Agri. Res. J. Kerala, 1974 12 (1) 49—55

# EFFECT OF SULPHUR IN PREVENTING THE OCCURRENCE OF CHLOROSIS IN PADDY SEEDLINGS*

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Chlorosis in the infant rice seedlings is one of the difficult problems to control in the alkaline calcareous soils of Udaipur and Kota regions in the State of Rajasthan and causes a large scale mortality of seedlings in the nursery. To ascertain whether the chlorosis in rice is due to a 'lack of sulphur' induced inactivation of iron or due to an actual deficiency of iron, and to evaluate the relative efficiency of commonly available sulphur and iron sources from the stand point of effectivenses and economy in preventing the iron chlorosis on calcareous soils, an experiment was conducted at the Agronomy farm of the College of Agriculture, University of Udaipur having representative clay loam calcareous soils for two consecutive years 1970-1971 and 1971-72.

## Materials and Methods

The treatments consist of a compination of 8 sulphur supplying and/or pH regulating materials 1. Elemental sulphur 2. $Fe_2 (SO4)_3$ 3. $Al_2 (SO4)_3$ 4. Cypsum and 5. $H_2$ So4, all applied at the rate of 500 kg sulphur per hectare, 6. Hcl, 7. $HNO_3$ on the $H_2 SO_4$ acid equivalent basis, and 8. No treatment with *1* levels of EDDHA (sequestrene 138 Fe to provide 0 and 2 kg Fe/ha) with 0 and 1 kg S/50 kg seed for coating of seeds. The experiment was laid out in a randomised block design with 4 replications. The soil has a pH of 8.5 but has neither soluble salts nor exchangeable sodium concentrations, Determination of N, P, K, S, Ca and Mg, Fe and chlorophyll contents and measurement of the pH of the leaf sap at 30 days after sowing, survival percentage of seedling and their dry matter producing ability were used as criteria for treatment evaluation.

## Results and Discussion

Data (Table 1) show that application of elemental sulphur significantly incresed N, P, K and S contents of seedlings and chlorophyll content of their

* Part of Ph. D. thesis approved by the University of Udaipur

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Table 1

**Effect of soil applied chemicals and seed treatment on**

Whole tissue basis

| Treatments | Nitrogen (%) 1970-71 | Nitrogen (%) 71-72 | Phosphorus (%) 1970-71 | Phosphorus (%) 71-72 | Potassium (%) 1970-71 | Potassium (%) 71-72 | Sulphur (%) 1970-71 | Sulphur (%) 71-72 |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | 'a' |
| Control | 3.43 | 2.55 | 0.262 | 0.264 | 2.85 | 2.76 | 0.092 | 0.105 |
| Elemental sulphur | 4.62 | 4.15 | 0,287 | 0.303 | 3.30 | 3.17 | 0.182 | 0.162 |
| Sulphuric acid | 3.79 | 3.79 | 0.261 | 0.258 | 2.98 | 2.98 | 0.128 | 0.124 |
| Hydrochloric acid | 3.35 | 3.52 | 0.271 | 0.279 | 2.97 | 2.86 | 0.118 | 0.121 |
| Nitric acid | 3.33 | 3.83 | 0.285 | 0.280 | 2.90 | 2.94 | 0,122 | 0.127 |
| Ferric sulphate | 4.64 | 4.13 | 0.305 | 0.307 | 3.12 | 3.12 | 0-163 | 0.161 |
| Aluminium sulphate | 4.30 | 3.88 | 0.338 | 0.357 | 3.10 | 3.20 | 0,154 | 0.155 |
| Gypsum | 3.45 | 2.37 | 0.273 | 0.304 | 2.85 | 2.74 | 0.112 | 0.125 |
| SEm ± | 0.14 | 0.17 | 0.009 | 0.009 | 0.01 | 0.05 | 0.003 | 0.005 |
| CD at 5% | 0.39 | 0.48 | 0.025 | 0.027 | 0.03 | 0.14 | 0.008 | 0.014 |
| | | | | | | | | . 'b' |
| No seed treatment | 3.59 | 3.40 | 0.265 | 0.273 | 2.91 | 2.91 | 0.130 | 0.131 |
| Seeds treated with sulphur | 4,14 | 3.80 | 0.305 | 0.315 | 3.06 | 3,10 | 0.138 | 0.139 |
| SEm ± | 0.06 | 0.05 | 0.004 | 0.006 | 0.01 | 0,03 | 0.002 | 0.002 |
| CD at 5% | 0.14 | 0.14 | 0.102 | 0,013 | 0,02 | 0.07 | 0,004 | 0.007 |
| | | | | | | | | V |
| No EDDHA | 3,84 | 3.52 | 0.280 | 0.285 | 2.99 | 2.95 | 0.134 | 0.134 |
| 2 kg Fe EDDHA | 3.88 | 3.58 | 0.290 | 0.303 | 3.02 | 2,98 | 0.134 | 0,136 |
| SEm ± | 0.06 | 0.05 | 0.004 | 0.006 | 0.01 | 0.03 | 0.002 | 0.002 |
| CD at 5% | NS | NS | NS | 0.013 | NS | NS | NS | NS |

chemical composition of rice seedlings 30 days after sowing

| Iron (%) | | Calcium + Magnesium (me/100 g) | | Leaf chlorophyll (mgm/g) | | Leaf sap pH | |
|---|---|---|---|---|---|---|---|
| 1970-71 | 71-72 | 1970-71 | 71-72 | 1970-71 | 71-72 | 1970-71 | 71-72 |
| 0.175 | 0.203 | 73,23 | 63.86 | 0.583 | 0.667 | 6,67 | 6.75 |
| 0.130 | 0.136 | 39.75 | 38.23 | 1,189 | 1,128 | 6.16 | 6.01 |
| 0,155 | 0.156 | 54.40 | 55.46 | 0.841 | 0.714 | 6,33 | 6.28 |
| 0.171 | 0.175 | 58,70 | 59.03 | 0.870 | 0.651 | 6,38 | 6.53 |
| 0.185 | 0.164 | 58.88 | 57.90 | 0.877 | 0.779 | 6.42 | 6.58 |
| 0.140 | 0.141 | 35,78 | 42.71 | 1.204 | 1,263 | 6.20 | 5.98 |
| 0.136 | 0.147 | 40.43 | 39.69 | 1.160 | 1.007 | 6.30 | 6.24 |
| 0.195 | 0.185 | 72.30 | 68.41 | 0.792 | 0.978 | 6.29 | 6.66 |
| 0.007 | 0.006 | 2.32 | 3.52 | 0.046 | 0.052 | 0.09 | 0.04 |
| 0.020 | 0.017 | 6.55 | 9.96 | 0,130 | 0.151 | 0.26 | 0.10 |
| 0.174 | 0,177 | 55,17 | 57.11 | 0.809 | 0.733 | 6.39 | 6.40 |
| 0.148 | 0.150 | 53.19 | 48.30 | 1.071 | 1.064 | 6.40 | 6.36 |
| 0.004 | 0.003 | 1.15 | 1.76 | 0.023 | 0.026 | 0.05 | 0.02 |
| 0.010 | 0.008 | NS | 4.98 | 0.065 | 0,073 | NS | NS |
| 0.169 | 0,165 | 54,85 | 54.27 | 0.896 | 0.853 | 6.40 | 6.30 |
| 0.164 | 0 163 | 53.52 | 54.10 | 0.983 | 0.942 | 6.39 | 6.38 |
| 0.004 | 0.003 | 1,15 | 1.76 | 0.023 | 0.026 | 0.05 | 0.02 |
| NS | NS | NS | NS | 0.065 | 0.073 | NS | NS |

leaves. Increases in N, P, K and S contents of seedlings and chlorophyll content of leaves of the transplants raised with an application of sulphur were associated with a decrease in Fe and Ca+Mg contents of seedlings and pH of their leaf sap during both years. The effects of ferric and aluminium sulphates on these characters were similar to that of sulphur. Application of $H_2$ $SO_4$, Hcl & $HNO_3$ had no effect on nutrient content of seedlings or on pH and chlorophyll content of the leaves. The effect of $H_2$ $So_4$ which was applied on sulphur equivalent basis was found to be better than that of Hcl and $HNo_3$ in increasing N, P, K and S content and in decreasing Ca+Mg, Fe and leaf sap pH.

Treating seeds with S increased significantly N, P, K and S content of seedlings and leaf chlorophyll content bnt it decreased Fe and Ca + Mg content of rice seedlings during both years.

An application of EDDHA increased leaf chlorophyll content of seedlings over no EDDHA in both years without affecting nutrient content of seedling or leaf sap pH.

The persistance of chlorosis inspite of a higher iron content in chlorotic seedlings and lower iron content of healthy seedlings (from plot receiving sulphur) show that chlorosis was due to a chemical and/or biological inactivation of iron after its absorption in the plant. It was also noticed that there was significantly higher response of chlorotic seedlings to elemental sulphur application even in preference to EDDHA (best known iron chelate for calcareous soil) and ferric sulphate on sulphur equivalent basis. An application of elemental sulphur seems to have forestalled chemical inactivation of iron and thus prevented the occurrence of chlorosis.

Application of elemental sulphur lowered pH of lhe leaf sap. Higher sulphur content of seedlings from plots treated with elemental sulphur clearly show a greater availability of sulphur on account of gradual oxidation. Since oxidation Was gradual there might have been only a limited release of sulphur each time. $Al_2$ $(So_4)_3$ and $H_2$ $So_4$ being very acidic, might have absorbed a lot of calcium in solution phase which might have neutralised a lot of sulphate sulphur rendering it ineffective. Gypsum being sparingly soluble in calcareous soils might have not been effective in supplying sulphur to plant requirements and thus did not have any effect on pH of leaf sap. EDDHA which did not supply sulphur had also no effect on pH of the leaf sap. Coating of seeds with sulphur which applied only a limited quantity of sulphur also did not affect leaf sap pH as it did not increase sulphur content of seedlings.

Rogers and Shive (1932) suggested that transport of iron within the plant might be affected by the pH of the conducting tissues. They found that iron accumulations usually occured in regions where the pH was high. It was concluded form the chemical analysis that iron in these accumulations is often in the preci-

**Table 2**

**Effect of soil applied chemicals and seed treatment on dry matter production and survival percentage of rice seedlings**

| Treatments | Dry matter production (g/m²) 1970-71 | 1971-72 | Mean | Survival percentage 1970-71 | 1971-72 | Mean |
|---|---|---|---|---|---|---|
| | | 'a' | | | | |
| Control | 58.45 | 76.90 | 67.67 | 43.50 | 45.50 | 43.00 |
| Elemental sulphur | 155.27 | 165.76 | 160.52 | 79.00 | 79.30 | 79.15 |
| Sulphuric acid | 102.53 | 80.33 | 91.43 | 53.00 | 62.00 | 57.50 |
| Hydrochloric acid | 70.01 | 66.31 | 68.16 | 54.50 | 43.50 | 49.00 |
| Nitric acid | 74.33 | 70.78 | 72.55 | 46.00 | 35.80 | 41.20 |
| Ferric sulphate | 138.64 | 139.28 | 138.96 | 75.00 | 73.80 | 74.40 |
| Aluminium sulphate | 137.48 | 98.97 | 118.23 | 73.25 | 65.30 | 69.27 |
| Gypsum | 63.76 | 66.40 | 65.08 | 57,50 | 52.50 | 55.00 |
| SEm ± | 2.90 | 2.16 | | 1.38 | 1.74 | |
| CD at 5% | 8.15 | 6.07 | | 5.15 | 6.46 | |
| | | V | | | | |
| No seed treatment | 77.45 | 73.08 | 75.27 | 53.50 | 49.20 | 51.35 |
| Seed treatment with sulphur | 122.67 | 118.11 | 120.39 | 68.70 | 65.20 | 66.95 |
| SEm ± | 1.45 | 1.08 | | 0.69 | 0.87 | |
| CD at 5% | 4.07 | 3.04 | | 1.94 | 2.44 | |
| | | 'c' | | | | |
| No EDDHA | 94.93 | 87.50 | 91.22 | 60.00 | 56.70 | 58.35 |
| 2 kg Fe EDDHA | 105.18 | 103.70 | 104.44 | 64.00 | 57.70 | 60.85 |
| SEm ± | 1.45 | 1.08 | | 0.69 | 0.87 | |
| CD at 5% | 4.07 | 3.03 | | 1.94 | NS | |

pitated form not available for plant processes. Iron accumulations were absent in plants with a low pH and in such plants iron content was low and uniformly distributed in all tissues. In the present case leaves from plots grown with elemental sulphur contained 84% more sulphur and 29.5% less iron than leaves from plants grown without sulphur. It is probably that increased sulphur content might have reduced the pH of the conducting tissues or prevented the formation of insoluble iron compounds. Decrease in the pH of the leaf sap of pea plants due to application of elemental sulphur was also reported by Mathur (1971) on alkaline calcareous soil.

Data (Table 2) show that an application of S significantly increased the dry matter production and survival percentage of rice seedlings in the nursery. As regards dry matter production, sulphur treatment excelled all other treatments including ferric sulphate and aluminium sulphate but as regards survival percentage of seedlings, the effect of sulphur was not significantly better than that of ferric sulphate.

Treating seeds with sulphur proved significantly better for dry matter production as well as for survival percentage of nursery seedlings when compared to ho seed treatment.

An application of EDDHA significantly increased dry matter production by 10.9% in 1970-1971 and 18.5% in 1971-1972 over control without effecting survival percentag of seedlings,

Increased survival and dry matter production of rice seedlings susceptible to chlorosis on calcareous soils due to application of elemental sulphur were also reported by Singh and Gupta (1968) and Singh (1971 b).

## Summary

Field experiments were conducted to ascertain whether the chlorosis in rice is due to a 'lack of sulphur' induced inactivation of iron or due to an actual deficiency of iron and to evaluate the relative efficiency of commonly available sulphur and iron sources, at the Agronomy Farm of the College of Agriculture, University of Udaipur for two consecutive years 1970-71 and 1971-72. It was found that application of elemental sulphur by increasing sulphur content of seedlings decreased leaf sap pH and Ca + Mg content and brought about a concomitant increase in N, K and chlorophyll content all of which created a balanced nutritional environment and forestalled the chemical or otherwise inactivation of iron. This, in turn prevented the occurence of chlorosis due to low supply of sulphur rather than iron as the cause of chlorosis,

## സംഗ്രഹം

രാജസ്ഥാനിലെ ഉദയപ്പൂർ, കോട്ട എന്നീ മേഖലകളിൽ കാണപ്പെടുന്ന ക്ഷാരരസമുള്ള കാൽസിയ മയ മണ്ണുകളിra%നെൽകൃഷിക്ക് വേണ്ടി ഞാററടികൾ തയ്യാറാക്കുമ്പോൾ ഇളം ഞാറുകൾക്ക് മഞ്ഞളിപ്പ് രോഗം ഉണ്ടാകുക സാധാരണമാണ്. ഇതുമൂലം ffroioooslocy'lKsi വൻതോതിൽ നാശനഷ്ടമുണ്ടാകാറുണ്ട്. സൾഫറിന്റെ അഭാവം, അയണിന്റെ പ്രേരിത നിഷ്ക്രിയത, അയണിന്റെ യഥാർത്ഥത്തിലുള്ള ന്യൂനത എന്നിവയിൽ ഏതാണ് ഇളം നെൽച്ചെടികൾക്കുണ്ടാ ACID ഇത്തരം ffisrgraiglojlrragg കാരണമെന്ന് കണ്ടുപിടിക്കാനും, സൾഫറും അയണും ഏററവും പ്രയോജനകരമായും ലാഭകരമായും fflgppjTKi?i ചേർക്കാൻവേണ്ടി ഉപയോഗിക്കാവുന്ന സാധാരണ go വിടം ഏതെന്ന് roilgwiTj^ttsraiOcTOo വേണ്ടിയുള്ള ഒരു പരീക്ഷണം 70–71, 71–72 എന്നീ വർഷങ്ങളിൽ ഉദയപ്പൂർ കാർഷിക കോളേജിൽ നടത്തുകയുണ്ടായി. സൾഫർ അടങ്ങിയിട്ടുള്ള എട്ടു വ്യത്യസ്ഥ പദാർത്ഥങ്ങൾ രണ്ടു നിരക്കിലുള്ള EDDHA fficaioasoruo വിത്തിൽ സൾഫർ പുരട്ടാതെയും പുരട്ടിയും പരീക്ഷിച്ചുനോക്കി. മൂലകരൂപ: OTtilltaft സൾഫർ നൽകിയപ്പോൾ ഇളം തൈകളിൽ സൾഫറിന്റെ അളവ് വർദ്ധിച്ചതോടുകൂടി പത്രരസത്തിന്റെ pHഉം Ca + Mg അളവും കുറയുകയും നൈട്രജൻ, പൊട്ടാഷ്, ക്ലോറോഫിൽ എന്നിവയുടെ അളവ് വർദ്ധിക്കുകയും ചെയ്തു. ഇതുമൂലം പൊതുവിൽ ഒരു സമീകൃത പോഷകപരിസ്ഥിതി സംജാതമായതിനാൽ അയണിന്റെ രാസപരമോ മററു വിധത്തിലുള്ളതോ ആയ പ്രേരിത നിഷ്ക്രിയത ഇല്ലാതാവുകയും ചെയ്തു.

## REFERENCES


Mathur, R. C., 1971. M.Sc. (Ag ) Thesis submitted to the University of Udaipur.

Singh, H. G. 1971 a. Sulphur application prevents chlorosis and ensures large crop yields on alkaline calcareous soils. Indian Fmg. **20,** 21-23.

Singh, H. G. 1971 b. Effects of sulphur on tissue composition and prevention of chlorosis in paddy seedlings Indian J. Argon **16**, 143-148

Singh, H .G. and Gupta, P, C. 1968. Nature and control of chlorosis in paddy seedlings on calcareous soils Indian J. Agric. Sci. **38,** 714-719.

Singh, H, G. and Singh, R. M. 1966. Role of iron . in preventing the death of rice seedlings in nursery. *Indian J. Argon.* **10**, 310*311


(M. S. *received:* 6-7-1974)