The Effect of Plant Spacing on Growth and Essential Oil Yield of Peppermint (Mentha Piperita L.)

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ABSTRACT
An experiment was conducted to study the effect of plant spacing on herbaceous yield and oil yield of peppermint (Mentha piperita L.) in Zalingei during 2018. Four levels of spacing were assigned to complete randomized plot design with four replications. Data on fresh leaf yield, dry leaf yield, fresh aboveground biomass yield, dry above-ground biomass yield essential oil (EO) content and EO yield were collected and analyzed. Row spacing significantly influenced all the parameters except for fresh leaf/stem ratio, dry leaf/stem ratio and EO content during the experiment. Row spacing affected fresh leaf yield, fresh above-ground biomass yield, dry above-ground biomass yield, significantly ($P < 0.05$) and dry leaf and EO yield highly significantly ($P < 0.01$). Fresh leaf and EO yield varied from 3,650.9–10,882.1 and 10.2–18.8 kg/ha, respectively and maximum values were obtained at the harvesting age of 120 days after planting at first harvest. Maximum yield of 62.89 kg/ha fresh leaf obtained with 10 cm row spacing and 0.50 kg/ha EO was obtained with a 40-cm row spacing and not significantly different with 10 cm row.

Keywords: Peppermint; Mentha; Limonene; Herbage yield; Lamiaceae; Mentha Piperiata; plant spacing.

INTRODUCTION
Mentha, commonly called mint, is a genus in the Lamiacae. The genus consists of 25–30 species [1]. Many varieties of mint exist and the cultivars selected for commercial production are generally specific to a geographic area. In the eastern hemisphere the most common species grown and studied is M. arvensis [2]. Mentha arvensis is commonly called field mint, wild mint, corn mint, or Japanese mint [3]. Mentha spicata, spearmint, and M. piperiti, peppermint, are the most common species cultivated in the western hemisphere [4]. Spearmint and peppermint are economic crops that are used raw or processed into oil for a variety of consumption purposes. Although mint grows the best in partially shaded, cool, moist areas [5], it can be grow in a wide range of environments when provide water. Mint tolerates many climates, growing throughout areas of Europe, Asia, North America, Australia and Africa [6]. Mint is propagated by division or from cuttings. Most mint producers harvest 3–4 years before replanting. Mint is harvested for fresh consumption and for processing. Mint hay is mown and dried for several days before being collected for distilling. Mint oil is extracted by steam at distilleries located not far from the mint production areas. Once oil is extracted, dealers create different oil blends for manufactures. Mint has medicinal and culinary uses. In the past, beneficial attributes and uses of the raw mint and mint oil have been passed down through tradition or folklore [7] (Pirbalouti et al., 2010). Fresh mint provides aroma and flavor to many foods [8] (Park et al., 2002). Mint is used in salads, chutneys, garnishes and dips. Mint flowers,
stems and leaves are commonly used to make herbal tea. Liqueurs and candies are also flavored with mint. Dried mint is an additive in commercial spice blends ([9] Kothari and Singh, 1995; [10] Moreno et al., 2002). Mint has historically been used as an anti-inflammatory, a carminative, an antiemetic, and a diaphoretic. Traditionally, mint has been prescribed as a treatment for flatulence, nausea, bronchitis, anorexia, and colitis [11] (McKay and Blumberg, 2006). Mint also is used a gastric stimulant ([12] Budavari et al., 1989; [13] Gupta, 1991) and an antispasmodic ([14] Iscan et al., 2002). Mint oil is widely used as a component of commercial medicines such as cough drops and cough syrups and poison ivy [15] (Kor, 2015). Mint oil can be used as a topical analgesic for muscle aches, cramps, arthritis, tendinitis and sprains. Mint oil is an antipruritic and can treat mosquito bites [16] (Khanzada, 2012). Cosmetically mint is used for aromatherapy. Mint is added to products to lend scent and enhance fragrance [17] (Herro and Jacob, 2010). Mint is widely used in beauty products and is added to shampoos, lotions, and balms. Mint is also added to some cigarettes to lessen the bitterness of tobacco [16] (Khanzada, 2012). Mint oil has also been shown to be an environmentally safe insecticide [18] (Nerio et al., 2010). Both fresh and dried spearmint plants are widely used in a variety of application [19] (Kee et al., 2017).

CONSTITUENTS

The constituents found in spearmint are shown in Table 1. Carvone, a phenolic compound, is the main constituent found in spearmint oil, followed by limonene ([20] Jirovetz et. al., 2002 and [21] Snoussi et. al., 2015]. Carvone is reported to be potential in inhibiting bacterial growth ([22] Helander et. at., 1998), as well as to act as fungicide ([23] Smid et. al., 1995) and insect repellent ([24] Lee et. al., 1997). Carvone also reversibly suppresses the sprouting in stored potatoes or flower bulbs [24] (Kerstholt et. al., 1997).

<table>
<thead>
<tr>
<th>Compound</th>
<th>Percentage (%)</th>
<th>Compound</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>β - myrcene</td>
<td>0.25</td>
<td>Trans-carveol</td>
<td>0.30</td>
</tr>
<tr>
<td>Limonene</td>
<td>11.50</td>
<td>Carvone</td>
<td>78.76</td>
</tr>
<tr>
<td>Γ-terpinene</td>
<td>0.16</td>
<td>Dihydrocarvyl acetate</td>
<td>0.57</td>
</tr>
<tr>
<td>Menthone</td>
<td>1.01</td>
<td>L-carveol</td>
<td>0.32</td>
</tr>
<tr>
<td>Menthol</td>
<td>1.00</td>
<td>β – bourbonene</td>
<td>1.23</td>
</tr>
<tr>
<td>Terpinen-4-ol</td>
<td>0.99</td>
<td>Trans-caryophyllene</td>
<td>1.04</td>
</tr>
<tr>
<td>Cl-terpinol</td>
<td>0.31</td>
<td>γ – amorphone</td>
<td>0.21</td>
</tr>
<tr>
<td>Dihydrocarveol</td>
<td>0.22</td>
<td>a-amorphone</td>
<td>0.16</td>
</tr>
<tr>
<td>Cis-dihydrocarveol</td>
<td>1.43</td>
<td>Other compounds</td>
<td>Other compounds</td>
</tr>
<tr>
<td>Dihydrocarvone</td>
<td>0.43</td>
<td>Total</td>
<td>100.00</td>
</tr>
</tbody>
</table>

(Adapted from Shahbazi, [25])

Material and Methods

The field experiment was conducted at the department of horticulture nursery of the faculty of agriculture of University of Zalingei during summer season of 2018. The nursery is located 1km away from Zalingei Nyala road at 12°.56 N latitude and 23°.30 E longitude and about 900 meters above the mean sea level. Summer is hot and dry; winter is cold and it’s raining in autumn. The experimental design was complete randomize plot design with four plant spacing and four replications. The crop was kept free from weeds by hand weeding. Sampling was performed from 4 middle rows in appropriate times. Plants were harvested at physiological maturity stage when plants lower leaves turn into yellowed. Five plants randomly were selected.
in each plot to measure the plant height, crop spread, and herbage yield, oil and suckers yield. The data relating to each character were analyzed statistically by applying the technique of analysis of variance and the significance was tested by "F" test (statistix 8). The data relating to each character were analyzed statistically by applying the technique of analysis of variance and the significance was tested by "F" test (statistix 8).

Results and Discussion

Herbage yield
Herbage yield is considered to be a function of various source of planting materials were planted (Table 2). The highest herbage (62.89. kg/ha) and branches yield (99.09kg/ha) were recorded with the closer plant spacing compared with the wider spacing. Among the plant spacing treatments, wider space (40cm) was recorded the highest herbage (no of leaves) yield (87) and fresh weight for the whole plant biomass (77.05kg/ha) and fresh leave weight (47.68 kg), respectively, in comparison to closer spacing (10-20 cm) treatment. Plant spacing (10-20 cm) also showed that significantly higher herbage yield (318.2 g/m2) compared to 40 cm spacing (Table 2). Its might be due to influenced by closer and wider spacing on herbage and suckers yield m2 contributed maximum yield which ultimately increased the yield. Similar results were supported by [25] Nakawuka et al., 2014, [26] Patra et al., 2000 and [27] Rathi et al., 2014 and [28] Shormin, 2009.

From the above discussion, consequently, it may be concluded that menthol-mint was most responsive to whole shoot treatment and wider space (30-40 cm) for growth, essential oil and suckers yield in comparison with upper portion of shoot (top plant part) and lower portion of shoot (lower plant part) treatments along with closer (10-20 cm) spacing treatment under irrigated conditions of Zalingei. Thus, it is concluded that combined application of whole shoot treatment and wider spacing (30-40 cm) may serve as a potent source for the eco-friendly, economically, and quality cultivation of menthol-mint in northern Indian plain zones.

Table (2) Effect of spacing on yield and oil content

<table>
<thead>
<tr>
<th>spacing</th>
<th>leaves</th>
<th>branches</th>
<th>height</th>
<th>Yield (g/m²)</th>
<th>oil</th>
<th>Fresh leaves yield kg/ha</th>
<th>Fresh whole plant yield kg/ha</th>
<th>Dry whole plant yield kg/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>10cm</td>
<td>83.80 a</td>
<td>13.15 a</td>
<td>8.32 A</td>
<td>318.2 a</td>
<td>0.46 a</td>
<td>62.89 a</td>
<td>99.09 a</td>
<td>22.73 a</td>
</tr>
<tr>
<td>20cm</td>
<td>58.65 a</td>
<td>10.65 a</td>
<td>9.00 A</td>
<td>315.2 a</td>
<td>0.45 a</td>
<td>52.27 b</td>
<td>77.72 b</td>
<td>17.40 b</td>
</tr>
<tr>
<td>30cm</td>
<td>79.20 a</td>
<td>11.55 a</td>
<td>9.82 A</td>
<td>301.8b</td>
<td>0.44 a</td>
<td>43.81 c</td>
<td>65.83 b</td>
<td>13.76 c</td>
</tr>
<tr>
<td>40cm</td>
<td>87.00 a</td>
<td>11.15 a</td>
<td>9.10 A</td>
<td>270.2b</td>
<td>0.50 a</td>
<td>47.68 bc</td>
<td>77.05 b</td>
<td>16.58 bc</td>
</tr>
<tr>
<td>LSD</td>
<td>48.68</td>
<td>6.9272</td>
<td>3.1794</td>
<td>31.65 0.05</td>
<td>5.85 13.70 3.17</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CONCLUSION

Results showed that the narrower spacing (20 cm) showed a significant increase in plant height, number of leaves and herb yield than 30 cm and 40 cm spacing. In contrast, wider spacing (40 cm) significantly promotes branching. However, oil content not greatly affected by spacing, while seasonal variation affected oil content.

REFERENCES


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