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Effect of varying levels of irrigation, mulches and nitrogen on herbage and oil yields of Japanese mint (*Mentha arvensis* subsp. *haplocalyx* var. *piperascens*)

ANURAG SAXENA[1], J. N. SINGH AND KEVALANAND

Department of Agronomy, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Uttar Pradesh 263 145

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ABSTRACT

The field experiment was conducted during 1989 and 1990 to study the effects of frequency of irrigations, mulches and nitrogen on growth and yield of Japanese mint [*Mentha arvensis* L. ssp. *haplocalyx* Briq. var. *piperascens* Holmes]. Frequent irrigations [50 mm cumulative pan evaporation (CPE)] increased the herb yield significantly by 46.8% compared with that of 150 mm CPE. Mulching increased the herb yield by 23.1% over no mulch treatment. Application of N @ 150 kg/ha significantly increased the green-herb yield by 10.6% compared with 100 kg N/ha. Oil yield followed the same trend as that of herb yield.

Japanese mint [*Mentha arvensis* L. ssp. *haplocalyx* Briq. var. *piperascens* Holmes] faces high temperature and desiccating winds during April–June. During this period soil moisture is limiting and soil temperature is high, both are harmful to the growth of field crops. Maintenance of soil moisture and optimum nutrition of N are important for obtaining higher yields. There is enough literature on the effects of irrigation (Singh *et al.*, 1989) and N fertilization (Kothari *et al.*, 1987). However, there is a little information available on the interactions of irrigation and N with growth and yield. Straw mulching is well known for conserving soil moisture and reducing soil temperature under arid and tropical climates. This study was conducted to find out the effects of irrigation, mulching and N fertilization on growth, herb and oil yields of Japanese mint.

MATERIALS AND METHODS

The field experiment was conducted during January–August 1990 on silty clay-loam soil of pH 7.1, containing 0.9% organic carbon, 0.12% total N, with 35.7 kg P/ha and 300.2 kg K/ha. The experiment was laid out in split-plot design with 3 irrigation treatments [50, 100 and 150 mm cumulative pan evaporation (CPE) level] in main plots, 2 mulch levels (0 and 5 tonnes/ha) in subplots with 4 N levels (0, 50, 100 and 150 kg/ha) in sub-subplots with 3 replications. Runners of Japanese mint were planted in rows 30 cm apart in the last week of January

Present address: [1]Division of Arable Cropping System, Central Arid Zone Research Institute, Jodhpur, Rajasthan 342 003

Table 1. Plant height, leaf : stem ratio and oil concentration of Japanese mint as influenced by irrigation, mulch and fertilizer treatments

Treatment	Plant height (cm)				Leaf : stem ratio				Oil concentration (%)			
	1989		1990		1989		1990		1989		1990	
	I	II	I	II	I	II	I	II	I	II	I	II
Irrigation												
50 mm CPE	59.2	46.3	54.5	45.1	0.84	0.94	0.93	0.94	0.54	0.48	0.52	0.49
100 mm CPE	52.5	43.6	49.1	42.2	0.87	0.96	1.04	1.04	0.56	0.52	0.54	0.51
150 mm CPE	46.3	43.4	43.8	35.6	0.89	0.97	1.14	1.05	0.59	0.55	0.55	0.55
CD (P = 0.05)	5.4	2.6	5.5	6.3	NS	NS	0.12	NS	0.03	0.03	0.02	0.02
Mulch (tonnes/ha)												
0	48.7	43.5	44.4	38.5	0.94	1.02	1.11	1.08	0.58	0.54	0.56	0.54
5	55.3	45.5	53.9	44.2	0.80	0.91	0.97	0.95	0.55	0.50	0.52	0.50
CD (P = 0.05)	5.2	1.8	2.5	5.2	NS	NS	NS	NS	0.01	0.02	0.02	0.01
N (kg/ha)												
0	47.6	42.7	45.4	38.0	0.89	0.99	1.09	1.60	0.58	0.54	0.56	0.57
50	52.0	43.8	48.2	40.6	0.87	0.96	1.06	1.02	0.57	0.53	0.54	0.52
100	52.5	45.4	50.5	42.7	0.87	0.95	1.03	1.00	0.56	0.51	0.53	0.51
150	56.7	46.0	53.6	44.2	0.85	0.93	0.99	0.96	0.56	0.52	0.52	0.49
CD (P = 0.05)	4.7	2.0	3.6	2.1	NS	NS	NS	NS	0.01	0.01	0.01	0.01

CPE, Cumulative pan evaporation; NS, non-significant; I, first harvest at 120 days; II, second harvest at 195 days after planting

in both the years. Two-thirds of N was applied in 2 equal splits (30 and 70 days after planting) before the first harvest and the remaining one-third was applied immediately after the first harvest. The crop was given 3 common irrigations (1 immediately, second 7 days after planting and third just after the first harvest) before the start of the different irrigation treatments. The crop was harvested 120 days after planting and 75 days after first harvest. On 5 random plants data were recorded on plant height, and plants were sampled from 0.5 m row length for the estimation of leaf : stem ratio. The net area (4.0 m × 1.8 m) of each plot was harvested and data on herbage yield were recorded. Essential oil concentration in the herb was extracted by hydro-distillation using Clavenger's apparatus and oil yield was calculated. The weather during the growing period was similar in both the years and favourable for growth. The data were analysed for herbage and oil yields in split split-plot design as per standard procedure. Observations on soil moisture were recorded in 0–60 cm profile, before and after each irrigation.

RESULTS AND DISCUSSION

Plant height, leaf : stem ratio and oil concentration

Increasing irrigation frequency up to 50 mm CPE and use of mulch increased the plant height significantly (Table 1). The leaf: stem ratio and oil concentration were maximum with lower irrigation frequency and with no mulching. Increasing frequency of irrigation and mulching significantly reduced the oil concentration (Table 1). Such changes occurred perhaps due to delaying effect of high moisture supply on plant maturity rather than on biosynthesis (Krupper *et al.*, 1968). The high oil concentration in the crops grown with lower

Table 2. Total fresh-herbage and oil yields of Japanese mint as influenced by irrigation, mulch and fertilizer

Treatment	Total herbage yield (q/ha)			Oil yield (kg/ha)		
	1989	1990	Pooled	1989	1990	Pooled
Irrigation						
50 mm CPE	278.8	256.4	267.6	143.7	130.1	136.9
100 mm CPE	216.2	233.4	224.8	121.1	123.6	122.4
150 mm CPE	194.3	170.2	182.3	109.6	94.6	102.1
CD (P = 0.05)	13.4	25.1	16.3	10.9	16.6	12.3
Mulch (tonnes/ha)						
0	187.3	192.7	190.0	104.6	104.1	104.4
5	220.3	247.3	233.8	121.2	123.7	122.5
CD (P = 0.05)	24.1	20.7	18.7	16.7	11.3	15.2
N (kg/ha)						
0	183.7	175.4	179.6	103.6	97.0	100.3
50	212.8	197.3	205.1	116.3	104.5	110.4
100	251.0	235.1	243.1	133.6	123.4	128.5
150	271.5	272.3	271.9	140.9	140.6	140.8
CD (P = 0.05)	18.3	10.1	12.4	7.2	5.6	4.8

CPE, Cumulative pan evaporation

moisture supply was probably because of high leaf : stem ratio. Reduction in leaf : stem ratio and oil content with high moisture supply was reported by Singh *et al.* (1989).

Plant height increased significantly with increasing N rate from 0 to 150 kg/ha (Table 1), comfirming the findings of Kothari *et al.* (1987). The leaf : stem ratio and oil concentration decreased with increasing level of N. Application of higher doses of N caused senescence of lower leaves, resulting in quick shading of lower leaves (Kothari *et al.*, 1987). This might have been instrumental in declined leaf : stem ratio and oil concentration.

Herb and oil yields

The herb and oil yields increased significantly with increase in the frequency of irrigation up to 50 mm CPE (Table 2). The pooled yield data indicated that the herb and oil yields under 50 mm CPE were 46.8% and 34.1% higher respectively than the yield under 150 mm CPE.

The higher herb and oil yields under 50 mm CPE than that under other irrigation treatments were due to increased plant growth. Under high moisture supply, the crop covered the ground at a quicker rate and developed sufficient photosynthetic surface needed for the maximum utilization of incident solar radiation. Straw mulching significantly increased herb and oil yields by 23.1 and 19.9% respectively (Table 2). Better moisture availability and edaphic environment under straw mulching appears to have enhanced the herbage yield. Higher oil yield under 50 mm CPE and straw mulching were due to higher herbage yield.

Pooled yield data showed that 150 kg N/ha gave a significant increase of 28.8 q/ha of herb yield (10.6%) and 12.3 kg/ha of oil yield (8.7%) compared with that of 100 kg N/ha. Singh *et al.* (1989) also reported similar results.

Consumptive use of water and water-use efficiency

The crop used higher water for the growth when the irrigations were scheduled at 50 mm CPE (Fig. 1). The average consumptive use of water was 1,000, 939 and 840 mm when irrigations were scheduled at 50, 100 and 150 mm CPE respectively. Randhawa *et al.* (1984) also observed similar results. The crop used 2.7% more water with straw mulching than no mulching. The results confirm the finding of Khera *et al.* (1986).

Water-use efficiency decreased with an increase in frequency of irrigation. The maximum and minimum water-use efficiency (1.40 and 1.21 kg oil/ha-cm) were obtained under 50 mm and 150 mm CPE levels of irrigation. The results are in close association with those of Randhawa *et al.* (1984). Straw mulching increased the water-use efficiency by 13.9% over no mulching. Khera *et al.* (1986) also observed the similar results.

Interaction effects were not significant in both the years.

It was concluded that mulch application is beneficial in obtaining higher yield of herbage and oil. To get higher oil yields the crop may be irrigated at 50 mm CPE before the onset of monsoon. Application of 150 kg N/ha is also beneficial in obtaining high herbage as well as oil yields.

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