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Effect of nitrogen and irrigation regimes on the yield and quality of sweet basil (*Ocimum basilicum* L.)

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Abstract

Field experiments were conducted at Bangalore, to study the effect of nitrogen and irrigation regimes on growth, herbage, yield and quality of oil of sweet basil (*Ocimum basilicum* L.). Application of nitrogen at 200 kg ha^{-1} significantly increased the plant height, plant spread, herbage and oil yield compared with control (no nitrogen). Irrigation at 0.75 IW : CPE ratio (irrigation water : cumulative pan evaporation) increased the plant spread, herbage and oil yield compared with that of 0.25 IW : CPE ratio. Oil content and quality were not influenced by nitrogen and irrigation regime. Water use efficiency (WUE) was maximum at 0.25 IW : CPE ratio (0.337 kg oil $ha^{-1}mm^{-1}$ water used) compared with 0.75 IW : CPE ratio (0.196 kg oil $ha^{-1}mm^{-1}$ water used). Similarly nitrogen application increased the water use efficiency compared with that of control.

Key words: essential oils, irrigation, nitrogen, *Ocimum basilicum*, water use efficiency.

Ocimum basilicum L., commonly known as sweet basil or French basil, is native to Central Asia, North East Africa and North West India. The basil oil is extensively used for flavouring of confectionery, baked food, spiced meat and beverages. Its oil is used in pharmaceuticals, cosmetics and perfumery industries. In India, basil is cultivated in northern states and is recently introduced in the red soil region of Bangalore. No information is available on the performance of this crop and influence of nitrogen and irrigation regimes on growth, herbage and oil yield and quality. Therefore, the present study was carried out to generate necessary data on sweet basil cultivated in this region.

Field experiments were conducted during 2000 and 2001 at the research farm of Central Institute of Medicinal and Aromatic Plants, Field Station, Bangalore (Karnataka, India). Bangalore is located at an altitude of 930 m above mean sea level. The climate of Bangalore is characterized as semi-arid tropical with 890 mm mean annual rainfall. The soil of the experimental plot was red sandy loam having a pH 6.3 with bulk density of 1.5 g cc^{-1}. The water holding capacity of the soil was 15.6% at –0.3 Mpa and 65% at –1.5 Mpa. The available nitrogen, phosphorus and potassium were 210, 11.5 and 195 kg ha^{-1}, respectively. The treatments consisted of three irrigation regimes (0.25, 0.50 and 0.75 IW : CPE ratio) as main plots and three rates of N application (0, 100 and 200 kg ha^{-1}) as sub plots in a split-plot design with three replications.

Table 1. Effect of irrigation and nitrogen on growth, herbage, oil yield, oil content and water use and water use efficiency of sweet basil (pooled data)

Treatment	Plant height (cm)		Plant spread (m^2)		Herbage yield (t ha^{-1})			Oil yield (kg ha^{-1})			Oil content (%)		Water used (mm)	WUE (kg oil ha^{-1} mm^{-1})
	Main	Ratoon	Main	Ratoon	Main	Ratoon	Total	Main	Ratoon	Total	Main	Ratoon		
Irrigation level (IW : CPE ratio)														
0.25	36.1	40.3	0.106	0.171	4.37	7.20	11.57	21.52	40.96	62.48	0.50	0.58	185.2	0.337
0.50	35.6	43.1	0.117	0.179	5.07	7.15	12.22	24.55	40.90	65.45	0.49	0.58	246.4	0.266
0.75	38.8	45.2	0.135	0.195	7.15	7.26	14.41	36.66	42.15	78.81	0.51	0.57	401.4	0.196
SEd	1.3	4.8	0.004	0.012	0.19	0.30	0.40	0.98	3.52	4.17	0.04	0.05	-	-
C.D. (P=0.05)	N.S.	N.S.	0.010	N.S.	0.54	N.S.	1.09	2.73	N.S.	11.59	N.S.	N.S.	-	-
N level (kg ha^{-1})														
0	34.0	38.0	0.089	0.109	3.51	3.80	7.31	17.34	22.18	39.52	0.50	0.59	227.6	0.174
100	36.9	44.8	0.126	0.211	5.95	7.29	13.24	29.66	41.35	71.01	0.50	0.57	230.0	0.309
200	39.7	45.8	0.143	0.226	7.13	10.42	17.55	35.73	60.49	96.22	0.50	0.57	2350.0	0.409
SEd	0.9	1.7	0.010	0.012	0.24	0.49	1.05	1.45	3.52	4.30	0.02	0.02	-	-
C.D. (P=0.05)	2.1	3.7	0.022	0.026	0.54	1.04	2.29	3.15	7.68	9.37	N.S.	N.S.	-	-

N.S. = Non significant; WUE = Water use efficiency

Rooted seedlings of sweet basil cv. Vikarshudha were transplanted in February 2000 and 2001 in a plot size of 9 m^2 with a spacing of 30 cm x 30 cm. During planting, P and K fertilizers (17.5 kg P ha^{-1} and 35.7 kg K ha^1, respectively) were applied as a basal dose and N was applied in three equal splits at monthly interval in the form of urea. Single super phosphate and muriate of potash were used to supply P and K, respectively. Supplementary irrigations were made when pan evaporation values reached 40, 60 and 120 mm, to represent 0.75, 0.50 and 0.75 IW : CPE ratios, respectively. In each irrigation, 30 mm of water was applied. Main crop was harvested in April and ratoon in May. At each harvest, fresh herbage yields were recorded.

The essential oil content of the fresh herbage was estimated by hydro-distillation using Clevenger's apparatus (Clevenger 1928). The quality of the essential oil was determined by GLC on a Perkin Elmer 8500 Gas Chromatograph fitted with Flame Ionization Detector (FID) and an electronic integrator using a 25 metres (0.25 mm dia) BP-1 fused silica column (methyl polysiloxane), N_2 carrier gas at 10 psi inlet pressure, and a temperature programme of 60°C (5 min), 60-220°C at 5°C per min, 220°C (3 min). Sample (0.1 ml) was injected in the split mode injection (split ratio 1 : 80).

Effective rainfall was estimated for computing water consumption. The quantity of water for the irrigation treatments was calculated from the amount of soil profile moisture use (irrigation water applied + changes in soil profile moisture and effective rainfall). Water use efficiency (WUE) was expressed as the ratio of oil yield to that of the water use (kg $ha^{-1}mm^{-1}$). Data was subjected to analysis of variance. Estimation of the significant difference of means was based on a probability of $P < 0.05$.

Total herbage of sweet basil yield increased significantly with the application of graded levels of N up to 200 kg N ha^{-1} and yield increases were to an extent of 140.1% over control at 200 kg N ha^{-1} (Table 1). Similar yield

Table 2. Interaction effect of irrigation and nitrogen levels on herbage and oil yield of sweet basil (pooled data)

Treatment	Herbage yield (t ha^{-1})			Oil yield (kg ha^{-1})		
	0*	100	200	0	100	200
Irrigation level (IW : CPE ratio)						
0.25	11.41	11.35	11.98	38.57	64.82	84.05
0.50	12.29	12.20	12.18	41.37	70.69	84.30
0.75	13.54	14.40	15.29	38.62	77.51	120.31
SEd	1.05	-	-	7.45	-	-
C.D. (P=0.05)	2.29	-	-	16.23	-	-

* N levels (kg ha^{-1})

increase with N application in red and lateritic soils was reported earlier in geranium and lemongrass (Singh 2000; Singh *et al.* 2001). Similarly oil yield increased 143.5% over control at 200 kg N ha^{-1} level (CIMAP 2001).

The total herbage and oil yields increased significantly with increase in the level of irrigation from 0.25 to 0.75 IW : CPE ratio (Table 1). The irrigation applied at 0.75 and 0.50 IW : CPE ratios increased herbage yield by 24.5% and 5.6%, respectively over that at 0.25 IW : CPE ratio while the corresponding increase in oil yield was only to the extent of 26.1% and 4.8%, respectively. The higher herbage and oil yields under 0.75 IW : CPE ratio was due to favourable moisture conditions maintained throughout the crop growth period. Under higher moisture supply, the crop covered the ground faster and developed sufficient photosynthetic area for maximum utilization of solar radiation resulting in significant increase in herbage and oil yield of sweet basil.

The interaction of irrigation regime with N rate was statistically significant for herbage and oil yield (Table 2). The treatment combination of 0.75 IW : CPE ratio along with 200 kg N ha^{-1} gave significantly higher yield than lower application rates. This may be ascribed to the proliferation of root biomass resulting in higher absorption of nutrients and water from soil resulting in higher biomass production (Taylor & Klepper 1978; Hamblin 1985). Similar result was reported by Singh *et al.* (1996) in Java citronella. Content and quality of oil were not influenced by irrigation and nitrogen doses (data not presented). Water use efficiency (WUE) of sweet basil was lowest at 0.75 IW : CPE ratio (0.196 kg oil ha^{-1}mm^{-1} water used) compared with that of 0.25 IW : CPE (0.337 kg oil ha^{-1}mm^{-1} water used). Similar results were reported in sugarcane and Java citronella (Yadav & Prasad 1988; Singh *et al.* 1996). The highest WUE with increased N rate may be due to higher production. It is obvious that application of high rates of N plays a key role in producing luxuriant growth under adequate moisture conditions leading to higher oil yield.

The study thus indicated that sweet basil, irrigated at 0.75 IW : CPE ratio with the application of 200 kg N ha^{-1}, gave maximum herbage and oil yields.

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