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# Determination of optimum harvesting management for better production of sage (saliva officianalis.L)

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**This experiment was conducted with the objective of determine the harvesting management of sage (Salvia officianalis. L.) for optimum biomass and oil yield at Wondo genet agricultural research center for two years from 2014/2015 to 2016/2017 cropping seasons. Data on plant height, branch number/plant, and fresh leaf weight/plant, fresh stem weight/plant, fresh leaf weight/ha, essential oil content (EOC) and essential oil yield/ha (EOY/ha) were collected arranged in randomized complete block design with three replications. Harvesting height has a significant (P < 0.05) influence on plant height and a very highly significant (P < 0.01) influence on fresh stem weight (Table 2). Branch number has a significant (P < 0.05) influence on plant height, fresh leaf weight/ha, fresh stem weight/plot, dry leaf weight/plot and essential oil yield/ha (Table 3). EOC=essential oil content, EOY=essential oil yield, BN= branch number**

**Key words;** branch number, harvesting height, and harvesting management

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## INTRODUCTION

Sage is one of the most important species of the genus Salvia which comprises nearly 1000 species throughout the world, and represents one of the largest genera in the Lamiaceae family (Lakusic et al., 2013). As its Latin name Salvia means 'to cure' and species name 'officianalis.L' means medicinal, it is clear that sage has a historical reputation of promoting health and treating ailments and even in ancient Rome, it was even called the sacred plant (Kamatou et al., 2008). Among the different species of the genus Salvia, *Salvia officianalis.L* is economically most important species being widely used in medicine, cosmetic and food industry (Al-Tawaha et al., 2013; Grzegorcazyk and Wysokinska, 2008). It was first found northern Mediterranean countries (Lakusic et al., 2013) and eventually spread to England, France and Switzerland in the fourteenth century (Miller, 1976). It has been grown as a perennial medicinal and culinary herb for thousands of years and can now be found in gardens everywhere indicating the significance of the crop in diversified communities of the world. Sage is one of the most appreciate herbs for its rich essential oil and its plethora of biologically active compounds extensively used in folk medicine (Aziz et al., 2013). It can be used as herbal tea, for food flavoring, in cosmetics, perfumery

and the pharmaceutical industries throughout world (Chalchat et al*.,* 1998). It is generally known for their multiple pharmacological effects including their antibacterial (Delamare et al., 2007; Kamatou et al., 2008), antiviral (Loizzo et al., 2008), anti-oxidative (Kelen and Tepe, 2008), antimalarial (Kamatou et al., 2008), anti-inflammatory (Baricevic et al., 2001), anti-diabetic (Eidi et al., 2009), cardiovascular, antitumor and anticancer (Loizzo et al., 2007)**.** Recent studies show that some plants from the lamiaceae family are very rich in phenolic compounds, such as flavonoids, phenolic acids and phenolic diterpenes and possess high antioxidant activities (Alizadeh et al., 2010; Lu and Foo, 2001; Zheng and Wang, 2001). Phenolic compounds are plant secondary metabolites and naturally present in all plant materials (Gülçin, 2005; Psomiadou et al., 2002). These compounds can delay or inhibit the oxidative damage caused by free radicals (Velioglu et al., 2007) and can protect human beings against major diseases such as coronary heart disease and cancer in human (Kris-Etherton et al., 2002). Due to the presence of sufficient phenolic compounds and its antioxidative properties, the leaves of Sage are reported to be used widely in the food processing industries (Farag et al., 1989; Lamaison et al., 1990; Cuvelier et al., 1994; Hohmann et al., 1999). There is increasing evidence to suggest that many degenerative diseases, such as brain dysfunction, cancer, heart diseases, and weakened immune system, could be the result of cellular damage caused by free radicals, and antioxidants present in human diet may play an important role in disease Prevention (Aruoma, 1998; Nees and Powles, 1997; Steinmetz and Potter, 1996). There are some reports that sage has been recommended through the centuries as restoratives of lost or declining mental functions (Tildesley et al., 2003; Tildesley et al., 2005).

Morphological characters, yield and quality of Sage are influenced by season, geographic origin, environmental factors, extraction methods, plant organ (Santos-Gomes et al., 2001), phonological stage (Mirjalili et al., 2006), sampling techniques (Putievsky et al., 1986) and genetic differences (Perry et al., 1996). Therefore it is important to understand to what extent environment affects the adaptability of Sage for Morph-logy, Agronomic and chemical characteristics in Ethiopia Sage is harvested at different heights or at different nodes without knowing its impact on growth, biomass and essential oil production in successive crop. To induce early sprouting of buds and transformation of laterals, branch numbers the levels of harvest plays an important role and also have an impact on plant height and fresh stem weight. Despite the diverse advantages of Salvia officianalis.L have, research works in Ethiopia on this plant has been limited. This lack of information on appropriate agronomic practices is considered to be among the major obstruction to embark on mass production and utilization of this valuable plant in the country. Thus, it is believed necessary to assess appropriate production technologies that would enable to maximize biomass and essential oil yield in order to exploit this economically important plant as a cash crop. Therefore, the objective of this study was to determine the optimum harvesting height with branch number left while harvesting on growth, biomass and oil sage (Salvia officianalis.L)

## MATERIALS AND METHODS

The experiment was conducted at Wondo Genet Agricultural Research Center experimental field from 2014-2016. The experimental site is located at an elevation of 1767m.a.s.l.situated at $7^0$5‘39.91N and $38^0$ 37’15.12”E. The area receives mean annual rainfall of 1880mm with maximum and minimum temperature of $27.8^0$ c and $10.1^0$ c, respectively. The soil type of the area is sandy loam. The experiment consisted of four levels of harvesting height (5cm, 10cm 15cm and 20cm ) and three number of branches lifted while harvesting (0, 1&,2) in factorial combination. The experiment was laid out in randomized complete block design with three replications. Each replication contained twelve treatment combinations. Cuttings were taken from healthy plants and planted in pots. Proper management was carried out for seedling in the nursery. After three months, healthy and uniform seedlings were transplanted to experimental field. Proper hoeing, weeding and watering of the experimental field were carried out uniformly whenever required. Data on plant height, branch number, fresh leaf yield/plant, fresh leaf yield/ha, dry leaf yield/plant, essential oil content and essential oil yield/ha were collected three times for about two years by six month harvesting age. For fresh leaf yield/plant, fresh leaf yield/ha, dry leaf yield/plant and essential oil yield/ha the sum of the two years yields were taken and analyzed using SAS computer software

## RESULT AND DISCUSSION

### Plant height (cm):

Harvesting height has a significant ($P$ < 0.05) influence on plant height (Table 2). The lowest value of plant height (46.963cm) was recorded for plants harvested at height of 20cm from the ground. The values of all of these parameters were decreased with increased harvesting height and the highest plant height (49.69cm) was recorded for harvested height of 5cm this result similar with research founding of (Kamla singh.et al, 1998) on Yield and quantity of three varieties of rosescented geranium (Pelargonium species) as influenced by height of harvesting rose-scented geranium harvested at 5 cm height from ground level.

**Fresh stem weight/plant**: Harvesting height has very

Table 1. Mean squares values on agronomic and chemical parameters of sage (salvia *officianalis.L*)

| Source of variations | Df | PH | BN | FLW t/ha | FSW | DLW | DSW | EOC% | EOY/ha |
|---|---|---|---|---|---|---|---|---|---|
| Rep | 2 | 23.34$^{ns}$ | 429.7$^{ns}$ | 7395.89$^{ns}$ | 335.61 | 748 | 41.49 | 0.0034$^{ns}$ | 191.89 |
| H .height(cm) | 3 | 12.64* | 318.5$^{ns}$ | 3779.22$^{ns}$ | 6255.62*** | 733.49 | 377.61* | 0.0015$^{ns}$ | 132.63 |
| Branch number | 2 | 29.35** | 316.6$^{ns}$ | 6421.36* | 3034.53 | 897.81* | 284.68 | 0.0019$^{ns}$ | 333.21* |
| H .height x Branch.N. | 6 | 2.207$^{ns}$ | 75.41$^{ns}$ | 2575.85$^{ns}$ | 622.76$^{ns}$ | 380.67$^{ns}$ | 387.7$^{ns}$ | 0.0015$^{ns}$ | 161.73$^{ns}$ |
| Error | 22 | 4.07 | 252.19 | 84361.6 | 522 | 246.04 | 170.14 | 0.0013 | 49.04 |
| Total | 35 | | | | | | | | |
| Cv % | | 4.2 | 20.81 | 9.27 | 14.85 | 10.68 | 22.01 | 6.26 | 9.75 |

**= highly significant at P<0.01; ns= non significant at P<0.5; according to the least significant difference (LSD) test at P<0.05; PH = plant height, BN= number of branches, DLW= dry leaf weight, FLW= fresh leaf weight, FSW= fresh stem weight, DSW= dry stem weight, EOC= essential oil content and EOY= EO yield/ha, H.height=harvesting height,

**Table 2.** Effect of different harvesting height on plant height and fresh stem weight of sage

| Harvesting heights(cm) | PH | FSW g/plant |
|---|---|---|
| 5 | 49.69$^{aa}$ | 185.72$^{aa}$ |
| 10 | 48.119$^{aabb}$ | 164.05$^{abb}$ |
| 15 | 47.467$^{abb}$ | 139.84b$^{cc}$ |
| 20 | 46.963$^{b}$ | 126.11$^{cc}$ |
| LSD(0.05) | 2.23 | 25.656 |

Mean followed by the same letter with in the same column are statistically non significant at P<0.05 according to the least significant difference (LSD) test at P<0.05; PH = plant height, FSW= fresh stem weight, DSW= dry stem weight, EOC= essential oil content and EOY= essential oil yield/ha

highly significant (*P*<0.01) influence on fresh stem weight (Table 2). The lowest value of fresh stem weight (126.11g) was recorded for plants harvested at height of 20cm from the ground. The values of all of these parameters were decreased with increased harvesting height and the highest fresh stem weight (185.72g) and was recorded for harvested height of 5cm this result similar with research finding of (Kamla singh.etal, 1998) on Yield and quantity of three varieties of rose scented geranium (Pelargonium species) as influenced by height of harvesting rose-scented geranium harvested at 5 cm higher from ground level. In contrary(R Chandra et al. 2013) on Harvest of flower stalk at 10 cm height recorded maximum number of buds sprouted per node (1.12). The influence of harvesting on number of buds sprouted per harvested stalk was significant (Table 1). The maximum number of buds sprouted per harvested stalk was recorded with harvest of flower stalk at 20 cm height (5.14). Harvest of flower stalk at 20 cm height could help to break apical dominance in carnation which might have resulted in sprouting of more number of axillary buds.

**Effect of branch number on plant height , fresh leaf weight, fresh stem weight , dry leaf weight and essential oil yield /ha of sage**

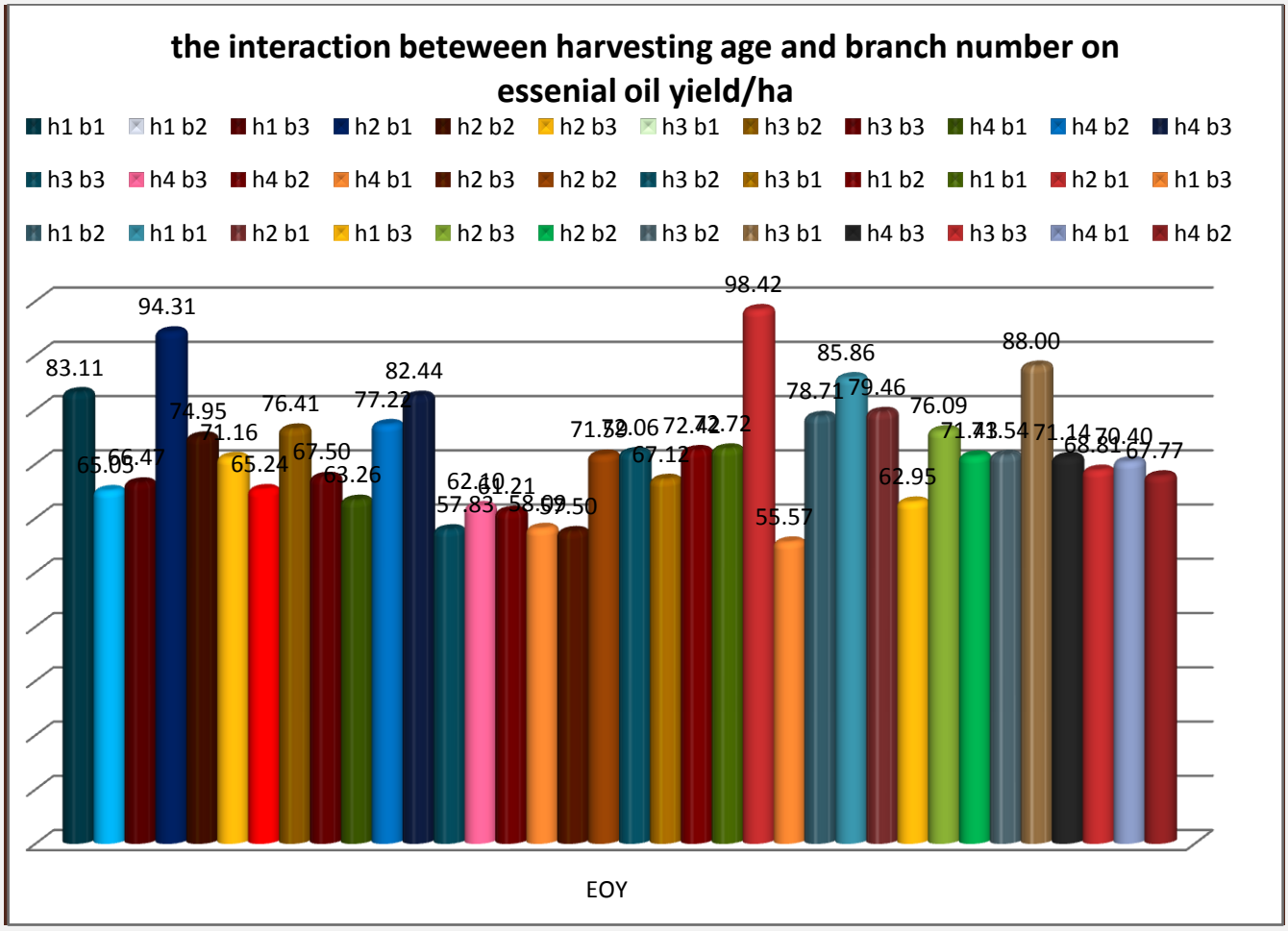
**Branch number:-** Branch number has a significant (*P* < 0.05) influence on plant height , fresh leaf weight/ha ,fresh stem weight/plot, dry leaf weight/plot and essential oil yield/ha (Table 3). The lowest value of plant height (46.77cm), fresh leaf weight/ha (11.95 t/ha), fresh stem weight (147.39), dry leaf weight (141.21) and essential oil yield/ha (66.63 t/ha) were recorded for plants had two number of branches while harvesting. The value of all of these parameters were decreased with increasing branch number and the highest plant height (49.8cm), fresh leaf yield/ha (1.38 t/ha), fresh stem weight (172.06), dry leaf weight (156.85) and essential oil yield/ha (77.17) were recorded with no branch number (Table 3).

**Fresh leaf weight (t/ha);** Branch number has a significant (*P* < 0.05) influence on fresh leaf weight/ha the lowest fresh leaf weight (11.95 t/ha), was recorded for plants had two number of branches while harvesting, however the highest fresh leaf yield/ha (1.38 t/ha) was

**Table 3.** Effect of branch number on plant height , fresh leaf weight, fresh stem weight , dry leaf weight and essential oil yield /ha of sage

| Branch numbers | PH | FLW t/ha | FSW | DLW | EOY/ha |
|---|---|---|---|---|---|
| 0 | 49.8[a] | 13.38[aa] | 172.06[aa] | 156.85[aa] | 77.17[aa] |
| 1 | 47.61[bb] | 12.42[abb] | 142.34[abb] | 142.63[abb] | 71.697[abb] |
| 2 | 46.77[b] | 11.95[b] | 147.39[b] | 141.214[b] | 66.630[b] |
| LSD(0.005) | 1.77 | 1.13 | 27.576 | 14.88 | 7.4 |

Mean followed by the same letter with in the same column are statistically non significant at P<0.05 according to the least significant difference (LSD) test at P<0.05; PH = plant height, DLW= dry leaf weight, FLW= fresh leaf weight, FSW= fresh stem weight and EOY= EO yield/ha




**Graph 1**. shows interaction effect of harvesting height's with branch numbers for EOY/ha of sage (salvia officianalis.L.)

recorded with no branch number remained. Left branch number while harvesting was not important for bud initiation of sage, to maximize the herbage yield like both fresh leaf and dry leaf weight. This may due to less transpiration rate, all year round rainfall and irrigation system and high rate of rejuvenation after harvest.

**Essential oil yield (t/ha) ;** Branch number has a significant ($P$ < 0.05) influence on essential oil yield/ha the lowest essential oil yield/ha (66.63 t/ha) was recorded for plants had two number of branches while harvesting, however the highest value of essential oil yield(77.17) was recorded with no branch number (Table 3). Essential

oil yield related to herbage yield so due to high herbage yield i.e. both fresh and dry leaf weight, fresh stem weight and plant height.

**Plant height;** the highest plant height (49.8cm) was recorded with no branch number, however the lowest value of plant height (46.77cm.The remained branch number has no a contribution for growth parameters like plant height and finally yield of sage due to well available rainfall and irrigation at wondo genet.

**1. NB**. After fully rejuvenate all the remained branches while harvesting should be harvested, that means after 3 weeks from harvest due to the occurrences diseases because of age

**Interaction effect of harvesting height and branch number**

The interaction between harvesting height and branch number has no significant difference among treatments; from this research particularly harvesting height is not that much an issue for sage simply harvests at 5cm from the ground is enough. (Graph 1)

## CONCLUSION AND RECOMMENDATION

As it can be seen from the result of this experiment, highest fresh leaf yield/ha, dry leaf yield/plant, plant height, fresh stem weight/plant and essential oil yield/ha were recorded without branch number/zero branch/ this may due to wondo genet agro ecology, less transpiration rate related all year round rainfall. Therefore for higher yield of this crop, harvest can be made without branch remained while harvesting. Concerning harvesting height, highest yield of the above parameters like plant height, essential oil yield/ha were recorded at harvesting height of 5cm from the ground, this similar/ agree with research study of (Kamla singh.etal, 1998) on Yield and quantity of three varieties of rose scented geranium (Pelargonium species) as influenced by height of harvesting rose-scented geranium harvested at 5 cm higher from ground level. Therefore we recommend this harvesting height better for optimum yield production of sage.

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