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RESPONSE OF *DIPLACHNE FUSCA* (KALLAR GRASS) TO N,P, AND Mg ON A SALINE SODIC SOIL

A. Saeed Bhatti, G. Sarwar and M.Tahir

Nuclear Institute for Agriculture and Biology, Jhang Road, Faisalabad.

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Data on the response of kallar grass to N, P, and Mg and the absorption of these mineral elements from a salinized sodic soil in pots are presented and discussed with respect to the salt relations of 'Kallar' grass.

INTRODUCTION

Diplachne fusca (kallar grass) is a highly salt tolerant plant which grows well on saline sodic soils in the country [10, 12, 14]. The grass also grows well in fields which never received fertilizer N. According to the work conducted at NIAB, Faisalabad and elsewhere (Fendrik and his colleagues, personal communication) species of *Anabaena* and *Azospirillum* associated with the plant could be responsible for the provision of nitrogen to certain extent. However, no report showing response of kallar grass to applied nutrients, e.g. nitrogen, phosphorus, and magnesium in soil has been seen.

The present paper reports some aspects of the response of kallar grass to these elements on a salinized soil in pots.

EXPERIMENTAL

Plant Culture and Analysis. - Plants were raised from nodes of kallar grass stems [2] in pots containing 500 g, non-treated Thikriwala (Faisalabad) soil (clay, 6.8%; silt, 10.5%; sand, 82.7%; EC (1:5), 0.23 mS; $CaCO_3$:3.4%; pH (water), 9.1; N: 0.05%) separated from 1.5 kg treatment soil below by a plastic sheet. At day 14, when new tops and roots developed, treatments were applied to the lower soil mass as 400 ml (at field capacity) NaCl solutions of 0, 10, 50 and 300 mM concentration containing nitrogen equivalent of kg/ha N: o(No), 60 (N_{60}), and 180 (N_{180}) as urea, phosphorus equivalent of kg/ha P_2O_5: o(Po) and 40 (P_{40}) as $NH_4H_2PO_4$, and magnesium equivalent of kg/ha $MgSO_4$: o(Mg_o) and 40 (Mg_{40}). The plants were exposed to the treated soil by removing the plastic sheet, as described earlier (Bhatti, *et al.*, 1983). The tops of plants were cut to uniform height on the 9th and 15th days of planting and the number of plants in each pot was thinned to three. Plants were harvested at day 64, dried in air and in an oven at 70^o, and part of plant material was analysed for Na (Flamephotometer 6a Karl Kolb), N (Kjeldahl apparatus), P (Spectrophotometer SP 600), and Mg (atomic absorption spectrophotometer).

RESULTS AND DISCUSSION

Na Effects. Application of NaCl increased Na concentrations in the tops (Table 2). The effect of 50 mM NaCl on Na concentration was small but 300 mM NaCl substantially increased Na concentration in the tops (Table 2).

The concentrations of Na in the tops in $N_+P_+Mg_+$ at all levels of NaCl, were, however, somewhat similar to those in $N_oP_oMg_o$. Although the dry weights of tops in $N_+P_+Mg_+$ at all levels of NaCl, in general, exceeded those in $N_oP_oMg_o$ (Table 1) the concentration of Na in the tops appeared to have been little affected by the increased growth (i.e., dilution effect). Conversely this growth response seems also not to have been stimulated by Na. On the other hand, Na concentrations in the tops of plants that received phosphate fertilizer (P_{40}) in combination with NaCl decreased, although at all levels of NaCl phosphate fertilizer (P_{40}) stimulated growth to a lesser extent than $N_+P_+Mg_+$ (Table 1). The dry weights of roots were, however, in general increased and the concentrations of Na were much more decreased indicating dilution of Na due to a growth response to P. In all treatments the concentrations of Na in the tops were higher than those in the roots supporting the evidence that in kallar grass [2] a mechanism for retention of Na in the roots equivalent to that found in corn [9] bean [11] and sorghum [8] was not functioning. That kallar grass also lacked a mechanism for root retention of Cl has been shown elsewhere [3].

Table 1. Effects of N, P, and Mg on the dry weights of kallar grass

Treatment (NaCl)	$N_oP_oMg_o$	$N_+P_+Mg_+$	N_{60}	N_{180}	P_{40}	$MgSO_{4\,40}$
	(g/plant)					
	Tops					
10 mM	0.198 ± 0.028	0.846 ± 0.069	0.194 ± 0.001	0.193 ± 0.021	0.620 ± 0.063	0.210 ± 0.018
50 mM	0.176 ± 0.009	0.979 ± 0.112	0.170 ± 0.026	0.153 ± 0.003	0.575 ± 0.048	0.155 ± 0.022
300 mM	0.090 ± 0.005	0.091 ± 0.013	0.091 ± 0.006	0.099 ± 0.009	0.219 ± 0.031	0.060 ± 0.016
	Roots					
10 mM	0.054 ± 0.012	0.172 ± 0.050	0.055 ± 0.018	0.061 ± 0.010	0.261 ± 0.025	0.044 ± 0.004
50 mM	0.042 ± 0.003	0.305 ± 0.066	0.054 ± 0.015	0.039 ± 0.006	0.286 ± 0.024	0.034 ± 0.005
300 mM	0.030 ± 0.001	0.014 ± 0.002	0.020 ± 0.001	0.021 ± 0.001	0.040 ± 0.003	0.018 ± 0.004

	$N_oP_oMg_o$	$N_+P_+Mg_+$
Tops	0.165 ± 0.024	0.661 ± 0.054
Roots	0.031 ± 0.003	0.067 ± 0.023

Table 2: Effect of N, P, and Mg on Na concentration in kallar grass

Treatment NaCl	$N_oP_oMg_o$	$N_+P_+Mg_+$	N_{60}	P_{40}
	(Na as % dry weight)			
	Tops (unwashed)			
10 mM	1.126 ± 0.040	1.297 ± 0.021	0.912 ± 0.009	0.577 ± 0.017
50 mM	1.143 ± 0.003	0.923 ± 0.033	1.105 ± 0.008	0.773 ± 0.057
300 mM	3.074 ± 0.100	3.320 ± 0.055	3.387 ± 0.013	2.067 ± 0.151
	Roots			
10 mM	0.644 ± 0.022	0.402 ± 0.013	0.634 ± 0.012	0.446 ± 0.008
50 mM	0.706 ± 0.013	0.482 ± 0.016	0.672 ± 0.021	0.458 ± 0.026
300 mM	1.423 ± 0.051	1.922 ± 0.031	1.624 ± 0.026	1.017 ± 0.113

	$N_oP_oMg_o$	$N_+P_+Mg_+$
Tops	0.678 ± 0.004	1.137 ± 0.034
Roots	0.414 ± 0.015	0.401 ± 0.003

Nitrogen effects. Nitrogen had little effect on the dry weights of tops or roots of kallar grass at all levels of NaCl (Table 1), and the concentrations of N in the tops of plants receiving N (Table 3) did not much differ from the concentrations of N in plants receiving no nitrogen. In addition, NaCl also had little or no effect on the concentrations of N in the tops. Clearly then, N fertilizer or NaCl had little effect on N uptake by kallar grass. Elsewhere chloride and sulphate salinities are reported to depress N absorption by wheat [15], beans [7] *Atriplex* spp. [6] and suppress N metabolism in Bermuda grass [1] and Star grass [13]. In grasses, however, a great variability existed in their response to N. Thus *Lolium perenne* and *Agrostis canina* showed greatest response to N at 243 ppm and *Agrostis stricta* at 27 ppm, while growth of *Nardus stricta* was suppressed at N levels higher than 27 ppm [4]. In

Table 3: Effect of N, P, and Mg on the concentration of N and P in kallar grass

Treatment (NaCl)	$N_oP_oMg_o$ N	$N_oP_oMg_o$ P	$N_oP_oMg_o$ Mg	$N_+P_+Mg_+$ N	$N_+P_+Mg_+$ P	$N_+P_+Mg_+$ Mg	N_{60} N	N_{60} P	N_{60} Mg	P_{40} N	P_{40} P	P_{40} Mg
(% dry weights) Tops												
10 mM	1.84 ± .02	0.12 ± .003	.23 ± .003	1.68 ± .02	0.13 ± .003	.22 ± .004	2.05 ± .05	0.10 ± .007	.27 ± .011	0.95 ± .02	0.16 ± .038	.20 ± .006
50 mM	1.85 ± .01	0.11 ± .004	.23 ± .005	1.52 ± .13	0.12 ± .002	.16 ± .012	1.91 ± .01	0.10 ± .003	.22 ± .006	1.02 ± .04	0.17 ± .005	.12 ± 005
300 mM	1.67 ± .03	0.16 ± .002	.19 ± .006	1.86 ± .02	0.16 ± .003	.20 ± .018	1.79 ± .02	0.11 ± .005	.25 ± .004	1.09 ± .05	0.15 ± .006	.17 ± .003
Roots*		P			P		–	P			P	
10 mM		0.087 ± .011			0.061 ± .001		30	0.070 ± .001			0.086 ± 001	
50 mM		0.096 ± .001			0.070 ± .001			0.096 ± .001			0.070 ± .004	
300 mM		0.081 ± .001			0.066 ± .001		–	0.098 ± .001			0.100 ± .001	

Control		$N_oP_oMg_o$ N	$N_oP_oMg_o$ P	$N_oP_oMg_o$ Mg	$N_+P_+Mg_+$ N	$N_+P_+Mg_+$ P	$N_+P_+Mg_+$ Mg
Control	Tops	1.78 ± .02	0.097 ± .001	.23 ± .005	1.85 ± .06	0.120 ± .008	.23 ± .018
	Roots*	–	0.095 ± .001	–	–	0.077 ± .001	–

* N and Mg could not be determined.

kallar grass, however, no response to N was obtained at levels equivalent of 60 and 180 kg/ha (approximate N levels 27 and 81 ppm respectively). In the present experiment, lack of response to N becomes, however, difficult to interpret in view of the substantial soil $N \simeq 500$ ppm). The plant response to lower concentration of NaCl in the soil (Table 1) to which no nitrogen was applied, could not also be attributed exclusively to NaCl in the presence of soil N. Since the dry weights of the plant at both N levels approximated those at NaCl 10 and 50 mM alone, the plant's response in the latter may be thought to be the result of a positive salinity-fertility interaction. It could then be limited only to low concentrations of both NaCl and N since increasing supplies of either had little effect on the dry weights of both tops and roots.

P Effects. Phosphate fertilizer increased the dry weights of tops and roots substantially at all levels of NaCl (Table 1). The dry weights in NaCl treatment were also much greater in the presence of NPMg than the weights in NaCl alone. A large part of the increased growth in salt treatments in the presence of NPMg than in their absence could be attributed to phosphate salts since dry weights in N (N_{60} and N_{180}) and Mg respectively fell in the range of weights obtained in $N_oP_oMg_o$. Phosphate treatment also increased the concentrations of P in plant tops in the presence of NaCl (Table 3): the concentrations in the roots remained, however, little affected.

The positive response of kallar grass to phosphate fertilizer as well as the P uptake in the presence of NaCl suggests that the effects arose from a positive phosphate – NaCl interaction in the plant. Elsewhere, chloride has been shown to be conducive to accumulation of P in plants [5]. Whether the positive growth response to phosphate and P accumulation in kallar grass was due to N or Cl would be investigated further.

Mg Effects. Application of $MgSO_4$ with 10 and 50 mM NaCl had, generally, little effect on the dry weights of tops and roots (Table 1). The dry weights of tops and roots were, however, decreased at high salt level in the presence of $MgSO_4$. Magnesium concentrations in the presence of phosphate, at all salt levels, were slightly decreased as compared with the plants with no phosphate (Table 2).

The lack of response to applied Mg indicated that the soil was not deficient in Mg. Neither were there symptoms of Mg deficiency on the leaves in plants given no Mg. No reports showing Mg deficiency in the area have also been seen. A substantial effect of Mg on the growth of kallar grass could not thus be demonstrated.

CONCLUSIONS

Kallar grass has been known to grow in the fields which never received fertilizer N. In the present experiments, kallar grass was grown in salinized sodic soil in pots with and without nitrogen. A positive response to applied N could not be demonstrated in these studies. The lack of response to N was difficult to explain in view of the high total soil N and a possible 'starter' effect which may have arisen from N fixation by kallar grass. Solution cultures are now being used to pursue further the plant-fertilizer

N relationship. Effects of Mg in kallar grass were examined in view of the importance of Mg to the growth of cereals and other grasses. The lack of response to applied Mg could also be related to substantial amounts of soil Mg. K effects on growth and tissue concentrations of the plant at various concentrations of K, including high Na and low K in the soil, have been described elsewhere [2]. A positive response to applied P by kallar grass was due, however, to P deficiency reported widespread in the region. The studies emphasize that where applicable, utilization of light to moderately saline sodic soils by growing kallar grass could be better accomplished if the mineral nutrition of the plant was given due consideration.

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