Though, this would result an increase in number of branches per plant.

The main effect harvesting age did not significantly ($p>0.05$) affect number of branches per plant (Table 2). Supporting result was reported by Zewdinesh *et al*. (2011) on Artemisia.

Likewise, interaction of the both factors did not significantly ($p>0.05$) affect number of branches per plant (Table 2). Similar result was reported by Zewdinesh *et al*. (2011) on Artemisia and Haileslassie and Kebede (2015) on rose-scented geranium.

Fresh leaves and flower weight/plant (g)

Fresh leaves and flower weight/plant was significantly ($p<0.01$) affected by plant spacing during the cropping seasons (Table 3). The same result was reported by Tadesse *et al*. (2016) on Stevia. Based on the combined result, the highest (755.39 g) and least (570.08 g) fresh leaves and flower weight/plant was obtained at 60*90 cm and 60*45 cm plant spacing, respectively (Table 3). As plant spacing increases, fresh leaves and flower weight/plant was increased and vice versa. This might be due to reduced competition of plants for light, water and nutrients in widest spacing would result in an increase in fresh leaves and flower weight/plant.

Fresh leaves and flower weight/plant was significantly ($p<0.001$) affected by harvesting age in 2017 cropping season. The highest (598 g) and least (456.02 g) fresh leaves and flower weight/plant was obtained at 60*90 cm and 60*45 cm plant spacing, respectively (Table 3). Whereas, it didn`t significantly ($p>0.05$) affected by harvesting age in 2018 cropping season and combined result (Table 3).

Likewise, fresh leaves and flower weight/plant was significantly ($p<0.05$) affected by the interaction of plant spacing and harvesting age in 2017 cropping season (Table 3). The highest (782.05 g) fresh leaves and flower weight/plant was obtained when lavender was planted at a spacing of 60*90 cm and harvested at 10 MAT; whereas, the least (441.1 g) fresh leaves and flower weight/plant was obtained when it was planted at a spacing of 60*45 cm and harvested at 10 MAT (Table 6). However, in 2018

cropping season and the combined result showed that, the interaction of both factors did not significantly ($p>0.05$) affect fresh leaves and flower weight/plant (Table 3).

Fresh leaves and flower yield (t/ha)

Plant spacing had a significant ($p<0.001$) effect on fresh leaves and flower yield/ha during the cropping seasons and combined result (Table 3). Supporting result was reported by Haileslassie and Kebede (2015) on rose-scented geranium and Jimayu *et al.* (2016) on Lemongrass. Based on the combined result, the highest (21.12 t) and least (13.99 t) fresh leaves and flower yield/ha was obtained at 60*45 cm and 60*90 cm plant spacing, respectively (Table 3). At the closest spacing, fresh leaves and flower yieldwas increased and vice versa. This might be due to the presence of many plants per unit area, this would result in an increase in fresh leaves and flower yield/ha.

As to fresh leaves and flower weight/plant, fresh leaves and flower yield/ha was significantly ($p<0.01$) affected by harvesting age in 2017 cropping season. The highest (15.09 t) and least (12.11 t) fresh leaves and flower yield /ha was obtained at 10 and 9 MAT, respectively (Table 3). Whereas, harvesting age had not a significant ($p>0.05$) effect on fresh leaves and flower yield/ha in 2018 cropping season and combined result (Table 3). This result is contradicted with the findings of Beemnet *et al.* (2011) on peppermint and Haileslassie and Kebede (2015) on rose-scented geranium.

The interaction of plant spacing and harvesting age not significantly ($p>0.05$) affect fresh leaves and flower yield/ha (Table 3). Similar result was reported by Beemnet *et al.* (2011) on peppermint. In the contrary, the contradicted finding was reported by Haileslassie and Kebede (2015) on rose-scented geranium

Table3. *Effect of plant spacing and harvest age on fresh leaves and flower weight per plant (g) and fresh leaves and flower yield (t/ha) of L. angustifolia L. at Hawassa during 2017 and 2018*

Treatment & Statistics	Fresh leaves and flower weight/plant (g)			Fresh leaves and flower yield (t/ha)		
	2017	2018	Combined mean	2017	2018	Combined mean
Plant spacing (cm)						
60*45	451.89^{b}	688.28^{b}	570.08^{b}	16.74^{a}	25.49^{a}	21.12^{a}
60*60	498.06^{b}	837.22^{ab}	667.64^{a}	13.84^{b}	23.26^{ab}	18.55^{b}
60*75	565.93^{a}	856.09^{a}	711.01^{a}	13.1^{bc}	19.82^{bc}	16.56^{b}
60*90	615.42^{a}	895.36^{a}	755.39^{a}	11.4^{c}	16.58^{c}	13.99^{c}
LSD (0.05)	**67**	**149.5**	**87.89**	**1.96**	**3.63**	**2.21**
Significance	***	*	**	***	***	***
Harvest age (MAT)						
9	456.62^{b}	807.17	631.89	12.11^{b}	21.04	16.58
10	598^{a}	815.17	706.58	15.09^{a}	21.17	18.13
11	543.86^{a}	835.38	689.62	14.1^{a}	21.65	17.88
LSD (0.05)	**58.02**	**129.47**	**76.11**	**1.7**	**3.14**	**1.92**
Significance	***	**NS**	**NS**	**	**NS**	**NS**
Spa*HA	*	**NS**	**NS**	**NS**	**NS**	**NS**
CV (%)	**12.86**	**18.67**	**13.3**	**14.6**	**17.44**	**12.9**

Means with the same letter at the same column are not significantly different.

Where, MAT = Months after transplanting, LSD = Least significance difference, CV = Coefficient of variation, Spa = Spacing, HA= Harvesting age, NS = Non significant at $p<0.05$, * = Significant at $p<0.05$, ** = Significant at $p<0.01$ and *** =Significant at $p<0.001$probability level

Essential Oil Content (%)

Essential oil content was significantly ($p<0.05$) affected by plant spacing in 2018 cropping season. The highest (0.54%) and least (0.42%) essential oil content were obtained at 60*75 cm and 60*60 cm

plant spacing, respectively (Table 4). Whereas, plant spacing had not a significant ($p>0.05$) effect on essential oil content in 2017 cropping season and combined mean (Table 4).

Based on the combined result, harvesting age had a significant ($p<0.001$) effect on essential oil content (Table 4). Similar result was reported by Haileslassie and Kebede (2015) on rose-scented geranium. The highest (0.67%) and least (0.54%) essential oil content was obtained when lavender was harvested at 11 and 9 MAT, respectively. When harvesting age increases, essential oil content also increased under rainfed condition. This could be due to the presence of more stressed leaves at 11 MAT.

However, the interaction of the plant spacing and harvesting age did not significantly ($p>0.05$) affect essential oil content (Table 4). Similar result was obtained by Beemnet *et al*., (2011) on peppermint and Zewdinesh *et al*. (2011) on Artemisia. Contrasting result was reported by Haileslassie and Kebede (2015) on rose-scented geranium.

Essential Oil Yield/ha (kg)

The combined result revealed that, the main effect plant spacing, and harvest age had a very highly significant ($p<0.001$) effect on essential oil yield/ha (Table 4).Supporting result was reported by Zewdinesh *et al*. (2011) on Artemisia; Haileslassie and Kebede (2015) on rose-scented geranium and Jimayu *et al*. (2016) on Lemongrass. The highest (119.2 t) and least (80.06 t) essential oil yield/ha was obtained when lavender was planted at a spacing of 60*45 cm and 60*90 cm, respectively (Table 4). This could be due to the presence of many plants per unit area contribute to an increase in fresh leaves and flower yield/ha thereby increased in essential oil yield/ha. The highest (115.5 t) and least (81.63 t) essential oil yield/ha was obtained when Lavender was harvested at 11 and 9 MAT, respectively. As to essential oil content, essential oil yield/ha increased when harvesting age increases. This could be due to an increase in essential oil content would contribute for an increase in essential oil yield/ha.

However, the interaction effect of plant spacing and harvesting age did not significantly ($p>0.05$) affect essential oil yield/ha (Table 4). Supporting result was reported by Zewdinesh *et al*. (2011) on Artemisia. Contradicted results were reported by Beemnet *et al*., (2011) on peppermint and Haileslassie and Kebede (2015) on rose-scented geranium.

Table 4. *Effect of plant spacing and harvest age on essential oil content (%) and essential oil yield/ha (kg) of L. angustifolia L. at Hawassa during 2017 and 2018*

Treatment & Statistics	Essential oil content (%)			Essential oil yield/ha (kg)		
	2017	2018	Combined mean	2017	2018	Combined mean
Plant spacing (cm)						
60*45	0.67	0.50^{ab}	0.59	112.28^{a}	126.11^{a}	119.20^{a}
60*60	0.69	0.42^{b}	0.56	95.49^{ab}	96.34^{bc}	95.91^{b}
60*75	0.69	0.54^{a}	0.62	90.89^{bc}	106.19^{b}	98.54^{b}
60*90	0.67	0.51^{a}	0.59	76.54^{c}	83.59^{c}	80.06^{c}
LSD (0.05)	**0.08**	**0.09**	**0.07**	**17.67**	**14.83**	**9.5**
Significance	**NS**	*	**NS**	**	***	***
Harvest age (MAT)						
9	0.64^{b}	0.43^{b}	0.54^{b}	76.46^{b}	86.80^{b}	81.63^{c}
10	0.67^{ab}	0.45^{b}	0.56^{b}	101.56^{a}	94.74^{b}	98.15^{b}
11	0.74^{a}	0.60^{a}	0.67^{a}	103.37^{a}	127.64^{a}	115.50^{a}
LSD (0.05)	**0.07**	**0.07**	**0.06**	**15.3**	**12.84**	**8.23**
Significance	*	***	***	**	***	***
Spa*HA	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
CV (%)	**12.66**	**17.61**	**11.68**	**19.27**	**14.72**	**9.88**

Means with the same letter at the same column are not significantly different.

Where, MAT = Months after transplanting, LSD = Least significance difference, CV = Coefficient of variation, Spa = Spacing, HA= Harvest age, NS = Non significant at p<0.05, * = Significant at p<0.05, ** = Significant at p<0.01 and *** =Significant at p<0.001

Table5. *Effect of plant spacing and harvesting age on plant height (cm) of L. angustifolia L. at Hawassa during 2018*

Treatment & Statistics	**Plant height (cm)**		
	Harvesting age(MAT)		
	9	**10**	**11**
Plant spacing (cm)			
60*45	**71.93^{abc}**	**68.87^{bc}**	**75.33^{abc}**
60*60	**75.8^{ab}**	**71.53^{abc}**	**72.33^{abc}**
60*75	**67.53^{bc}**	**70.67^{abc}**	**76.07^{ab}**
60*90	**68.8^{bc}**	**79.8^{a}**	**65.73^{c}**
LSD (0.05)	**9.62**		

Where, MAT = Months after transplanting and LSD = Least significance difference

Table6. *Effect of plant spacing and harvesting age on fresh leaves and flower weight/plant (g) of L. angustifolia L. at Hawassa during 2017*

Treatment & Statistics	Fresh leaves and flower weight/plant (g)		
	Harvesting age (MAT)		
	9	**10**	**11**
Plant spacing (cm)			
60*45	446.88^{e}	441.10^{e}	467.69^{de}
60*60	444.57^{e}	532.79^{bcde}	516.82^{cde}
60*75	483.10^{de}	636.05^{b}	578.63^{bcd}
60*90	451.91^{e}	782.05^{a}	612.31^{bc}
LSD(0.05)	116.05		

Where, MAT = Months after transplanting and LSD = Least significance difference

4. Conclusion and Recommendation

The study showed that, the highest number of branches/plant (180.7) and fresh leaves and flower weight/plant (755.39 g) was obtained at the spacing of 60*90 cm; fresh leaves and flower yield/ha (21.12 t) and essential oil yield/ha (119.2 kg) was obtained at a spacing of 60*45cm. Harvesting age also had a significant influence on essential oil content and essential oil yield/ha; but it did not significantly influence plant height, number of branches per plant, fresh leaves and flower weight/plant and fresh leaves and flower yield/ha. The highest essential oil content (0.67 %) and essential oil yield/ha (115.5 kg) were obtained at 11 MAT; however, the least values (0.54 % and 81.63 kg, respectively) were obtained at 9 MAT. The interaction of plant spacing and harvesting age had not a significant influence on plant height, number of branches per plant, fresh leaves and flower weight/plant, fresh leaves and flower yield/ha, essential oil content and essential oil yield/ha. Therefore, it was concluded that further investigation is needy by adding additional levels of harvesting age above 11MAT to investigate at which age the essential oil yield/ha will be declined. But, for the time being until another investigation obtained, at Hawassa and a place where having similar agroecology, it is highly recommended to plant Lavender at a spacing of 60*45cm and harvest it at 11MAT to get the highest essential oil yield/ha.

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