Indian Journal of Agricultural Sciences **91** (5): 792–5, May 2021/Short Communication
https://doi.org/10.56093/ijas.v91i5.113107

Water economization in Japanese mint through crop establishment, irrigation and nitrogen levels

KAIROVIN LAKRA[1] and S K VERMA[2]*

Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad, Uttar Pradesh 224 229, India

Received: 12 June 2020; Accepted: 22 December 2020

Keywords: Economics, Irrigation, Mentha, Nitrogen, Sowing method, Water productivity

Japanese mint (*Mentha arvensis* L.) is the source of menthol rich essential oil which has a variety of industrial applications and its cultivation supports livelihoods of more than one million farmers in India. Its leaves contain flavonoids, triterpenoids, vitamins, iron, phosphorus, calcium and potassium (Hasanah *et al*. 2019). Presently about 80% of the world requirement of mint oil is met by India. In India, production of mentha oil was about 38000 metric tonnes from an area of 0.34 million ha, with average productivity of 120 kg/ha (Singh *et al*. 2018). Crop establishment methods play a key role in the establishment of transplanted seedlings and use of applied water. Flat planting followed by irrigation is the common practice of raising mint crop in India. Ridge and bed plantings have been shown to be more efficient in relation to water and nutrient use. Mint is a shallow rooted, high water demanding crop, responds well to irrigation and water stress reduce its productivity and oil content. It is a heavy feeder of nitrogen and can take approximately 180 kg N/ha for better yield (Rosete *et al*. 2014). Proper crop establishment and the application of optimum quantity of irrigation water and nitrogen are the key inputs for optimum productivity and economic returns from the crop. Keeping this in view, a field experiment was conducted to evaluate the influence of crop establishment methods, irrigation and nitrogen levels on water economization in Japanese mint.

The study was carried out during summer (March-June) of 2016-17 at NDUAT, Kumarganj, Faizabad, Uttar Pradesh, in split plot design, with three crop establishment methods, viz. flat bed planting, ridge planting and raised bed planting and three irrigation regimes, viz. 0.8 IW/CPE, 1.0 IW/CPE and 1.2 IW/CPE ratio in the main plots and three N levels, viz. [RDN (160 kg N/ha), 75% RDN (120 kg N/ha) and 125% RDN (200 kg N/ha)] in subplots with three replications. The suckers of variety Kashi were transplanted at spacing of 45 cm × 20 cm on 22 March, 2017 as per land configuration treatments. The depth of irrigation water was 6 cm applied through a Parshall Flume. Half amount of nitrogen (through urea) as per treatment, and full dose of phosphorus (60 kg/ha, through SSP) and potassium (60 kg/ha, through MOP) was applied as basal at the time of planting. Remaining quantity of nitrogen was given in two equal splits, at 25 and 40 days after planting (DAP). For the determination of soil moisture content soil samples were taken from different soil layers and dried in electric oven at 105°C ± 5°C for 48 h to the constant weight. From the soil moisture content and meteorological data consumptive use of water (CU), rate of water-use (RWU), water use efficiency (WUE) and moisture extraction pattern were determined. Whereas, WP was calculated considering the gross returns and amount of total water used by the crop and expressed in ₹/mm (Behera *et al*. 2014). Water productivity = Gross returns (₹/ha)/Total water used (mm). All the general crop management practices were followed to the crops. The crop was single harvested at 100 days after planting. The fresh harvested herbage from net plot was weighed by an electronic balance and the data were converted to kg/ha. The essential oil content was extracted from the fresh herbage through steam distillation method using Clevenger's type extracting apparatus made up of glass. The oil percent was multiplied with corresponding fresh herbage yield of each treatment to get the oil yield. The economics was calculated on the basis of cost of production and gross returns including sale prices of mint oil in local market ₹ 850/l. The experimental data were analysed statistically and interpreted.

Raised bed planting resulted in significantly higher plant height, number of branches, leaves/plant, fresh and dry weight of plant, herbage and oil yield of mint as compared to ridge and flat bed planting (Table 1). Maximum crop growth, herbage and oil yield was recorded at higher irrigation regime (1.2 IW/CPE ratio) due to adequate

Present address: [1]Chandra Shekhar Azad University of Agriculture & Technology, Kanpur; [2]Banaras Hindu University, Varanasi, Uttar Pradesh. *Corresponding author e-mail: suniliari@gmail.com

Table 1 Effect of sowing methods, irrigation regimes and nitrogen levels on crop growth, yield and economics of mint

Treatment	Plant height at 60 DAS (cm)	Branches/ plant at 60 DAS	Leaves/ plant at 60 DAS	Fresh weight at 60 DAS (g/m^2)	Dry weight at 60 DAS (g/m^2)	Herbage yield (kg/ha)	Oil yield (kg/ha)	Cost of cultivation (₹/ha)	Gross returns (₹/ha)	Net returns (₹/ha)	B-C ratio
Land configuration											
Flat-bed planting	45.1	11.4	155.4	1161.8	266.3	15257	111.4	39976	94670	54694	2.37
Ridge planting	46.5	12.2	162.2	1210.8	277.3	15899	119.2	41976	101356	59380	2.41
Raised-bed planting (Paired row)	50.9	13.5	183.8	1368.2	287.2	17957	136.5	42976	116002	73026	2.70
CD (P=0.05)	1.12	0.64	5.87	53.57	10.33	960.0	7.49	-	14231	13420	0.24
Irrigation regimes											
0.8 IW/CPE	43.8	11.5	161.5	1269.4	259.5	15358	113.6	39976	96602	56626	2.42
1.0 IW/CPE	48.5	12.5	174.9	1276.3	281.5	16638	123.1	41976	104653	62677	2.49
1.2 IW/CPE	50.2	12.8	180.0	1304.0	289.8	17117	130.1	42976	110576	67600	2.57
CD (P=0.05)	1.69	0.38	5.07	27.73	9.01	485.0	6.52	-	3812	2809	0.03
Nitrogen levels											
RDN (160 kg N/ha)	48.0	12.4	174.4	1259.5	279.7	16625	126.4	41643	107398	65755	2.58
75% RDN (120 kg N/ha)	45.6	11.8	160.7	1196.9	265.7	15365	110.6	41034	94034	53000	2.29
125% RDN (200 kg N/ha)	48.9	12.6	181.3	1284.5	285.4	17124	131.9	42250	112077	69827	2.65
CD (P=0.05)	0.98	0.25	6.9	26.01	6.01	615.0	5.59	-	10287	9678	0.21

availability of soil moisture over 1.0 and 0.8 IW/CPE ratio. Better development of crop under irrigated treatments was the result of better moisture availability was reported by Singh *et al*. (2018). Significantly the highest crop growth parameters, herbage and oil yield of mint was recorded at 125% RDN level over 75% RDN and it was statistically at par with 100% RDN. Adequate supply of nutrients increased herbage yield due to better vegetative growth (Behera *et al*. 2013). Raised bed planting and irrigation at 1.2 IW/CPE ratio resulted in higher CU of water and RWU due to increased water supply (Table 2). Results are corroborate with the research finding of Behera *et al*. (2013). However, significantly maximum CU (64.2 cm) and RWU (0.64 cm/day) was recorded under125% RDN over 75% RDN and at par with 100% RDN. Raised bed planting increased WUE by 11.8 and 17.6% as compared to ridge and flat bed planting, respectively, because of higher yield (Table 2). The highest WUE was with irrigation at 0.8 IW/CPE ratio (2.1 l/ha-cm) followed by 1.0 IW/CPE ratio (1.88 l/ha-cm) and 1.2 IW/CPE ratio (1.79 l/ha-cm). Irrigating the crop at 0.8 IW/CPE increased the WUE by 10.5% and 14.8% than 1.0 and 1.2 IW/CPE, respectively. Maximum WUE (2.12 kg/ha-cm) was recorded with 125% RDN level which decreased with reduction of fertilizer dose. Crop planted on raised bed recorded maximum WP (12.3 and 18.1% higher) followed by ridge and flat bed, respectively. Under different irrigation schedules, crop irrigated at 0.8 IW/CPE ratio recorded 10.0 and 20.9% higher WP than 1.0 and 1.2 IW/CPE ratio, respectively. Results are close conformity with research findings of Singh *et al*. (2018). The 125% RDN level had highest WP, which was 4.2 and 16.1% higher than 100% RDN and 75% RDN, respectively. At 0–20 and 20–40 cm soil depths, higher per cent of moisture was extracted under raised bed planting while, at and 40–60 cm soil depth, the moisture extraction was higher with flat planting (Fig 1). Among the irrigation regimes, at 0–20 and 20-40 cm soil depth, the highest soil moisture was extracted with irrigation at 1.2 IW/CPE ratio. Whereas, at 40-60 cm soil depth, the highest soil moisture was extracted with irrigation at 1.0 IW/CPE ratio. With regard to N management, the highest soil moisture was extracted from 0-20 and 20-40 cm soil depth with the application of 125% RDN while from 40-60 cm soil depth, the highest soil moisture was extracted with 75% RDN (120 kg N/ha).

The maximum cost of cultivation was observed in raised bed planted mint, whereas, flat bed showed the lowest cost of cultivation (Table 1). Cost of cultivation increased with increased level of irrigation due to the extra cost incurred by more number of irrigations at higher values of 1.2 IW/CPE ratio. Among nitrogen management treatment, highest cost of cultivation was incurred under 125% RDN over 75% RDN and 100% RDN, respectively. Crop planted on raised bed recorded maximum gross and net returns and B-C ratio. It earned 18.7 and 25.1% higher net returns and 10.7 and 12.3% higher B-C ratio than ridge and flat bed planting, respectively. Application of irrigation at 1.2 IW/CPE ratio gave significantly highest gross and net returns

Table 2 Effect of sowing methods, irrigation regimes and nitrogen levels on water use and water productivity of mint

Treatment	Irrigation water (cm)	Effective rainfall (cm)	Total water received (cm)	Consumptive use of water (cm)	Rate of water use (cm/day)	Water use efficiency (l oil/ha-cm)	Water productivity (₹/cm)
Land configuration							
Flat-bed planting	58.0	9.5	67.5	63.9	0.64	1.74	140.1
Ridge planting	58.0	9.5	67.5	63.6	0.64	1.87	150.0
Raised-bed planting	58.0	9.5	67.5	64.2	0.64	2.12	171.7
CD (P=0.05)	-	-	-	-	NS	0.24	18.4
Irrigation regimes							
0.8 IW/CPE	48.0	9.5	57.5	54.0	0.54	2.10	167.4
1.0 IW/CPE	60.0	9.5	69.5	65.9	0.66	1.88	150.6
1.2 IW/CPE	66.0	9.5	75.5	71.9	0.72	1.79	146.5
CD (P=0.05)	-	-	-	-	0.04	0.18	15.6
Nitrogen levels							
RDN (160 kg N/ha)	58.0	9.5	67.5	64.0	0.64	1.88	159.0
75% RDN (120 kg N/ha)	58.0	9.5	67.5	62.8	0.63	1.74	139.2
125% RDN (200 kg N/ha)	58.0	9.5	67.5	64.8	0.65	2.12	165.9
CD (P=0.05)	-	-	-	-	0.02	0.24	7.2

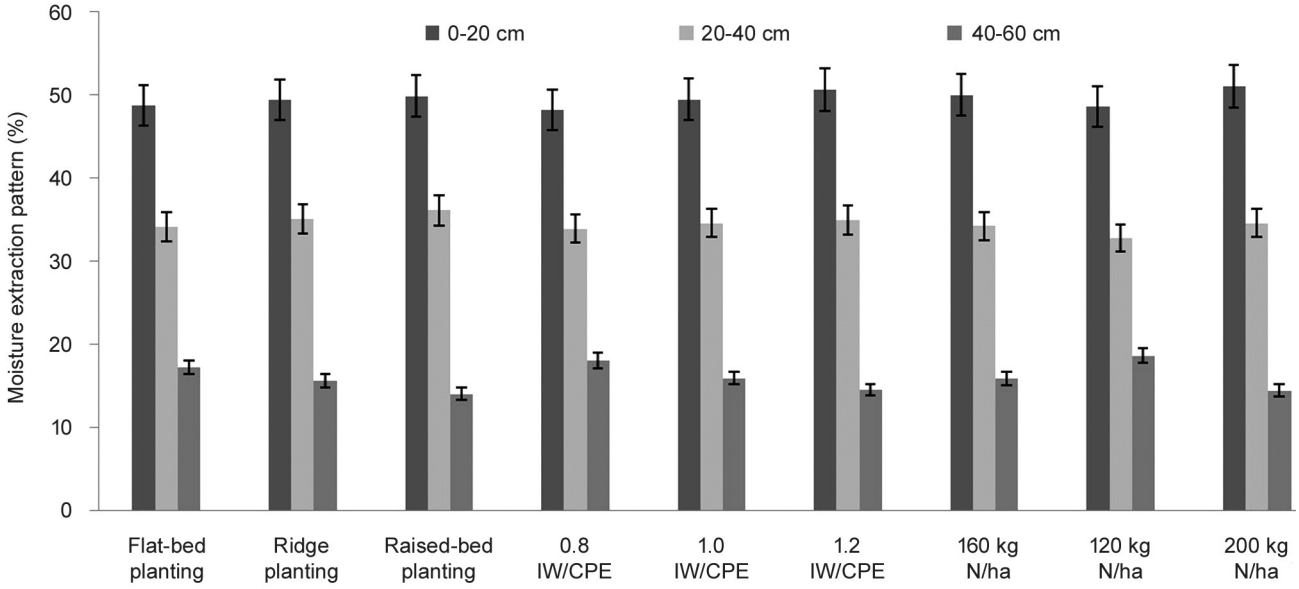

Fig 1 Per cent moisture extraction from different soil depths under different treatments.

of ₹ 110576 and 67600/ha, respectively with benefit-cost ratio of 2.57. Similar results were reported by Behera *et al*. (2013) and Singh *et al*. (2018). Application of 125% RDN recorded significantly the highest gross and net returns of ₹ 112077 and 69827/ha, respectively and cost-benefit ratio of 2.65 over 75% RDN and it was statistically at par with 100% RDN.

SUMMARY

An experiment was conducted at Faizabad (UP) during summer 2016-2017 in split plot design with three replications to optimize the use of water and enhance the economic returns of Japanese mint. Results revealed that raised bed planting recorded maximum herbage and oil yield, CU, RWU, moisture extraction (ME), WUE, WP, returns and B-C ratio than the ridge and flat bed planting. Soil moisture regimes maintained at 1.2 IW/CPE ratio significantly enhanced crop growth and yield with maximum water use, WP, returns and B-C ratio over others. Application of 125% RDN significantly produced maximum herbage (17124 kg/ha) and oil yield (131.9 kg/ha), water use, WP and economic returns over 75% RDN and it were at par with RDN. Irrigation at 1.2 IW/CEP ratio under raised bed planting using 125% RDN was the better option for higher yield, water use and economic returns of Japanese mint in saline soil of eastern Uttar Pradesh.

REFERENCES

Behera M S, Mahapatra P K, Singandhupe R B, Kundu D K, Kannan K, Manda G K and Singh A. 2014. Effect of drip fertigation on yield, water use efficiency and water productivity of mint. *Journal of Agricultural Physics* **14**(1): 37–43.

Behera M S, Verma O P, Mahapatra P K, Singandhupe R B and Kumar A. 2013. Effect of irrigation and fertility levels on yield, quality and economics of Japanese mint under drip irrigation system. *Indian Journal of Agronomy* **58**(1): 109–13.

Hasanah Y, Sitepu F E and Butar R R. 2019. Morphological characters and N uptake of mint with the growing media composition treatment. *(In) Proceeding of IOP Conference*: *Earth and Environment Science,* Medan, Indonesia, October 24–25, Series 260:012147, pp 1-6.

Rosete C R J, Rivas A O, Castillo J A A, Montoya R B and Ramos B G A. 2014. Nutrition assessment of N-P-K in mint cultivated in soilless system. *Annual Research and Review in Biology* **4**(15): 2462–70.

Singh G, Saha T, Chandra S, Bhatnagar A and Samarth. 2018. Productivity of menthol mint (*Mentha arvensis*) and wheat as relay and sequential cropping system under different irrigation scheduling. *Indian Journal of Agronomy* **63**(1): 110–16.