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PRODUCTIVITY AND NUTRIENT CONCENTRATION OF FENUGREEK (*TRIGONELLA FOENUM-GRAECUM* L.) INFLUENCED BY DIFFERENT RSC WATERS AND ZINC FERTILIZATION

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ABSTRACT

A pot experiment was conducted to evaluate the effect of different RSC (Residual Sodium Carbonate) waters and zinc fertilization on soil properties, and yield of fenugreek on loamy sand soil during. The experiment comprising 12 treatment combinations replicated three times was laid out in completely randomized block design with four levels of RSC water (control, 2.5, 5.0 and 7.5 mmol/L) and three levels of Zn (0, 10 and 20 mg $ZnSO_4$/ha soil). Results revealed that less than 7.5 mmol/L RSC of irrigation water, the ECe, content of different fractions of soil Zn and available soil Zn was decreased significantly, while pH and ESP of soil increased significantly. The seed and straw yield of crop, P/Zn in straw and Ca/Mg ratios of seed and straw decreased significantly with all levels of RSC of irrigation water. While, Na + K/Ca and Na/Ca ratio of seed and straw increased significantly. P/Zn and Fe/Zn ratios of seed also increased significantly. The increasing level of zinc significantly increased the seed and straw yield of crop, Ca/Mg ratio of seed and straw. While P/Zn, Zn/Fe, Na/K, Na + K/Ca and Na/Ca ratios of seed and straw were decreased significantly.

Keywords:
RSC waters, zinc, ESP, Chemical fractions.

INTRODUCTION

Fenugreek (*Trigonella foenumgraecum* L.) popularly known as “Methi” is an important condiment crop grown in northern India during *rabi* season. It occupied prime place amongst the seed spices grown in northern India particularly in Rajasthan. In many parts of the arid and semi-arid regions, ground water is either the major or the only source of irrigation. The salinity and sodicity of soil and inadequate supply of water, that too of poor quality, are some of the severe problems faced by the farmers of arid and semi arid regions, which leads to unsatisfactory returns from their lands. Most of the ground water is highly saline and also has high residual sodium carbonate (RSC) which is also a serious problem. Amongst the various categories of poor quality waters, alkali water have greater irrigation potential by virtue of these low salinity and amenability for reclamation especially in semi-arid an arid regions of north-west India where their occurrence in ground waters is around 30-54 per cent (Minhas and Bajwa, 2001).

Scarcity of good quality water in these regions often forces the farmers to use available poor quality water for irrigation. High RSC irrigation water is characterized by low total salt concentration. The relative proportions of calcium and magnesium salts are much smaller as compared to sodium salts. Such waters usually have sodium carbonate as a predominant salt. The prolonged use of such water immobilizes soluble calcium and magnesium in the soil by precipitating them as carbonates. The increased exchangeable sodium percentage (ESP) resulting from their long term use leads to break down of soil structure due to swelling and dispersion of clay particles. Chemical degradation by salinization (5.50 M ha) and alkalization (4.50 M ha) is reported to extend to 10.00 M ha (Tomar, 2005) of which Rajasthan occupies 1.18 M ha (Sen, 2003) and the problem is increasing at an alarming rate in arid and semi-arid region. Distribution of various chemical fractions of Zn depends upon several factors such as inherent ability of soil to maintain supply the element, soil management practices and various physico-chemical properties of soil.

When Zn is applied to soil from external sources to correct deficiency, it undergoes transformation to various chemical pools, the nature and magnitude of which, may however, differ across soils, depending on physico-chemical properties and the associate environmental conditions. Its deficiency generally occurs in soil having coarse texture, high pH, high $CaCO_3$ and low organic carbon content (Sakal, 2001). The continuous use of high RSC water increases the ESP of soil and pH which decreases the availability of zinc. Concentration of Zn in soil solution has been shown to be a function of the solubility of Zn minerals as a function of pH. Zinc in soil solution increases as pH of the soil solution decreases, which has been attributed to increased solubility of soil Zn minerals (Lindsay, 1972). The knowledge regarding the distribution of Zn fractions in soil helps in understanding the contribution of individual Zn fraction to plant availability. Zinc

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applied to the soil reacts with soil constituents, forms a number of sparingly soluble compounds, which together determine the concentrations of Zn in soil solution and its availability to plants.

MATERIALS AND METHOD

Pot experiment on Fenugreek was conducted at cage house S.K.N. College of Agricultrue, Jobner, Rajasthan. The soil was loamy sand with pH 8.4, available N 118.10 kg/ha, P 13.25 kg/ha and K 152.18 kg/ha. The treatments comprised of four levels of RSC water (control, 2.5, 5.0 and 7.5 mmol/L) and three levels of Zn (0, 10 and 20 mg $ZnSO_4$/ha soil) and were laid out in completely randomized block design. The fenugreek seed of variety RMt-1 was treated with bavistin @ 3 g/kg seed to control seed borne diseases. 10 treated seeds per pot were sown on 8^{th} November, 2005 and after germination, only three plants per pot were maintained. The annual rainfall of locality ranges between 400 to 500 mm.

RESULTS AND DISCUSSION

A marked decrease in ECe of soil has occurred as a result of an increase in levels of RSC in irrigation water. However the pH and ESP of soil increased with increasing levels of RSC in irrigation water (Table 1). The observed decrease in ECe due to application of RSC rich waters may be attributed to the fact that amount of Ca and Mg in the soil solution decreased owing to its precipitation as carbonates and conversion of soluble Na to adsorbed state have decreased the electrolyte concentration in the soil solution and thereby decreased the ECe of soil. The low degree of observed salinity at higher RSC level is perhaps, due to the precipitation of alkaline earth was also reported by Chouhan *et al.* (1988). Increase in pH and ESP of the soil due to use of different RSC water for irrigation is attributed to an increased sodicity and decreased activity of Ca in irrigation water because of precipitation of Ca and Mg as carbonates providing more opportunity for Na to be adsorbed on the exchange complex. Increasing levels of RSC waters on P/Zn and Fe/Zn ratio in seed increased significantly, while, P/Zn ratio in straw decreased significantly (Table 2). The trend of increase or decrease in these ratio with increasing levels of RSC might be due to decreased translocation of Zn with higher level of RSC water in upper parts of the plant due to physiological disorder induced by high pH and excessive accumulation of HCO_3 in soil as a consequence of irrigation with high RSC waters. It is supposed that abundant HCO_3 ions in root medium, the ionic form of Zn cation is changed to its hybroxide form which is insoluble and not available to the plants thereby lower concentration of Zn resulted into higher P/Zn and Fe/Zn ratio in seed. Soils characterized by high pH are generally associated with the occurrence of Zn and P deficiencies as attributed to their adsorption and/ or precipitation into the products of lower solubility was also stated by Yadav (1992). Seed and straw yield of fenugreek significantly decreased with increasing levels of RSC water (Table 1). This may be explained on the basis that increasing levels of RSC water increased the ESP and pH of soil resulting into decreased availability of P, K, Ca, Zn and Fe but increased the uptake of Na which is toxic element. The higher amount of Na may adversely affect the physiological, metabolic and enzymatic activities and utilization of photosynthates in plant.

Table 1 Effect of different RSC Waters and Zinc Fertilization on ECe, pH and ESP of soil and yield of fenugreek

Treatment	ECe (dS/m)	pH	ESP	Seed yield (kg/ha)	Straw yield (kg/ha)
RSC waters					
W_1	3.00	8.03	17.21	12.59	24.67
W_2	2.81	8.22	18.31	11.51	21.68
W_3	2.46	8.52	19.81	9.92	18.37
W_4	2.21	8.92	21.01	7.52	12.85
CD (*P*=0.05)	0.240	0.291	1.15	0.429	0.810
Zinc levels					
Zn_0	2.36	8.53	19.25	8.52	15.01
Zn_{10}	2.58	8.43	19.15	10.40	19.46
Zn_{20}	2.91	8.30	18.85	12.24	23.66
CD (*P*=0.05)	0.208	NS	NS	0.371	0.702

NS= Non significant

Increasing levels of Zn to the soil significantly increased the ECe of soil but did not affect the pH and ESP significantly. This suggests that Zn does not have any significant role in improvement of physico-chemical properties of soil. Similar results were reported by Singhal and Rattan (1999) and Singh (2001). The ratios of P/Zn and Fe/Zn in seed of fenugreek decreased with increasing levels of zinc (Table 2). The decrease in P/Zn ratio in seed and straw could be due to the antagonistic relationship between Zn and P.

The increased concentration of the zinc created hindrance in the absorption and translocation of P from roots to the above parts. The trend of variation in P/Zn ration indicated increased accumulation of Zn with higher level of Zn application in upper parts of the plant. Higher P/Zn ratio in seed as compared to straw is mainly due to higher P accumulation in farmer than in the latter. The results obtained gets support from the findings of Gupta and Gupta (1984), Singh *et al.* (1988) and Reddy and Yadav (1994).

Table 2. Effect of different RSC waters and zinc levels on Na/K, Ca/Mg, Na+K/Ca and Na/Ca, P/Zn and Fe/Zn ratio in seed and straw

Treatments	Na/K		Ca/Mg		Na+K/Ca		Na/Ca		P/Zn		Fe/Zn	
	Seed	Straw	Seed	Straw	Seed	Straw	Seed	Straw	Seed	Straw	Seed	Straw
RSC waters												
W_1	0.347	0.350	1.899	8.512	5.627	2.420	1.448	0.638	172.04	84.37	5.587	14.564
W_2	0.359	0.373	1.876	8.102	5.684	2.624	1.500	0.725	173.76	82.61	5.701	14.432
W_3	0.393	0.444	1.838	7.856	5.900	2.845	1.662	0.889	182.95	80.10	6.184	14.353
W_4	0.464	0.558	1.738	7.353	6.233	3.134	1.972	1.142	201.14	79.95	7.224	14.209
CD (*P*=0.05)	0.016	0.018	0.040	0.351	0.185	0.098	0.055	0.035	7.58	2.90	0.185	NS
Zinc levels												
Zn_0	0.424	0.456	1.810	6.989	6.000	3.176	1.791	1.007	247.39	110.72	7.326	17.531
Zn_{10}	0.395	0.438	1.833	7.955	5.802	2.700	1.647	0.837	176.59	82.35	6.091	14.431
Zn_{20}	0.354	0.399	1.870	8.923	5.718	2.429	1.498	0.701	132.13	59.26	5.106	11.206
CD (*P*=0.05)	0.014	0.016	0.035	0.304	0.160	0.085	0.048	0.031	6.57	2.51	0.160	0.50

The Fe/Zn ratio decreased in seed of fenugreek with increasing levels of zinc because of higher concentration of zinc due to zinc application resulted into increased Zn/Fe ratio in plant parts. The results get supports from the findings of Singh and Mittal (1986). Significant improvement in seed and straw yield was observed with increasing levels of applied zinc (Table 1). The favourable influence of applied Zn on these characters may be explained to its catalytic or stimulatory effect on most of the physiological and metabolic process of plants. The increase in yield might be due to role of Zn in biosynthesis of indole acetic acid (IAA) and especially due to its role in initiation of primodia for reproductive parts and partitioning of photosynthates towards them.

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