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Effect of Pyrite on Growth and Yield of Pearl Millet-Wheat Cropping System under Sodic Environment

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ABSTRACT

A field experiment was carried out during 1999-2000 and 2000-2001 on sandy loam soil to evaluate the effect of pyrite on growth and yield of pearl millet -wheat cropping system. The experiment consisted of nine treatments of Residual Sodium Carbonate (RSC) waters viz., 5, 10, 15, 20 meL^{-1} Na_2CO_3 and 5, 10, 15, 20 meL^{-1} $NaHCO_3$ and no RSC water (control) and three levels of pyrite (0, 5 and 10 t ha^{-1}). Plant height, dry matter production, grain and straw yields of pearlmillet and wheat decreased with increase in the levels of RSC water. Relatively lower uptake of calcium owing to high concentration of exchangeable sodium caused the adverse effect of sodium uptake on plant growth in sodic soil. After two year crop cycle, reduction in ECe, pH and ESP and improvement in hydraulic conductivity of soil was more with pyrite than 5 and 10 t ha^{-1} higher pyrite levels had more favourable effect on plant growth in that it increased the availability of nutrients to the plants and improved the physical condition of the soil. Soil application of pyrite @ 10 t ha^{-1} was therefore found to be the best treatment.

Key word: RSC, SAR, ESP, Pyrite, Nutrients

Introduction

Sodic soils, pose serious problem for crop production owing to their poor physical and chemical properties. Several amendments, including acid and non-acid forming materials have been used to improve soil properties (Oster, 1982). However, despite the addition of soil amendments the concentration of the resulting soil solution still remains too low to achieve rapid replacement of the sodium. To shorten the time for reclamation, there is need to increase the permeability of soil by enhancing the electrolyte concentration of the applied water (Dubey, 1994).

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The pearl millet-wheat is a traditional, popular and irreplaceable cropping system in the Agra region of southwestern Uttar Pradesh. Farmers of this region often suffer from the problem of salt affected soil and poor quality of the ground water with particularly high RSC and Sodium Adsorption Ratio (SAR). Since, the use of such ground water is unavoidable in this area, crop productivities are adversely affected. Addition of Gypsum is widely recommended for the reclamation of sodic soils, however, meager information is available on the effect of pyrite on physico- chemical properties of sodic soil and growth and productivity of pearlmillet-wheat cropping system. Hence, the present investigation was carried out.

Materials and Methods

A field experiment was carried out at research farm of RBS College, Bichpuri, Agra during 1999-2000 and 2000-2001 to evaluate the permissible limit of RSC waters for successful cultivation of pear millet-wheat crop sequence. The experiment consisted of nine treatments of RSC waters viz., 5, 10, 15, 20 meL^{-1} Na_2CO_3 and 5, 10, 15, 20 meL^{-1} $NaHCO_3$ including no RSC water (control) and three levels of pyrite (0, 5 and 10 tha^{-1}) were imposed in randomized block design with four replications. The soil of the experimental site was sandy loam in texture having pH 8.5, EC 2.1 dSm^{-1}, CEC 9.5 me/g soil and water soluble cations as Ca^{++}, Mg^{++}, Na^{+} and K^{+} with 2.2, 3.0, 15.0 and 0.49 meL^{-1}, respectively along with anions as CO_3^{-} and HCO_3^{-}, Cl^{-} and SO_4^{2-} as 1.0, 6.0, 9.0 and 4.4 meL^{-1} concentration at 0-15 cm of soil depth. The plots were separated from each other by providing strong bunds of 50 cm width which also had polythene sheet inserted to a depth of 90 cm to check the lateral movement of water. The recommended doses of N, P, and K were given to pearlmillet (80: 40: 40 kg ha^{-1}) and wheat (120: 60: 60 kg ha^{-1}) through urea, single super phosphate and muriate of potash, respectively. The crops were raised under irrigated condition (2 irrigation to pearl millet and 5 to wheat) with varying quality of irrigation water. Pearlmillet and wheat were sown during third week of July and third week of November respectively and harvested during third week of October and third week of April, respectively during 1999-2000 and 2000-2001. Pearlmillet was sown in rows 30 cm apart using seed rate @ 5 kg ha^{-1}. Crop was thinned at 15 days after sowing by removing overcrowded and weak plants and plant to plant distance of 15 cm was maintained. Wheat was sown in row spacing of 20 cm apart using 100 kg ha^{-1} during both the years.

Results and Discussion

Pooled data, presented in Table 1, shows that plant height, tillers per m^2 , dry matter production of both pearl millet and wheat crops decreased

Table 1. Effect of RSC Irrigation water and pyrites levels on the growth, yield attributes and yield of pearl millet-wheat system (pooled data)

Treatments RSC (meL^{-1}) levels & sources		Plant height (cm)		Dry matter production/plant (g)		Shoots/tillers & per row length		Grain yield (qha^{-1})		Stover/straw yield (q ha^{-1})	
		Pearl millet	Wheat	Pearl millet	Wheat	Pearl millet	Wheat	Pearl millet	Wheat	Pearl millet	Wheat
Control		178.9	85.0	178.1	139.0	15.1	78.9	25.1	40.6	109.7	56.3
5	CO_3HCO_3	178.1	84.6	177.1	138.4	17.7	77.4	24.8	39.1	110.1	57.4
		178.0	84.9	177.5	138.3	14.7	77.6	24.9	39.6	109.5	56.6
10	CO_3HCO_3	175.5	83.8	175.6	136.6	13.8	74.6	24.4	37.9	108.9	55.5
		177.4	84.0	175.5	136.5	14.1	74.9	24.5	39.2	109.4	55.1
15	CO_3HCO_3	169.5	82.2	169.0	132.3	13.0	70.0	23.7	34.5	106.9	52.7
		170.5	82.0	171.4	136.4	13.3	71.5	23.8	34.7	107.0	52.9
20	CO_3HCO_3	161.8	77.2	163.1	120.6	11.1	65.8	21.3	31.2	102.7	50.2
		162.5	78.6	164.5	124.1	11.8	67.3	21.4	31.4	101.5	50.3
LSD(P=0.05)		11.26	8.50	12.40	16.40	4.30	12.40	2.30	3.01	6.80	4.50
Pyrites levels (t/ha)											
Control		178.4	84.2	177.5	130.3	14.9	78.9	25.0	39.6	109.7	56.3
5		179.9	85.9	180.1	140.0	15.7	79.8	26.9	42.3	111.3	57.5
10		181.5	86.8	182.5	141.5	16.8	80.9	28.1	43.9	113.5	59.6
LSD(P=0.05)		1.5	1.6	2.4	6.5	0.6	0.8	1.3	2.6	1.6	1.2

Table 2. Effect of RSC water and pyrites levels on the soil chemical properties at the end of experiments (pooled data)

Treatments RSC (meL^{-1}) levels & sources		pH (1:2.5 soil water suspension)	ECe (dSm^{-1})	Hydraulic Conductivity	SAR (mel^{-1})	ESP	Cationic composition in saturation extract			
							Na	K	Ca^{++}	Mg^{++}
Control		8.5	2.1	1.61	10.3	10.9	17.0	0.30	1.8	2.3
5	CO_3HCO_3	8.6	3.8	1.48	20.1	17.2	27.2	0.28	3.3	8.1
		8.5	4.0	1.55	23.0	16.2	28.9	0.29	3.8	8.2
10	CO_3HCO_3	8.7	3.9	1.38	23.8	22.0	29.2	0.20	2.9	7.8
		8.6	4.2	1.49	24.3	20.0	32.2	0.22	3.0	7.9
15	CO_3HCO_3	8.9	3.6	1.25	31.4	29.0	31.3	0.16	1.8	4.9
		8.8	4.3	1.33	27.8	27.5	33.8	0.18	2.8	6.1
20	CO_3HCO_3	9.1	3.1	1.10	32.9	32.6	26.9	0.15	1.9	3.0
		8.9	3.6	1.20	30.5	30.5	28.5	0.16	2.6	3.9
Pyrites levels (t ha^{-1})										
Control		8.5	2.4	1.62	10.9	11.9	15	0. 41	2.0	2.2
5		8.4	2.3	1.65	9.5	11.2	13	0. 43	2.4	3.3
10		8.2	2.1	1.68	9.8	10.3	11	0. 45	3.2	4.1

significantly at 15 or 20 meL^{-1} levels of RSC water over control. The reduction in these growth attributes might be to due to maximum accumulation of sodium salts in irrigation waters (Minhas *et al.*, 1995).The reduction in all these growth attributes was more pronounced under carbonate than bicarbonates RSC.

Yield attributes- ear length, number of grains/ ear, weight of grain/ear, 1000- grain weight and grain and stover/straw yields of pearl millet and wheat reduced significantly with increasing RSC values. The lowest values of these characters were recorded at 15 and 20 meL^{-1} RSC values over control, irrespective of sources. The reduced yield characters were attributed to higher values of ESP attained in soil and adverse effect of excessive amount of free CO_3^{--} and HCO_3^{-} ions (Manchanda *et al*., 1998). The reduction in grain yield of pearl millet and wheat was 15.2 and 23.2 per cent, respectively due to 20 meL^{-1} Na_2CO_3 RSC water over control (Table 1). However, the differences in grain yields of both the crops due to presence of carbonate or bi-carbonate ions at 10 meL^{-1} of RSC water and control treatment were non significant. Reduction in grain and stover yield at increased levels of RSC water may be attributed to increased pH and RSC which in turn, caused nutritional imbalance, resulting in to reduced growth and yield attributes. Similar, results were also reported by Padole *et al,*. 1995. Application of pyrite @ 10 t ha^{-1} was found superior over control for both crops as also reported by Prasad *at al*., 1982. Increase in plant growth at higher levels of pyrite application may be attributed to the increase in nutrient availability and improvement in the physical conditions of the soil. As expected, exchangeable sodium also increased uniformly down the soil. The profile after sufficient time has elapsed for the surface applied pyrite to dissolve and moves in the percolating rainwater magnesium sodium and exchangeable sodium percentage was reduced (Table 2). Ear length, number of grains/ear and grain weight/ear and dry matter production increased with increase in levels of pyrite in both the crops.

Conclusion

From the above study, it is concluded that soil application of pyrite @ 10 t/ha to sodic soils proved best. Further 10 meL^{-1} RSC of irrigation water can be used without any significant reduction in grain yields of pearl millet-wheat cropping system in western parts of Agra.

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