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NUTRIENT ABSORPTION IN BARLEY AS INFLUENCED BY GENOTYPIC VARIATION IN SALIC USTOCHREPT

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SUMMARY

A higher straw/grain ratio and higher removal of nutrients per quintal of grain production was noticed in susceptible varieties of barley. Radiochemical analysis revealed that cultivars DL 70 and DL 3 utilized applied phosphorus more efficiently as compared to Jyoti and DL 36. Among the various cultivars of barley tested, DL 103 was most affected while Ratna remained unaffected to a given level of salinity in the soil.

INTRODUCTION

Plant growth is adversely effected when exposed to saline condition. The deleterious effects associated with saline conditions are water stress arising from osomtic imbalances between plant and soil, and ion toxicity/imbalances associated with excessive salt accumulation (Gorham *et al.*, 1985). The plant response to soil water stress depends upon the nature of plant species, soil type and evaporative demand. Nutrient requirement of a crop is dependent to a great extent on plant type, growth habit and yield potential. Introduction of new, high yielding varieties of barley necessitated a critical study of nutrient absorption in the wake up of increasing use of chemical fertilizers. The present study was taken to evaluate genotypic variation in barley in relation to yield and nutrient uptake under saline condition.

MATERIALS AND METHODS

Two sets of field experiments were carried out during two consecutive *rabi* seasons (1980-81, 1981-82). In the first set five cultivars of barley, namely, Ratna, Clipper, DL 69, DL 70 and DL 103 were grown in saline (Palam loam, Salic Ustochrept) field (Genetics-E) at Indian Agricultural Research Institute New Delhi.

The experimental soil had pH 7.9 to 8.4; ECe 5.6 to 10.7 dSm^{-1} available N

202 to 293, P 7.5 to 12.4 and K 192 to 279 kg/ha; DTPA+$CaCl_2$+TEA extractable Zn 0.7 to 1.7 ppm, Mn 0.8 to 1.5 ppm and Cu 0.2 to 0.6 ppm and water soluble ions, Ca 1.8 meq/1, Mg 0.6 meq/1, Na 1.6 meq/1, K 0.2 meq/1, Cl 3.3 meq/1 and SO_4 2.1 meq/1.

The fertilizers were broadcasted to the soil at the rate of 120 kg N, 60 kg P_2O_5 and 40 kg K_2O/ha in the form of urea single superhosphate and muriate of potash and mixed well in the soil before sowing the crop. The crop was sown in 3m×4m plot-size and was replicated four times in a randomized block design.

At maturity, the crop was harvested and grain and straw samples were separated and were dried at 70°C. Both grain as well as straw samples were finally digested in diacid (HNO_3 : $HC1O_4$ in the ratio 5:1). The digested material was used for the determination of P, K, Na, Ca, Mg, Zn, Cu and Mn. P was estimated by vando-molybdate yellow colour method of Koenig and Johnson (1942). K and Na by flame photometry and Ca, Mg, Zn, Cu and Mn were determined in digested plant samples by using atomic absorption sepectrophotometer.

In second set of experiment four cultivar of barley, namely DL 3, DL 70, Jyoti and DL 36 were grown using same soil and fertilizer treatment as mentioned in the first one, except that phosphorus was applied in the form of ^{32}P tagged SSP (*Sp. act* 0.3 mCi/g of P_2O_5).

The crop of the second set of experiment was harvested at flowering and dry-matter yield was recorded after drying at 70°C in an oven. The total and radioactive P in plant were determined by the methods of Koenig and Johnson (1942) and Makenzie and Dean (1950) respectively, after wet dijestion in triacid mixture. The per cent P derived from fertilizer (Pdff) values were calculated directly. Dry matter yield, total P uptake, per cent Pdff, fertilizer P uptake and per cent P utilization were statistically analysed separately for different genotypes.

RESULTS AND DISCUSSION

A perusal of data (Fig.1) reveals marked variation in grain/straw yields of barley varieties. Among the barley varieties tested, the lowest yield under saline condition was recorded in DL 103 (18.7 q/ha) followed by cultivar Clipper (23.3 q/ha) as compared to variety DL 70 (30.2 q/ha), variety DL 69 (35.4 q/ha) and Ratna. Almost similar trend in respect of straw yield was observed. The straw/grain ratio indicated that susceptible varieties had wider straw/grain ratio than the tolerant ones (Table I). Similarly, removal of nutrients per quintal of grain production was also found to be more in most susceptible variety of barley.

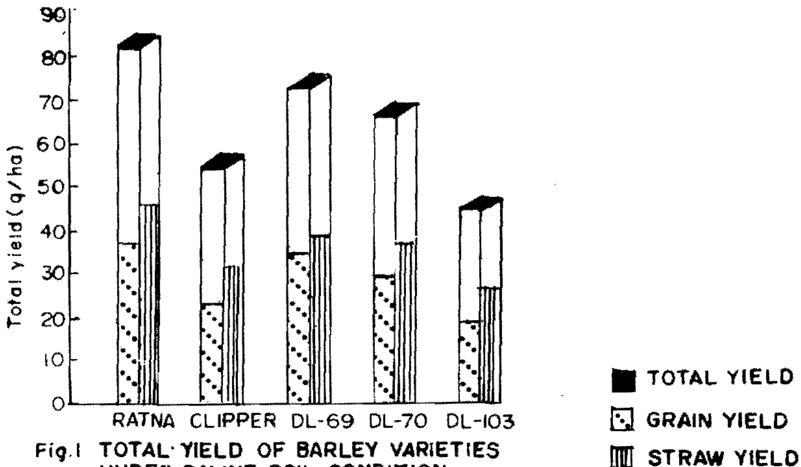

Fig. 1 TOTAL YIELD OF BARLEY VARIETIES UNDER SALINE SOIL CONDITION

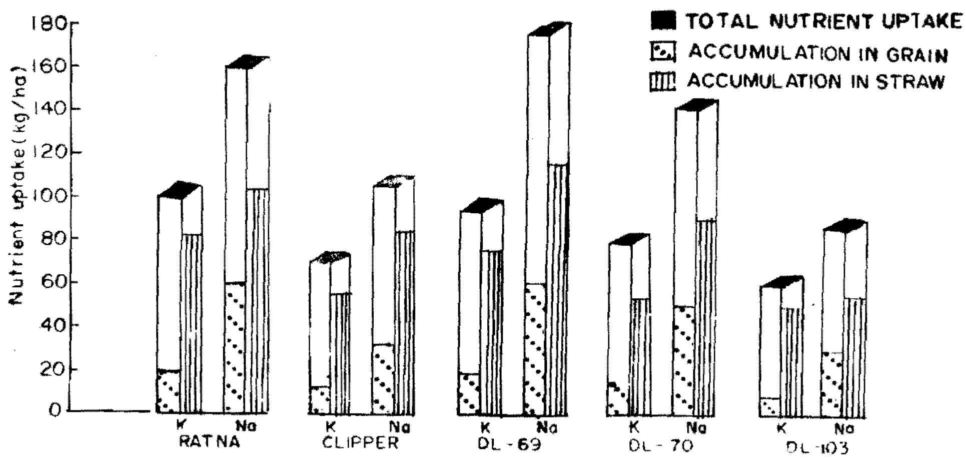

Fig. 2. Absorption of K and Na by barley cultivars under saline soil condition

The higher yield in Ratna may be ascribed to stimulating effect of salts on the crop. In addition, higher accumulation of Na in Ratna also resulted in making it more tolerant to salinity than other barley cultivars (Fig 2). Reports concerning the accumulation of Na have also been given by various other workers (Bernstein, 1962 and Heikal, 1977) The lower yield on the other hand, is attributed to poor root growth caused by an accumulation of soluble salts in the soil which increased the osomtic potential of the soil and thus restricted the absorption of water and uptake of nutrients.

Table I. Effect of salinity on straw/grain ratio and nutrient removal per quintal of grain production

Attributes/ varieties	Straw/Grain ratio	Removal of nutrients per quintal of grain produciion (kg)							
		P	K	Na	Ca	Mg	Zn	Cu	Mn
Ratna	1.24	0.31	2.74	2.35	0.79	0.31	0.055	0.072	0.040
Clipper	1.35	0.31	2.95	4.90	0.80	0.37	0.059	0.072	0.058
DL-69	1.09	0.31	2.69	5.00	0.72	0.34	0.058	0.064	0.042
DL-70	1.21	0.33	2.65	4.70	0.63	0.33	0.052	0.071	0.035
DL-103	1.41	0.37	3.17	4.55	0.70	0.38	0.075	0.084	0.056

Table II. Drymatter yield, total P uptake, % Pdff, fertilizer P uptake and per cent P utilization

Attributes/ varieties	Drymatter (g/ha)	P-uptake (kg/ha)	% Pdff	Fertilizer P (kg/ha)	% P utilization
DL-3	31.0	5.9	40.2	2.4	9.1
DL-70	38.2	7.2	51.2	3.7	14.1
Jyoti	27.2	6.0	36.3	2.2	8.3
DL-36	24.1	3.4	30.7	1.0	3.9
C.D. at 5% level	2.1	0.76	3.5	0.46	1.3

There were distinct differences in uptake behaviour of two rowed (Clipper and DL-103) and six rowed (Ratna, DL 70 and DL 69) barley varieties. The latter absorbed more amont of nutrients than the former.

Mean P uptake in barley decreased with increase in salinity and cultivars differed significantly in their capacity to absorb soil-P. Uptake by barley straw also revealed significant differences and cultivars DL 70 and DL 103 exhibited highest amount of P in straw compared to cultivars Ratna, Clipper and DL 69. The increase in P uptake under such condition could be ascribed to the fact that applied phosphorus might have encouraged proliferation of roots which ultimately may have resulted in more exchange sites on root tips. The reduction in P-uptake may be due to its decreased availability as a result of reduced root growth caused by salinity (Kamath *et al.*, 1977) (Fig. 3).

Variation in Ca uptake was also observed in barley grain and it was in the order of Ratna>DL 69>DL 70>Clipper>DL 103, while in the case of straw in the order of Ratna>DL 69>Clipper>DL 70>DL 103. Uptake of Mg by barley grain and straw also resulted in significant decrease due to salinity. However, the magnitude of decrease in Mg uptake was higher in grain as compared to straw. Greater absorption of Ca than Mg by different barley cultivars is presumably due to higher amount of available Ca than Mg in the soil. In general, data also showed that P content was more in grain while Ca was equally distributed and Mg was higher in straw (Fig. 3).

Varying degress of salinity in soil also showed a significant difference in both K and Na uptake in grain and straw of barley. The uptake of K and Na in straw was more than grain. Amongst the cultivars, DL 69 followed by Ratna and DL 70 accumulated higher amounts of K and Na as compared to the Clipper and DL 103 (Fig. 2). The higher absorption of both K and Na by DL 69, Ratna and DL 70 could be attributed to intrusion of Na in plant tissues by ensuring a proper level of K in the growth medium (Heimann *et al.*, (1962). Lower absorption of both K and Na in Clipper and DL 103 was possibly due to both the cations appeared to be bound at the site of root (Huffakar *et al.*, 1959).

Accumulation of Cu, Zn and Mn, in general, was more in straw. Highest Cu, Zn and Mn uptake was observed in Ratna and DL 69 compared to Clipper and DL 103 while DL 70 was intermediate in this respect (Fig. 4).

The reduced accumulation of Zn in some of the cultivars might be due to higher level of Na in the soil, which adversely affected membrane permeability, resulting in inccreased diffusive influx of Na either due to coprecipitation of $ZnCO_3$ and $Zn(OH)_2$ or formation of ZnS. Decrease in Mn absorption may be due to some

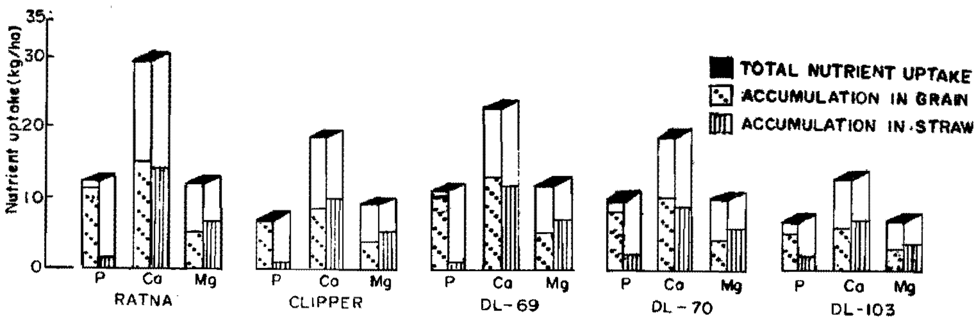

Fig. 3 ABSORPTION OF P, Ca AND Mg BY BARLEY CULTIVARS UNDER SALINE SOIL CONDITION

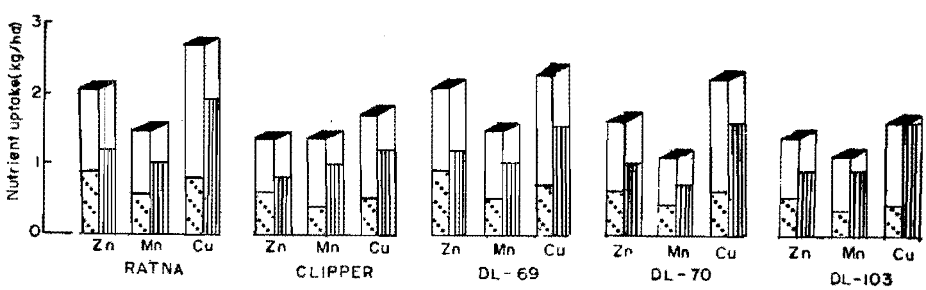

Fig. 4. Total uptake of Zn, Mn and Cu by barley cultivars under saline soil condition

specific inhibitory effects on ions, caused by reduction in photosynthesis and poor utilization of photosynthate in the presence of high osmotic pressure in the root medium. Since copper is poorly mobile in soil, reduction in root growth and surface area could account for its decreased uptake. Increase in copper uptake might be due to transformation of fixed copper to more easily available forms. The higher uptake of Mn caused due to higher oxidation potential of Mn and Mn^{2+}. The higher absorption of Zn in some of the cultivars was due to its ability to suppress Na in plants and widening of Ca/Na and K/Na ratios.

Results of microplot field experiment, in general, revealed that cultivar DL 70 and DL 3 gave significantly higher dry matter production, total P uptake, per cent Pdff, fertilizer P uptake and per cent P utilization values as compared to cultivar Jyoti and DL-36. This shows that DL 36 and Jyoti could thrive better even under saline soil condition with low supply of P.

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