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Research Article

Growth, Yield and Yield Components of Spanish Mint (*Menthaspicata* 'Spanish Pointed') as Influenced by Environment and Harvesting Cycle

Basazinew Degu*, Sulti Amano and Beemnet Mengesha

Ethiopian Institute of Agricultural Research, Wondo Genet Agricultural Research Center, P.O. Box 198, Shashemene, Ethiopia
***Corresponding author:** basdegu@gmail.com

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ABSTRACT

The trial was conducted at three locations such as at Wondo Genet, Hawassa and Koka during 2014/2015 to determine appropriate environment and harvesting cycle for enhancing the growth, yield and yield components of Spanish mint. The experiment comprised two levels of harvesting cycle (Cycle 1 and Cycle 2) were used on a plot size of 1.8 m length and 3.6 m width arranged in Randomized Complete Block Design (RCBD) with four replications. SAS (version 9) software was used to compute the analysis of variance. The LSD test was used to compare the mean separations at 5 % probability level. The result showed that, location had a significant influence on fresh leaf weight/plant, fresh leaf yield/ha and percent essential oil content; however, it did not significantly influence on plant height and essential oil yield/ha. The highest fresh leaf weight/plant and fresh leaf yield/ha was obtained at Wondo Genet; whereas, the least values were obtained at Hawassa. Harvesting cycle had a significant influence on plant height, fresh leaf weight/plant and fresh leaf yield/ha; however, percent essential oil content and essential oil yield/ha were not influenced by the different in harvesting cycle. The highest plant height was obtained at the first harvesting cycle; whereas, the least value was obtained at the second harvesting cycle. Conversely, the highest fresh leaf biomasses per plant and per hectare were obtained at the second harvesting cycle. In contrast, the least fresh leaf biomasses per plant and per hectare were obtained at the first harvesting cycle. Moreover, the interaction of the two factors had a significant influence on all parameters like plant height, fresh leaf weight/plant, fresh leaf yield/ha, percent essential oil content and essential oil yield/ha. Therefore, cultivation of Spanish mint at Wondo Genet and at a place where having identical environment with Wondo Genet is much more advantageous than Hawassa and Koka for fresh leaf production. But for essential oil production, cultivation of Spanish mint at Hawassa and at a place where having identical environment with Hawassa is advantageous than Wondo Genet and Koka.

Key words: Spanish mint, Fresh leaf yield, Essential oil yield

INTRODUCTION

Spanish mint *(Menthaspicata* 'Spanish Pointed') is a hardy perennial herb which belongs to Lamiaceae family, producing mauve flowers summer through fall. A full flavored mint, use Spanish mint in tea, soups, stirs fry, salads and more. It is used in teas, beverages, jellies, syrups, ice creams, confections, chutneys. It contains Vitamin C and Vitamin A and a cup of fresh mint tea has been known as an herbal remedy to many cultures for many generations. Mint was originally used as a medicinal herb to treat stomach ache and chest pains. During the middle ages, powdered mint leaves were used to whiten teeth. It`s essential oil is also used as an environmentally-friendly insecticide for its ability to kill some common pests like wasps, hornets, ants and cockroaches (https://www.piedmontfarmandgarden.com/product-p/herb_mint_spanish.htm).

Even if the Spanish mint has such benefits, there are a few literatures which states about it. It is one of the herbs which can able to grow in most soil with deep, well-drained, wealthy in humus, with good moisture retention. Location and harvesting cycle has its own impact on production and productivity of most herbs. Among these herbs Spanish mint is the one. However, there is a limitation of research which has been doing on this herb concerning this issue even if it has a valuable health benefit for the communities. Therefore, the objective of

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this study was to determine appropriate environment and harvesting cycle for enhancing the growth, yield and yield components of Spanish mint.

MATERIALS AND METHODS

Spanish mint which was used for this particular experiment was obtained from Green Mark Herbs PLC. It was tested at Wondo Genet, Koka and Hawassa to test its adaptability for agronomic and chemical traits during 2014/2015. The descriptions of tested locations were presented at table 1 below. The experiment was lied out in Randomized Complete Block Design (RCBD) with four replications. SAS (version 9) software was used to compute the analysis of variance. The LSD test was used to compare the mean separations at 5% probability level. The experiment comprised two levels of harvesting cycle (Cycle 1 and Cycle 2) were used on a plot size of 1.8 m length and 3.6 m width. A spacing of 30, 60 and 100 cm were used between plants, rows and replications, respectively. Six plants/row and six rows were maintained per plot.

Young top shoot cutting with 10 cm length was taken from an actively growing and disease free mother plants which were maintained at Wondo Genet Agricultural Research Center for seedling preparation. The bottom two thirds of the leaves were stripped from each cutting and plant the cuttings on the polyethylene tube which was filled with proportion of 1:2:1 forest soil, sand and top soil, respectively. Seedlings were raised at nursery for two months before transplanting to the main field experimental plots.

During the experiment, all nursery and field horticultural management practices such as weeding, hoeing and watering were performed as required. Harvestings were under taken when the lower leaves of the branches start to turn to yellow. The whole aboveground biomass was cut 5-10 cm from the ground level by using sickle.

Data on plant height, leaf yield/plant, above ground biomass/plant, leaf to stem ratio, leaf yield/ha, percent essential oil content and essential oil yield/ha were critically recorded for the different harvesting cycles.

Mean values of all data for all characters which were measured are subjected to analysis of variance (ANOVA) by using SAS (version 9) computer software programs (SAS inst., 2002). Least Significant Difference (LSD) was used to compare significant means at 5% probability level.

RESULTS AND DISCUSSION

Plant height (cm)

The analysis of variance table showed that, the main effect location did not significantly ($P>0.05$) influence plant height. Supporting result was reported by Beemnet *et al*. (2015) and Tigist (2015) on Chamomile and *Aloe vera*, respectively. This could be due to the consistency of planting height. Whereas, the main effect harvesting cycle and interaction effect exerted a highly significant ($P<0.01$) influence on plant height (Table 2). This could be due the variability of planting height at each harvesting cycle and interaction of the two factors. The higher plant height was recorded at the first harvesting cycle whereas, the lower value was recorded at the second harvesting cycle (Table 4). From interaction of the two factors, the highest and the least plant height was obtained at Koka from the first and the second harvesting cycle, respectively (Table 5).

Fresh leaf weight per plant (g)

The main effects location (and harvesting cycle) and interaction effect of the two factors had a very highly significant ($P<0.001$) influence on fresh leaf weight/plant (Table 2). This result is in line with the findings of Beemnet *et al*. (2011; 2014b; 2014c), Kassahun *et al*. (2015) and Tigist (2015). The highest and least fresh leaf weight/plant was recorded at Wondo Genet and Hawassa, respectively (Table 3). As to fresh leaf weight/plant, this could be due to the favorable climatic conditions of Wondo Genet for the growth and development of Spanish mint.

Likewise, harvesting cycle and interaction effect of the two factors had a very highly significant ($P<0.001$) influence on fresh leaf weight/plant (Table 2). Similar result was reported by Tigist (2015) on *Aloe vera*. The higher fresh leaf weight/plant was recorded at the second harvesting cycle whereas, the lower value was recorded at the first harvesting cycle (Table 4).

The mean performance of interaction effect indicated that, the highest fresh leaf weight/plant was obtained at Wondo Genet from the second harvesting cycle; while, the least value was recorded at Hawassa from the first harvesting cycle (Table 5).

Fresh leaf yield per hectare (kg)

The main effect location had a very highly significant ($P<0.001$) influence on fresh leaf yield/ha (Table 2). This result is in line with the findings of Beemnet *et al*. (2011; 2012; 2014a; 2014b, 2014c), Kassahun*et al*. (2015) and Tigist (2015). The highest and least fresh leaf yield/ha was recorded at Wondo Genet and Hawassa, respectively (Table 3). This might be due to the favorable climatic conditions of Wondo Genet for the vegetative growth of Spanish mint as compared to Hawassa and Koka.

Likewise, harvesting cycle and interaction effect of the two factors had a very highly significant ($P<0.001$) influence on fresh leaf yield/ha (Table 2). Similar result was reported by Tigist (2015) on *Aloe vera*. The higher fresh leaf yield/ha was recorded at the second harvesting cycle whereas, the lower value was recorded at the first harvesting cycle (Table 3).

The interaction of the two factors showed that, the highest and the least fresh leaf yield/ha was obtained from the second and the first harvesting cycle at Wondo Genet, respectively (Table 5).

Essential oil content (%)

The main effect location had a very highly significant ($P<0.001$) effect on percent essential oil content (Table 2). Similar result was reported by Beemnet *et al*. (2011; 2012; 2014a; 2014b; 2014c) and Kassahun *et al*. (2015). The significantly higher essential oil content was recorded at Hawassa followed by Koka; while, the least value was recorded at Wondo genet (Table 3). This could be due to the presence of high concentration of essential oil within the harvested leaves at Hawassa and Koka as compared to Wondo Genet.

Table 1: Summary of site descriptions of tested locations in Ethiopia

Location	Latitude	Longitude	Soil pH	Soil type	Mean Annual Rainfall (mm)	Altitude (m.a.s.l)	Annual average temperature (°C)	
							Minimum	Maximum
Hawassa	7°05'N	39°29'E	7.2	Sandy loam (Andosol)	964	1700	12.94	27.34
Wondo Genet	7°19'N	38°38'E	6.4	Sandy clay loam (Nitosol)	1128	1780	11	26
Koka	8°26' N	39°1' E	-	Clay soil	830.9	1604	13.68	28.30

Table 2: Analysis of variance for growth and yield of Spanish mint (*Menthaspicata* 'Spanish Pointed')

SOV	DF	PH	FLWPP	FLYPH	EOC	EOYPH
Replication	3	122.32	863.80	2666005.73	0.0019	51.20
Location (Loc.)	2	152.80^{ns}	3967.53***	12245205.14***	0.006***	57.23^{ns}
Cycle	1	1004.92**	5602.26***	17290577.85***	0.056^{ns}	96.48^{ns}
Loc.*Cycle	2	735.64**	14607.09***	45082715.67***	0.189***	154.10*
Error	15	73.48	329.39	1016611.4	0.005	31.65
R-Square	-	0.74	0.90	0.90	0.88	0.59
CV (%)	-	17.37	22.95	22.95	16.41	35.08

Where, SOV= Source of variance, DF= Degree of freedom, PH= Plant height (cm), FLWPP= Fresh leaf weight/plant (g), FLYPH= Fresh leaf yield/ha, EOC= Essential oil content (%), EOYPH= Essential oil yield/ha (kg), CV= Coefficient of variance, ns= Not Statistically Significant at 0.05 probability level, *= significant at 0.05 probability level, **= significant at 0.01 probability level and ***= significant at 0.001 probability level.

Table 3: Mean performance of locations on growth and yield of Spanish mint (*Menthaspicata* 'Spanish Pointed') during 2014/15

Location	PH (cm)	FLWPP (g)	FLYPH (kg)	EOC (%)	EOYPH (kg)
Wondo Genet	53.66	102.21^{a}	5678.1^{a}	0.33^{b}	13.09
Hawassa	49.50	57.78^{c}	3209.8^{c}	0.49^{a}	16.71
Koka	44.93	77.29^{b}	4293.8^{b}	0.44^{a}	18.31
Overall mean	49.36	79.09	4393.90	0.42	16.04
LSD $_{0.05}$	ns	19.34	1074.5	0.07	ns
CV (%)	17.37	22.95	22.95	16.41	35.08

Where, PH= Plant height (cm), FLWPP= Fresh leaf weight/plant (g), FLYPH= Fresh leaf yield/ha, EOC= Essential oil content (%), EOYPH= Essential oil yield/ha (kg), CV= Coefficient of variance, ns= Not Statistically Significant at 0.05 probability level, *= significant at 0.05 probability level, **= significant at 0.01 probability level and ***= significant at 0.001 probability level.

Table 4: Mean performance of harvesting cycles on growth and yield of (*Menthaspicata* 'Spanish Pointed') during 2014/15

Cycle	PH (cm)	FLWPP (g)	FLYPH (kg)	EOC (%)	EOYPH (kg)
1st	55.83^{a}	63.81^{b}	3545.1^{b}	0.40	14.03
2nd	42.89^{b}	94.37^{a}	5242.7^{a}	0.43	18.04
Overall mean	49.36	79.09	4393.90	0.42	16.04
LSD $_{0.05}$	7.46	15.79	877.36	ns	ns
CV (%)	17.37	22.95	22.95	16.41	35.08

Where, PH= Plant height (cm), FLWPP= Fresh leaf weight/plant (g), FLYPH= Fresh leaf yield/ha, EOC= Essential oil content (%), EOYPH= Essential oil yield/ha (kg), CV= Coefficient of variance and ns= Not Statistically Significant at 0.05 probability level.

Table 5: Mean performance of interaction effects of location and harvesting cycle on growth and yield of Spanish mint ((*Menthaspicata* 'Spanish Pointed') during 2014/15

Loc*Cycle	PH (cm)	FLWPP (g)	FLYPH (kg)	EOC (%)	EOYPH (kg)
WG*Cycle1	54.05^{ab}	39.64^{c}	2202.2^{c}	0.48^{bc}	10.63^{b}
WG*Cycle2	53.28^{ab}	164.78^{a}	9154.1^{a}	0.17^{e}	15.55^{ab}
Hawassa*Cycle1	51.00^{ab}	53.95^{c}	2997.2^{c}	0.34^{d}	10.57^{b}
Hawassa*Cycle2	48.00^{b}	61.61^{c}	3422.5^{c}	0.63^{a}	22.86^{a}
Koka*Cycle1	62.45^{a}	97.85^{b}	5436.1^{b}	0.39^{cd}	20.91^{a}
Koka*Cycle2	27.40^{c}	56.73^{c}	3151.6^{c}	0.50^{b}	15.72^{ab}
LSD $_{0.05}$	12.92	27.35	1519.6	0.10	8.48
CV (%)	17.37	22.95	22.95	16.41	35.08

Similarly, interaction of the two factors had a very highly significant (P<0.001) effect on percent essential oil content (Table 2). The highest and the least essential oil content was obtained from the second and the first harvesting cycle at Hawassa, respectively (Table 5). However, harvesting cycle did not significantly (P>0.05) affect percent essential oil content (Table 2).

Essential oil yield per hectare (kg)

Essential oil yield/ha was significantly (P<0.05) affected by the interaction of location and harvesting cycle; whereas, the main effects location and harvesting cycle did not significantly (P>0.05) affect essential oil yield/ha (Table 2). The interaction of the two factors showed that, the highest and the least essential oil yield/ha was obtained at Hawassa from the second and the first harvesting cycle, respectively (Table 5).

Conclusion

The present study revealed that, experimental location had a significant influence on fresh leaf weight/plant, fresh leaf yield/ha and percent essential oil

content; however, it did not significantly influence on plant height and essential oil yield/ha. The highest fresh leaf weight/plant and fresh leaf yield/ha were obtained at Wondo Genet; whereas, the least values were obtained at Hawassa. This might be due to the presence of conducive environmental conditions for the growth and development of Spanish mint at Wondo Genet than Hawassa and Koka. Plant height, fresh leaf weight/plant and fresh leaf yield/ha were significantly influenced by harvesting cycle; however, the chemical traits such as percent essential oil content and essential oil yield/ha were not influenced by the different in harvesting cycle. The highest plant height was obtained at the first harvesting cycle; whereas, the least value was obtained at the second harvesting cycle. On the other hand, the highest fresh leaf biomasses per plant and per hectare were obtained at the second harvesting cycle. In contrast, the least fresh leaf biomasses per plant and per hectare were obtained at the first harvesting cycle. Moreover, the interaction of the two factors had a significant influence on plant height, fresh leaf weight/plant, fresh leaf yield/ha, percent essential oil content and essential oil yield/ha. Therefore, cultivation of Spanish mint at Wondo Genet and at a place where having identical environment with Wondo Genet is much more advantageous than Hawassa and Koka for fresh leaf production. But for essential oil production, cultivation of Spanish mint at Hawassa and at a place where having identical environment with Hawassa is advantageous that Wondo Genet and Koka.

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