CHAPTER 6

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In Chapter 1, the importance of the problem has been discussed briefly, justifying the basis for undertaking the present work.

In Chapter 2, relevant recent researches undertaken in India have been reviewed.

In Chapter 3 are included: (i) meteorological and edaphic data pertaining to Aligarh and (ii) details of the materials and methods employed for the 13 field experiments conducted.

In Chapter 4 are given the data regarding the response of the selected alliums, namely Allium cepa L. (onion), Allium sativum L. (garlic) and Allium porrum L. (leek) in terms of growth parameters, carbonic anhydrase activity, leaf N, P, K and S content and yield characteristics. Most results were found significant at $P < 0.05$. The results of each experiment are summarised below.

Experiments 1, 2 and 3, conducted simultaneously on the selected alliums during the winter of 1994-1995, were of an exploratory nature. The relative efficacy of various combinations of soil-applied N (urea), P (diammonium phosphate) and K (muriate of potash) was tested to select the best combination of NPK for each crop.

Experiment 1 was a factorial randomised block design field trial on three onion varieties (Nasik Red, Poona Red and White Globe). Five combinations of nutrients (kg/ha), viz. (i) $S_{N0P0K0}$, (ii) $S_{N40P8K30}$, (iii) $S_{N80P16K60}$, (iv) $S_{N120P24K90}$ and (v) $S_{N160P32K120}$ were applied to the soil. Of
these, $S_{N120P24K90}$ proved best for Nasik Red and White Globe and $S_{N80P16K60}$ for Poona Red.

The simple randomised block design Experiments 2 and 3 were carried out on white garlic and Suttons Prizetaker leek respectively. Six soil-applied nutrient combinations, i.e. (i) $S_{N0P0K0}$, (ii) $S_{N30P6K20}$, (iii) $S_{N60P12K40}$, (iv) $S_{N90P18K60}$, (v) $S_{N120P24K80}$ and (vi) $S_{N150P30K100}$ were applied to each crop. The data revealed that garlic responded best to $S_{N90P18K60}$ and leek, to $S_{N120P24K80}$.

Experiments 4, 5, 6 and 7 were carried out concurrently on the alliums during the winter of 1995-96 (i) to confirm the results of the previous year and (ii) to test if yields could be boosted by exploiting the technique of foliar feeding. To attain aim (i), a slight variation was made in the soil-applied NPK regime of Experiments 1, 2, and 3, narrowing down the range of the applied nutrients. For aim (ii), split (soil + foliar) application of N and P was adopted. Thus, for applying the supplemental foliar (F) spray (applied in two equal splits), at the rate of 20 kg N (urea), designated as $F_{N20}$ and/or 2 kg P/ha ($F_{P2}$), as sodium dihydrogen orthophosphate, the quantity of N and P applied to the soil was pre-adjusted accordingly.

The factorial randomised block design Experiment 4 was conducted on Nasik Red and White Globe onion. These had shown better interactive performance in Experiment 1, particularly with treatment $S_{N120P24K90}$ which was retained. In addition, two new combinations were added, one being $S_{N100P20K75}$ (in between the best and $S_{N80P16K60}$) and the other, $S_{N140P28K105}$ in between the best and $S_{N160P32K120}$ of Experiment 1. Each of these was sprayed with N and/or P, with spray of de-ionised water providing the requisite controls. There were thus 12 treatments as under:
Comparison of the data for the three water-sprayed controls confirmed the results of Experiment 1, whereas \( S_{\text{N100P22K70} + F_{\text{N20P2}}} \) proved the best treatment. Nasik Red again performed better than White Globe.

Experiments 5, 6 and 7 were performed on Poona Red onion, white garlic and Suttons Prizetaker leek respectively according to a simple randomised block design simultaneously with Experiment 4 (1995-96). Three combinations of NPK (\( S_{\text{N60P12K45}}, S_{\text{N80P16K60}} \) and \( S_{\text{N100P20K75}} \) for Poona Red; \( S_{\text{N75P15K50}}, S_{\text{N90P18K60}} \) and \( S_{\text{N105P21K70}} \) for garlic and \( S_{\text{N105P21K70}}, S_{\text{N120P24K80}} \) and \( S_{\text{N135P27K90}} \) for leek) were applied to the soil on the basis of the data of Experiments 1-3. When water was sprayed, they provided three controls. When N and/or P were sprayed, the quantity applied was adjusted in the soil-applied N and/or P as in Experiment 4. Thus, there were 12 (soil + foliar) treatments for each crop. The controls confirmed the data of the previous year. Treatment \( S_{\text{N60P14K60} + F_{\text{N20P2}}} \) proved best for Poona Red, \( S_{\text{N70P16K60} + F_{\text{N20P2}}} \), for garlic and \( S_{\text{N100P22K80} + F_{\text{N20P2}}} \), for leek.

Experiments 8, 9 and 10 were undertaken during the winter of 1996-97 on the same alliums, however Poona Red onion was discarded from the trials for economic considerations. The aim was (i) to confirm the main results of the preceding year and (ii) to test if their performance could be improved further by including a small quantity (2 kg/ha) of S (sodium sulphate) in the spray containing N and/or P, as these are sulphur-rich crops. The best soil-applied doses of NPK (Experiments 4-7) were sprayed with
de-ionised water and formed the controls. Combinations of $S_{\text{NPK}}$ and $F_N$ and/or $F_p$ and/or $F_S$ completed the 12 treatments.

The factorial randomised block design Experiment 8 was conducted on Nasik Red and White Globe onion. The best soil-applied dose ($S_{\text{N120P24K90}}$) was applied on the basis of the data of Experiment 4 but the number of treatments was reduced to eight:

(i) $S_{\text{N120P24K90}} + F_w$ (Control), (ii) $S_{\text{N100P24K90}} + F_{N20}$, (iii) $S_{\text{N120P22K90}} + F_{P2}$, (iv) $S_{\text{N120P24K90}} + F_{S2}$, (v) $S_{\text{N100P22K90}} + F_{N20P2}$, (vi) $S_{\text{N100P24K90}} + F_{N20S2}$, (vii) $S_{\text{N120P22K90}} + F_{P2S2}$ and (viii) $S_{\text{N100P22K90}} + F_{N20P2S2}$.

The data confirmed the results of the preceding year. Treatment $S_{\text{N100P22K90}} + F_{N20P2S2}$ and Nasik Red onion proved best singly as well as in combination.

The simple randomised block design Experiments 9 and 10 were performed on white garlic and Suttons Prizetaker leek respectively. The already confirmed best doses, viz. $S_{\text{N90P18K60}}$ for garlic and $S_{\text{N120P24K80}}$ for leek were applied to the soil and sprayed with water for controls. For the 7 split (soil + foliar) applications, adjustments were made as in Experiment 8. The data of the preceding year were confirmed. Treatment $S_{\text{N70P16K60}} + F_{N20P2S2}$ proved best for garlic and $S_{\text{N100P22K80}} + F_{N20P2S2}$ for leek.

Experiments 11, 12 and 13 were carried out on the selected alliums during the winter of 1997-98 with the twin aim: (i) to confirm the results of the last year and (ii) to compare the efficacy of the laboratory grade sources of leaf-applied P (Experiments 4-10) and S (Experiments 8-10) with two less expensive commercial grade sources of P and one of S to test if the already established cost-effectiveness of the technique could be
improved further for these trials, the best combinations of soil-applied N and P and spray N, P and S established in Experiments 8, 9 and 10 were selected for each crop. Spray of de-ionised water formed the control. By manipulating the source and quantity of these nutrients applied to the soil and foliage, the total quantity received by the control and each of the treatments was kept at the optimum levels mentioned above. The inexpensive source of both P and S together was the commercial grade single superphosphate (SSP) while the source of phosphorus was commercial grade diammonium phosphate (DAP). The conventional sources of P and S used for research on foliar feeding world-wide as well as in our own laboratory are, of course laboratory grade sodium dihydrogen orthophosphate for P and sodium sulphate for S and these were retained for comparison of efficacy and cost.

Experiment 11 was undertaken on Nasik Red and White Globe onion according to a factorial randomised block design. The two most efficacious combinations \( (S_{N100P22K90} + F_{N20P2} \) and \( S_{N100P22K90} + F_{N20P2S2} \) emerging in Experiments 4 and 8 were selected for this trial. There were in total six treatments as under:

(i) \( S_{N120P24K90} + F_W \) (Control), (ii) \( S_{N100P22K90} + F_{N20P2} \), (iii) \( S_{N100P22K90} + F_{N20P2(DAP)} \), (iv) \( S_{N100P22K90} + F_{N20P2S2} \), (v) \( S_{N100P22K90} + F_{N20P2(DAP)S2} \), and (vi) \( S_{N100P22K90} + F_{N20P2(DAP)S2(SSP)} \).

The results of this experiment confirmed the findings of Experiments 4 and 8. Treatment \( S_{N100P22K90} + F_{N20P2(DAP)S2(SSP)} \) proved best on the basis of cost-benefit ratio. Nasik Red again emerged as the more efficient variety and interacted best with the above combination of nutrients.

The Experiments 12 and 13 were performed on white garlic and Suttons Prizetaker leek respectively according to a simple randomised block design.
design. The three treatments of Experiment 9, viz. $S_{N90P18K60} + F_W$, $S_{N70P16K60} + F_{N20P2}$ and $S_{N70P16K60} + F_{N20P2S2}$, were retained for garlic and of Experiment 10 ($S_{N120P24K80} + F_W$, $S_{N100P22K80} + F_{N20P2}$ and $S_{N100P22K80} + F_{N20P2S2}$) for leek. Of course, the sources of P and S had to be changed as in Experiment 11. The data of these experiments confirmed the findings of the preceding years on these two crops. Treatments $S_{N70P16K60} + F_{N20P2(DAP)S2(SSP)}$ and $S_{N100P22K80} + F_{N20P2(DAP)S2(SSP)}$ proved best for garlic and leek respectively on the basis of cost-benefit ratio.

In Chapter 5, the main results have been discussed in the light of the findings of earlier researchers, particularly those from India. The additions to the literature on the mineral nutrition of the common alliums emerging from the present thesis have been highlighted.

The present Chapter 6 is followed by an up-to-date bibliography of available literature cited in the text and one appendix containing photocopies of research papers already published by the present author on mineral nutrition of crops other than the alliums, including mustard and linseed as required by the Academic Ordinances of the Aligarh Muslim University, Aligarh (India) governing the award of the degree of D.Sc.