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Influence of Soil Sodicity on Growth, Oil Yield and Nutrient Accumulation in Vetiver (*Vetiveria zizanioides*)

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Abstract : Vetiver (*Vetiveria zizanioides*) was grown for 18 months in artificially prepared sodic soils having pH from 8.0 to 11.0. Herb and oil yield of vetiver were not significantly affected upto pH 9.5. Soil pH did not influence oil content. Accumulation of N and K did not decrease upto pH 9.5, whereas, that of P declined beyond pH 9.0. Exchangeable sodium decreased due to cropping in all the soils. Electrical conductivity did not significantly change in soils having pH up to 9.0, above which, it increased. Soil pH decreased by 0.5 to 1.4 units from the initial value due to cropping.

Key words : Sodic soils, herb, vetiver, exchangeable sodium, essential oil.

Some aromatic grasses withstand soil salinity and alkalinity to a considerably higher level, as compared to traditionally grown agricultural crops (Singh and Anwar, 1985; Anonymous, 1992). Palmarosa (*Cymbopogon martinii*) and lemon grass (*Cymbopogon flexuosus*) have been observed to tolerate soil salinity of 10-12 dS m^{-1} and soil pH upto 9.5-10.0 (Singh and Anwar, 1985). These crops can be grown in problem soils with marginal inputs, without any significant deleterious effect on the yield and quality of the produce. Vetiver (*V. zizanoides* (Linn) Nash), popularly known as 'Khus', has been reported to withstand soil alkalinity. It has been reported that periodical water logging and higher soil pH (9.5-10.0) do not adversely affect the yield and quality of vetiver oil. Vetiver yields essential oil on steam distillation of roots and the oil is widely used in perfumery and cosmetic industries as a fixative or an odour contributor. Roots are often woven in to screen mats, fans etc., to mitigate heat during summer and these retain their delightful fragrance for long periods, specially when water is sprinkled. Besides, 'khus' oil has some medicinal value as well. The present study was undertaken to investigate the effect of soil alkalinity on growth and oil yield of vetiver.

Materials and Methods

The soil used was an Entisol having pH, 7.5 (water 1:2.5); Ec, 0.30 dS m^{-1}; Na, 73 m mol L^{-1}; Ca + Mg, 90 m mol L^{-1}; $CO_3^{=}$ + HCO_3, 3.40 m mol L^{-1} and free $CaCO_3$, 0.6 m mol L^{-1}. The graded levels of soil pH were developed by treating the air dried soil (< 2 mm) with 0.535 N $NaHCO_3$ solution as described by Bains and Fireman (1964) for the development of different ESP of soil. The pH developed were, 8.0, 8.5, 9.0, 9.5, 10.0 and 11.0 and the corresponding ESP levels were, 22.7, 27.5, 53.0, 56.5, 71.4, 82.0 and 88.0, respectively. 10 kg soil, in triplicate, of each pH level (control, 7.5, 8.0, 8.5, 9.0, 9.5, 10.0, 10.5 and 11.0) were taken in 10 L ceramic pots (dia. 30 cm) having no provision of lateral or vertical drainage. One third of the prescribed doses of N, and full P and K were applied and one slip of vetiver was planted in July 1989. The remaining por-

Table 1. Influence of soil pH on dry matter and oil yield of vetiver

Soil pH	Dry matter yield (g pot^{-1})		Oil yield (ml plant^{-1})
	Shoot	Root	
7.5 (Control)	1259	172.8	0.78 (0.45)*
8.0	1643	181.2	0.85 (0.46)
8.5	1486	161.3	0.74 (0.45)
9.0	1405	159.8	0.72 (0.45)
9.5	1373	143.5	0.64 (0.45)
10.0	1100	109.1	0.50 (0.46)
10.5	917	91.9	0.42 (0.46)
11.0	785	66.7	0.31 (0.46)
CD (P = 0.05)	36	15.3	0.14

* Figures in parenthesis represent % oil content in roots.

tion of N, in two equal splits, was applied after six and twelve months of planting and the crop was harvested after eighteen months during December 1990. Roots were excavated and fresh and dry weight of shoots was recorded. The oil was extracted by hydrodistillation of air dried roots. The contents of major and minor nutrients in the plants, and ionic composition of soil was estimated following standard chemical procedures as described in Jackson (1973) and Piper (1966).

Results and Discussion

The root and shoot dry matter and oil yield were not significantly influenced as the pH of the soil increased from 7.5 to 9.0, beyond which, it declined (Table 1). The shoot dry matter yield, on the other hand, increased with increasing pH up to 9.5. Similarly, oil content in plant did not exhibit any adverse effect of increased soil pH and oil yield did not significantly change over control up to pH 9.0. A comparison of the data reveals that shoot and root dry matter yield, as well as oil yield, were highest with soil pH 8.0. The extent of increase in shoot dry matter yield in increasing soil pH, over control, were 30, 18, 12 and 9% at pH 8.0, 8.5, 9.0, 9.5, respectively. Similarly, the extent of reduction in oil yield, over control, due to increasing soil pH, were 18, 36, 46 and 60% at pH 9.5, 10.0, 10.5 and 11.0, respectively. Similar observations were also made by Singh *et al.* (1987) who observed that high soil pH (9.0) and waterlogging have favourable influence on herb and oil yield of vetiver.

Table 2. Influence of soil pH on nutrient accumulation by vetiver

Soil pH	Nutrient accumulation (g plant^{-1})		
	Nitrogen	Phosphorus	Potassium
7.5 Control	17.37 (1.38)*	2.69 (0.214)	15.86 (1.26)
8.0	23.82 (1.45)	3.09 (0.188)	20.04 (1.22)
8.5	19.17 (1.29)	2.80 (0.189)	18.28 (1.23)
9.0	18.27 (1.30)	2.09 (0.149)	16.86 (1.20)
9.5	16.29 (1.28)	1.85 (0.135)	16.34 (1.19)
10.0	13.86 (1.26)	1.39 (0.126)	12,98 (1.18)
10.5	11.64 (1.27)	1.13 (0.123)	10.45 (1.14)
11.0	8.63 (1.10)	0.96 (0.122)	8.79 (1.12)
CD (P = 0.05)	1.99 (0.05)	0.02 (0.006)	0.23 (0.06)

* Figures in parenthesis represent concentraion in per cent.

Table 3. Ionic composition and some physico-chemical characteristics of the soil after the harvest of vetiver

Soil pH	(Ions m mol L^{-1})			EC (1:2.5) (dS m^{-1})	pH (1:2.5)
	Na^+	$Ca^{++}+Mg^{++}$	$CO_3^{-}+HCO_3^{-}$		
7.5 (Control)	69.09 (74.72)*	80.80	3.00	0.27	7.2
8.0	83.46 (87.64)	86.44	4.66	0.35	7.5
8.5	86.79 (89.92)	110.88	5.28	0.37	8.0
9.0	100.1 (108.9)	124.86	7.34	0.38	8.3
9.5	114.7 (122.5)	136.48	7.85	0.39	9.0
10.0	118.6 (125.4)	150.90	8.54	0.40	9.3
10.5	132.1 (135.9)	164.10	8.78	0.41	9.5
11.0	147.6 (152.5)	172.72	10.34	0.43	9.6
SEm±	1.32	4.42	0.808	0.042	0.25
CD (P=0.05)	3.98	13.44	1.44	0.123	0.75

* Figures in parenthesis represent original status.

Tissue concentration of nitrogen and phosphorus decreased significantly over control with increase in soil pH. The N content was, however, significantly higher in plants grown at pH 8.0 than that in control (pH 7.5). The K content, at higher pH was, however, not significantly different from that in control up to pH 9.0, but declined thereafter.

Accumulation of N in plants increased by about 37% over that in control at pH 8.0 and remained unchanged (from that in control) as pH further increased to 9.0, beyond which, it declined. Like nitrogen, both phosphorus and potassium uptake were highest at pH 8.0. Phosphorus uptake recorded an increase up to pH 8.5 over control, but decreased when pH of the soil further increased. The K uptake, on the otherhand, significantly increased over control at pH 9.5 and above.

Results on the estimates of ions, pH and Ec after harvest of vetiver indicate that ammonium acetate exchangeable sodium content in soil significantly decreased due to cropping; both Ca+Mg and CO_3+HCO_3 decreased marginally from the original values (data not given). Electrical conductivity of the soil, which was originally maintained at 0.28 dS m^{-1}, did not significantly change in soils having pH up to 9.0 after harvest of the crop. However, it significantly increased in the remaining soils at pH 9.5 and above. The pH of the soils reduced by 0.5 to 1.4 units, from the original values, due to cropping. The extent of decrease has been 0.35 unit in control to 1.40 unit in soil having original pH 11.0. The reduction in soil pH may be due to higher removal of Na by the crop as well as due to release of organic substances which help in removing exchangeable Na through dissolution of the native $CaCO_3$ of the soil.

Vetiver withstands soil alkalinity to a higher degree (pH 9.5) as compared to other crops. It could be successfully tried for utilization of sodic wastelands having ESP as high as 55, which are not suitable for cultivation of

common agricultural crops. Similarly, its capability to adjust in soils having higher Na and other ions that give rise to adverse soil conditions and higher removal of such ions would be helpful in ameliorating sodic soils. Detailed field investigations are, however, necessary to support these findings.

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