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Growth Performance of *Melissa officinalis* on Two Different Sites in Himachal Pradesh

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ABSTRACT: This study was carried out to explore the performance of Melissa officinalis on two different sites *i.e*. Nauni (Solan) and Sharbo (Kinnaur). Results indicated that under Site-I, highest percentage of cutting survival (98%) was recorded and in addition to this maximum number of branches (6), plant height (40.2 cm), root length (16.6 cm), number of branches/plant (26) was also registered at Site-I. In terms of biomass of saplings, highest fresh weight/plant (28.8 g) and dry weight/plant (8.7 g) was recorded at Site-I. The maximum essential oil content of lemon balm can be obtained by harvesting them in evening hours. However, it was concluded that Site-I was found best for survival rate, growth and development parameters of Melissa officinalis.

Keywords: Sites, Survival, Saplings, Essential oil, Growth.

INTRODUCTION

Herbal remedies have been used for thousands of years. Early in human history, people practiced herbal medicine as a magical or religious healing art (Backer, 1965). Today, a lot of people use herbal medicine or rely on them. There are many various drug plants. One of them is lemon balm (*Melissa officinalis* L.), in other words bee herb or sweet balm. In scientific classification, lemon balm is a member of the family *Lamiaceae* and a perennial herb that lives at least three years. It is bushy and upright, reaching a height of about 1 m. The soft, hairy leaves are 2 to 8 cm long and either heart-shaped. The leaf surface is coarse and deeply veined, and the leaf edge is scalloped or toothed. White or pale pink flowers which consist of small clusters of 4 to 12 blossom in the summer. It is commonly referred to as Lemon Balm because of its lemon-like flavor and fragrance (İlisulu, 1992; Anonymous, 2003). Lemon balm, among the most significant therapeutic plant species grown in Turkey's natural flora, particularly in the Mediterranean region, is native to southern Europe and northern Africa, as well as the Caucasus and northern Iran. Its wild forms can be found throughout the Mediterranean and in the southern portion of the Alps. Other subspecies identified in our wild flora include subsp. *officinalis*, subsp. *altissima*, and subsp. *inodora* (Davis, 1982; Ilisulu, 1992; Anonymous, 2003). According to Ceylan (1987), Tansi and Zgüven (1995), the plant is primarily grown in Germany, France, Italy, Romania, Bulgaria, and North America. According to Zargari (1991), the subspecies of *M. officinalis* are evaluated in domestic markets and are included on the list of exported medicinal and aromatic plants. It has been utilized in traditional medicine since antiquity. French monks and nuns, as well as Paracelsus (1493-1541), a Swiss physician and chemist, produced and utilized tonics including lemon balm. This plant was described by English writer John Evelyn (1620-1706) as a "ruler of brain, strengthening to mental, and removing from melancholia." Its essential oil is known in Hebrew as "balsmin" or "leader of the oils." Lemon balm was recommended by Avicenna to strengthen the heart (Asmgil, 2001; Anonymous, 2003). Lemon balm is now employed in a variety of industries (including medical, perfume and cosmetics, and food) in many nations across the world.

The essential oil obtained from fresh or dried flower, leaf, and branches of this plant by water steam distillation or chemical extraction, is characteristic with fresh lemon odor, and light yellow colored. Its viscosity is lighter than that of water (Anonymous, 2003). It was desired that this value should not be lower than 0.05 per cent (Baytop, 1984). The main components of the essential oil are 39 percent citronellal, 33 percent citral (citronellol, linalool) and 2 percent geranial. In addition, this oil contains such as three terpinene, phenol carbon-acid (rosmarinic acid), and flavonglychoside acids in low ratio. There are also caffeic acid (a kind of tannin), several flavonoids (luteolin-7-O-glucoside, isoquercitrin, apigenin-7-Oglucoside, and rhamnocitrin), rosmarinic acid, ferulic acid, methyl carnosoate, hydroxycinnamic acid, and 2-(3', 4'-dihydroxyphenyl)-1, 3-benzodioxole-5-aldehyde

and some other aldehydes: beta-caryophyllene, neral and geranyl acetate (Kucera and Herrmann 1967; Baytop, 1984; Mulkens and Kapetanidis 1987; Peake *et al*., 1991; Dimitrova *et al*., 1993; Vaverkova *et al*., 1995; Chevallier, 1996; Ceylan, 1997; Tagashira and Ohtake 1998; Hohmann *et al.,* 1999).

Harvesting time is very important to obtain higher essential oil content and better quality (Carvalho Filho *et al*., 2006). In addition, for maximum oil production, long days and high light intensities are required during the maturation period for maximum oil production (Green, 1985). However, Murray *et al.* (1988); Court *et al*. (1993) revealed that the peppermint harvesting period has a significant impact on the essential oil content. Thus, regulating the harvesting time is important for raising the efficiency of essential oil. The oil output of essential oil plants was influenced by the season or month of harvesting. Weiss (1997) stated that in southern India, the maximum oil content of geranium was observed in July (rainy/monsoon) and the lowest in February (spring). According to Doimo *et al*. (1999), not only the seasons and months of harvest affected oil yield, but so did the geographical location where these plants were grown. Photoperiod alterations may benefit essential oil yield and composition at the expense of plant biomass.

MATERIALS AND METHODS

This experiment was carried out at the research farm of medicinal and aromatic plants, Dr Y S Parmar University of Horticulture and Forestry, Nauni (HP) and at RHRTS & KVK, Sharbo (Kinnaur). The plants of *Melissa officinalis* were transplanted in the month of January, 2021. The location site-I is located in the mid-hill zone of Himachal Pradesh at 30º N latitude and 76º 11′ E longitude, with an elevation of 1200m above mean sea level having slope of 7-8 per cent. The area falls in sub-tropical, sub-humid agro-climatic zone of Himachal Pradesh, India. There is considerable variation in the seasonal and diurnal temperature. The area experiences a wide range of temperature within a minimum of 1º C in winter to a maximum of 37º C in summer. The annual rainfall varies from 1000-1400 mm; about 75 per cent of it is received during monsoon period (mid-June to mid-September). Whereas, Site-II (Regional Horticultural Research & Training Station and Krishi Vigyan Kendra Kinnaur, Sharbo) is situated at 2,121 m above mean sea level and lies between 31º 5' 55" and 32º 5' 20" north latitude and 77º 45' and 79º 10' 50" east longitude**.** In summers, temperatures in Kinnaur can reach a maximum of 32º C and in the winters, temperatures can get down to 4º C around January. However, site-II also experience mild to heavy snowfall during the month of January to first fortnight of March.

This investigation was carried out to evaluate the performance of *Melissa officinalis* saplings in different type of beds (B_1: Control, B_2: Soil + vermicompost and B_3: Soil + vermicompost + FYM) and at two different sites moreover to yield the maximum amount of oil content based on the harvesting times (Morning, afternoon and evening). The data for survival percentage was taken on daily basis and for the vegetative growth parameters was taken twice in a week till final development of seedlings.

Germination and vegetative growth parameters

- Survival per cent (%)
- Stem height (cm)
- Root length (cm)
- Number of branches/plant
- Fresh weight/plant (g)
- Dry weight/plant (g)

RESULTS AND DISCUSSION

The data of survival per cent and vegetative growth parameters of *Melissa officinalis* showed normal variation in replications planted at Site-I and Site-II that are shown in Tables 1 to 3. With regard to Site-I, the maximum survival per cent (98%) was found in the B_1R_1 and B_2R_3 that was significantly followed by B_3R_3 (96%) and B_2R_1 (95%). In Site-II, the highest survival per cent was recorded in B_2R_3 (95%) subsequently followed by B_3R_3 (92%) and B_2R_1 (92%). However, there is negligible critical difference among the different bed types in both the sites.

In case of Site-I, the highest stem height (40.2 cm) was recorded in the B_3R_1 statistically followed by B_2R_3 (40.0 cm) and B_3R_3 (39.6 cm). With respect to Site-II, the maximum stem height was registered in B_2R_3 (38.3 cm) that was significantly followed by B_3R_3 (38.0 cm) and B_1R_2 (37.6 cm).

With regard to Site-I, the maximum root length was registered in the B_3R_1 (17.3 cm) statistically followed by B_3R_3 (16.6 cm), B_2R_2 (16.3 cm) and B_2R_3 (16.3 cm). In case of Site-II, the highest root length (15.2 cm) was recorded in the B_2R_3 statistically followed by B_3R_3 (14.8 cm) and B_1R_2 (14.7 cm).

In Site-I, the maximum number of branches per plant (26) was recorded in the B_3R_1 statistically followed by B_3R_2 (25) and B_3R_3 (24). With respect to Site-II, the maximum number of branches per plant was registered in the B_1R_2 (24) statistically followed by B_1R_1 (23) and B_2R_3 (23).

With regard to Site-I, the fresh weight per plant was recorded highest (28.8 g) in B_3R_1 followed by B_2R_2 (27.7 g) and B_3R_2 (27.4 g). In case of Site-II, the maximum fresh weight per plant (26.9 g) was recorded in the B_2R_2 subsequently followed by B_1R_2 (25.4 g) and B_1R_1 (25.3 g).

With respect to Site-I, the highest dry weight per plant (8.7 g) was recorded in B_3R_1 followed by B_2R_2 (8.5 g) and B_3R_2 (8.3 g). With regard to Site-I, the dry weight per plant was recorded maximum (8.5 g) in B_2R_1 followed by B_2R_2 (8.4 g) and B_3R_3 (8.4 g).

It was found that among both the sites, the maximum survival per cent, plant height, root length, number of branches per plant, fresh weight and maximum dry weight per plant was registered at Site-I.

Table 1: Survival percentage and stem height (cm) of different bed types at Site 1 and Site 2.

Site: 1						
	Survival percentage			Stem height		
Bed type	**R1**	**R2**	**R3**	**R1**	**R2**	**R3**
B_1	98%	83%	91%	35.0	36.3	37.7
B_2	95%	86%	98%	32.7	38.7	40.0
B_3	87%	89%	96%	40.2	38.0	39.6
C.D.	N/A			N/A		
SE(m)	2.85			1.35		
SE(d)	4.04			1.91		
C.V.	5.41			6.21		
Site: 2						
	Survival percentage			Stem height		
Bed type	**R1**	**R2**	**R3**	**R1**	**R2**	**R3**
B_1	95%	85%	85%	32.0	37.6	37.0
B_2	92%	80%	90%	35.2	35.4	38.3
B_3	90%	89%	92%	33.0	32.9	38.0
C.D.	N/A			N/A		
SE(m)	2.33			1.05		
SE(d)	3.30			1.48		
C.V.	4.56			5.11		

Table 2: Root length (cm) and number of leaves per plant of different bed types at Site 1 and Site 2.

Site: 1						
	Root length			Number of leaves per plant		
Bed type	**R1**	**R2**	**R3**	**R1**	**R2**	**R3**
B_1	12.7	13.3	16.0	23	20	21
B_2	12.3	16.3	16.0	21	20	23
B_3	17.3	16.3	16.6	26	25	24
C.D.	N/A			3.10		
SE(m)	0.91			0.77		
SE(d)	1.29			1.09		
C.V.	10.39			5.91		
Site: 2						
	Root length			Number of leaves per plant		
Bed type	**R1**	**R2**	**R3**	**R1**	**R2**	**R3**
B_1	11.2	14.7	13.1	23	24	20
B_2	12.6	13.5	15.2	21	22	23
B_3	12.4	14.1	14.8	20	21	22
C.D.	N/A			N/A		
SE(m)	0.52			0.96		
SE(d)	0.73			1.36		
C.V.	6.60			7.65		

Table 3: Fresh weight (g) and dry weight per plant (g) of different bed types at Site 1 and Site 2.

Site: 1						
	Fresh weight per plant			Dry weight per plant		
Bed type	**R1**	**R2**	**R3**	**R1**	**R2**	**R3**
B_1	26.6	20.2	26.3	8.1	8.2	7.6
B_2	27.2	27.7	19.5	8.0	8.5	7.6
B_3	28.8	27.4	26.4	8.7	8.3	8.0
C.D.	N/A			N/A		
SE(m)	2.09			0.13		
SE(d)	2.95			0.19		
C.V.	14.14			2.83		
Site: 2						
	Fresh weight per plant			Dry weight per plant		
Bed type	**R1**	**R2**	**R3**	**R1**	**R2**	**R3**
B_1	25.3	25.4	23.1	7.8	8.0	7.3
B_2	22.8	26.9	24.3	8.5	8.4	7.8
B_3	23.5	20.4	24.2	8.2	7.6	8.4
C.D.	N/A			N/A		
SE(m)	1.29			0.25		
SE(d)	1.82			0.35		
C.V.	9.30			5.33		

Site-I: Nauni (Solan) ; Site-II: Sharbo (Kinnaur)

Thus, it is clear that Site-I was found superior in terms of survival percentage and vegetative growth parameters of *Melissa officinalis*. However, for the growth behaviour of this medicinal plant the climate of Nauni is regarded as appropriate. However, the air filled porosity (AFP), easily available water (EAW), and aeration of vermicompost and FYM were not at the recommended levels, limiting root growth and lowering water holding capacity. As a result, the medium with vermicompost and FYM is more suitable due to the improved physical properties and increased nutrient level (Bhardwaj, 2014).

The best performance of seedling growth was came out due to FYM at Site-I, which boosts the medium's water and nutrient retention capacity, which improves the plant's water consumption capacity. Because of the presence of farm yard manure, soil porosity, water content, drainage, soil permeability, and water availability improve with decrease in soil density (FYM). Because of the availability of improved nutrition with water and oxygen in the root zone, it has offered support for fast growth cutting. As a result, good physical and biological conditions in soil + FYM (1:1) had a positive influence on root development, which was also useful in increasing the proportion of saplings that survived in the field after transplantation (Verma, 2018).

The maximum essential oil was obtained in the month of August during morning and evening harvesting time as shown in Table 4. The essential oil content came out in range of 0.10 per cent to 0.30 per cent, which is quite low compared with other members of the Lamiaceae family. Because of this, the production cost and price of the essential oil is very high in the market (Brickell and Judith 1997). Lemon balm oil has contain potentially active components primarily include monoterpenoids and sesquiterpenes, in particular geranial, neral, citronellal, geranyl acetate, β-caryophyllene, caryophyllene oxide and 1, 8-cineole (Davis, 1997). Although the composition of essential oil from lemon balm (*Melissa officinalis*) has been much studied (De Sousa *et al*. 2004; Mimica-Dukic *et al*., 2004; Saeb and Gholamrezaee 2012), the interference of certain factors such as drying period and harvesting times that influenced the yield and composition of essential oil, remains to be explored so far. With respect to lack of information about drying period and harvesting times effects on essential oil yield, this research was conducted to determine and optimize the harvesting times (cutting numbers) for distillation of essential oil from *M. officinalis*. Said-Al Ahl *et al.* (2018), reported that highest essential oil content was obtained in September harvesting, followed by August and then by October harvesting time. The results of this study suggest that the highest essential oil content of *M. officinalis* can be obtained by harvesting it in warmer months (September, August and October).

Table 4: Essential oil content (ml) of *Melissa officinalis* during different harvesting times.

Harvesting time	July	August	September
Morning	0.20	0.30	0.22
Afternoon	0.10	0.20	0.10
Evening	0.25	0.30	0.25

Plate 1. Growth of *Melissa officinalis* at Site-I.

Plate 2. Harvesting of *Melissa officinalis* at Site-I.

Plate 3. Growth of *Melissa officinalis* at Site-II.

CONCLUSIONS

Conclusively, it emerges that Site-I favours the survival rate, growth and development parameters of *Melissa officinalis* saplings. B_3 (Soil + vermicompost + FYM) was found the best performing bed type among three bed types. The highest essential oil content of *M. officinalis* is obtained by harvesting them in warmer months (September, August and October) in evening hours. Thus, Site-I and bed type B_3 are recommended for the successful production of *M. officinalis* saplings for the benefit of farmers for resource outcomes and income generation.

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