Effect of Iron-Pyrites and Rhizobium Inoculation on Number of Nodules, Nitrogen and Protein Content in Black Gram under Sodicity Stress Condition

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Abstract

The experiment revealed that Rhizobium inoculation of seeds and application of iron pyrites @ 50 g pot^{-1} increased the number of root nodules upto 33.33% over the control conditions even when irrigated with RSC water of 2.5 meL^{-1}. With the same combinations the protein content increased upto 2.3% and nitrogen content increased to 2.4% over the control. On the contrary, these values decreased significantly over control when at the same treatment when irrigated with RSC water of 7.5meL^{-1}, the number of nodules decreased upto 11.13% showing that the process of nodulation is dependent on the soil pH. The protein and nitrogen contents decreased upto 1.88% in the uninoculated treatment that was irrigated with 5 meL^{-1} and 50 g pyrites pot^{-1}.

Key words: *Nodules, pyrites, RSC, nitrogen, protein.*

I. INTRODUCTION

Salinity is the limiting factor for crop productivity which is the major problem in arid and semi-arid regions irrigated with underground water containing load of soluble salts. Accumulation of salts is also a problem encountered in the arid regions. It is also encountered in low lying and poorly drained areas in subhumid and semiarid zones. Broadly, high water table followed by tropical aridity seem to be the major factors responsible for development of salinity and sodicity in the soil. Salinity affects all major processes such as growth, photosynthesis, nitrogen fixation, protein synthesis and metabolic processes. Such soil conditions may result in poor yields especially in legume which is a relatively salt sensitive family with little tolerance for salinity. Legumes are most succeptible to salinity at seedling stage. This reason also accounts for the marginal shortfulness of legume production in India. With the deteriorating soil and water quality around the globe there is an urgent need to raise the plants with better suitability towards changing environment. Various efforts are being employed to overcome the problem and Singh et al[2] (1999) reported that incorporation of pyrites as an ameliorating agent neutralizes the ill effects of salinity and increases the availability of nutrients and hence its uptake.

Legumes are also known for their ability to fix atmospheric nitrogen into a form which is usable by the plants with the help of naturally occurring symbiotic *Rhizobium* bacteria in the root of leguminous plants. These bacteria thrive well in neutral or slightly acidic pH. *Rhizobium* produces plant growth substances such as indole derivatives, cytokinins and traces of gibberellic acid. Virendra Sardana[1] (1997) reported that the response of this colonial bacteria is in the form of nodule clusters on the tap root of the plant which are red or pink due to leghaemoglobin which is associated with nitrogen fixation. In arid and semi-arid regions the soil is deficient in nutrients and poor nodulation occurs due to low population of naturally occurring Rhizobium in the soil. The seeds can be inoculated with a culture of Rhizobium and shows significant enhancement in nodulation. Nodulation directly affects nitrogen and protein content of the plant since they are related to the bio-chemical efficency of the plant.

II. METHOD AND MATERIAL

A pot experiment was laid down in the School of Chemical Sciences, Chemistry

Dept., St. John's College, Agra, using factorial randomized block design and replicated thrice using black gram (*Vigna mungo L.*) C.V. Pant.U-19 as the test crop. The experiment consisted of four levels of RSC water viz. R_0(0 meL^{-1}), R_1(2.5 meL^{-1}), R_2(5.0 meL^{-1}) and R_3(7.5 meL^{-1}) and three levels of pyrite viz. S_0(0 gm pot^{-1}), S_1(25 gm pot^{-1}) and S_2(50 gm pot^{-1}) with and without rhizobium inoculation (I1, I0). The essential nutrients were supplied through basal application in the soil before sowing the test crop by applying urea, single super phosphate and muriate of potash @ 20, 40 and 60 g pot^{-1} containing 10 kg of soil each. Pyrite was incorporated through basal application before sowing as treatment. Inoculation of seeds was done and dropped at depth of about 6cm equally in all the pots. RSC water was prepared by dissolving the sodium salts containing carbonate and bicarbonate in the best available water. The pots were irrigated with RSC water after every 15 days. Control sets were irrigated with best available water (bore well water). The number of nodules was counted by randomly selecting five plants from each treatment at 45 DAS. Plant material samples were collected from each pot after harvest and analysed nitrogen content by Nesslers Reagent[3] method. The protein content was estimated by multiplying the Nitrogen percentage by factor of 6.25. The results obtained were subjected to statistical analysis with the help of variance.

Table 1 . Nodulation, N% and protein content of plant and grain as affected by various levels of iron pyrites in inoculated and uninoculated plants irrigated by varying levels of sodic water.

Treatments	No. of nodules at 45 DAS	N % in grain	Protein % in grain	N % in plant material	Protein % in plant material
$R_0S_0I_0$	15	3.7	23.4	1.19	11.94
$R_0S_1I_1.$	18	3.8	23.6	1.96	12.25
$R_0S_2I_0.$	16	3.7	23.4	1.90	11.88
$R_1S_0I_1.$	16	3.7	23.6	1.86	11.68
$R_1S_1I_0.$	15	3.6	22.6	1.83	11.44
$R_1S_2I_1.$	20	3.8	23.9	2.02	12.63
$R_2S_0I_0.$	12	3.6	22.5	1.78	11.13
$R_2S_1I_1.$	14	3.8	23.7	1.97	12.31
$R_2S_2I_0.$	12	3.6	22.9	1.80	11.25
$R_3S_0I_1.$	12	3.6	22.8	1.80	11.25
$R_3S_1I_0.$	11	3.5	21`.8	1.76	11.00
$R_3S_2I_1.$	13	3.7	23.1	1.82	11.40
CD at 5%	2.92	0.1	1.10	0.47	2.52
SEm ±	0.99	0.2	0.37	0.16	0.86

III. RESULT AND DISCUSSION

The results were subjected to analysis through variance. These results were compared by at the two levels of inoculation. In table 1, results show that sulphur application increased the nodulation by 6.66% when irrigated with best available water but irrigation with RSC water of 5 meL^{-1} decreased the nodulation by 20% over the control at all the levels of sulphur application. Similar trends were observed in nitrogen and protein contents. Maximum reduction n of 3.7% in both was observed when irrigated with 5 meL^{-1} without sulphur application. These results are in conformity with the observations of other workers like Chauhan[4] (1989) who previously reported legumes to be salt sensitive and irrigation with RSC reportedly reduced nodulation and hence nitrogen and protein content.

When inoculated plants were compared and it was observed that the nodulation increased upto 33.33% when supplied with sulphur and irrigated with 2.5meL^{-1} RSC water. With pyrite application there was an increase in the nitrogen and protein content as reported by Sonune[5] (2001) and it deteriorated at higher levels of RSC water as reported according to Somani[6] (1982). All the above mentioned parameters declined over the control at the highest level of RSC water i.e.7.5 meL^{-1} even with the incorporation of pyrites but without inoculation i.e. $R_3S_1I_0$. At this treatment, the average number of nodules were 11 per plant at 45 DAS, N% and protein in grain was recorded at 3.49% and 21.81% respectively and that of plant material was 1.76% and 11.0% resp. The maximum number of nodules was 20 at the same time in the treatment $R_1S_2I_1$ and nitrogen and protein content was 3.83% and 23.94% respectively in grain and 1.76% and 12.63% respectively in the plant material. It is clearly evident from the results that the irrigation of test crop with RSC water adversely affects nodulation and nitrogen content was significantly reduced over the control pots. On the contrary incorporation of pyrites as an ameliorating agent considerably neutralizes the adverse effects of RSC water at lower concentration i.e 2.5 and 5 meL^{-1} but higher concentrations could not be neutralized. This could be due to the increased concentration of carbonate and bicarbonate ions in the soil that reduces the availability of several nutrients to the plant and also increases the soil pH. And since Rhizobium flourish well under neutral or slightly acidic pH the adverse effect on nodulation increased with increasing levels of RSC water. The decrease in the tissue N content may be due to the reduced rate of urea mineralization in the presence of excess soluble carbonate and bicarbonate ions in the soil and there was a significant reduction in the N content with increasing levels of RSC water. With a decline in the nitrogen content there was a relative decrease in the protein content of the grain and plant material at higher levels of RSC water. It can be inferred from the foregoing observations that the incorporation of pyrites @ 50 gm pot^{-1} along with Rhizobium inoculation combines effectively to combat the ill effects of 2.5 meL^{-1} RSC water completely and enhances the plant metabolism.

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