BRIEF COMMUNICATION

Net assimilation rate, relative growth rate and yield of pea genotypes under different $NaHCO_3$ concentrations

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Abstract

The net assimilation rate (NAR), relative growth rate (RGR) and yield were negatively correlated with different exchangeable sodium percentage (ESP) levels; maximum reduction in NAR, RGR and yield was observed at 30 ESP. However, the cultivar NDP-2 showed maximum percent reduction in all the characters at 30 ESP as compared to cultivars NDP-7 and Rachna.

Sodicity is a major constraint in agriculture and induces a series of physiological changes in crop plants. Salt stress inhibits growth throughout the plant life cycle and ultimately affect the yield. However, little attempts have been made so far to isolate osmotic and ionic effects of salt stress with respect to growth characters and other metabolic changes in pea. The present investigation was therefore, carried out to quantify the effect of salt stress on growth parameters and grain yield of pea.

A pot experiment was conducted during two successive seasons of 1990-91 and 1991-92 with *Pisum sativum* L. cvs. Rachna, NDP-2 and NDP-7 with three replications in Completely Randomised Design. The soil used was sandy loam with initial pH and ESP of 8.2 and 10, respectively. To create different levels of ESP, desired quantities of sodium bicarbonate was thoroughly mixed with the soil prior to filling the pots. Ten seeds were sown in each pot and after germination, seedlings were thinned to five plants per pot. The RGR and NAR were calculated by the following formulas:

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$$RGR = \log_e \frac{W_2 - W_1}{t_2 - t_1} \qquad \text{(Fisher 1920)}$$

$$NAR = \frac{W_2 - W_1}{A_2 - A_1} \quad \frac{\log_e A_2 - \log_e A_1}{t_2 - t_1} \qquad \text{(Redford 1967)}$$

where W_2 and W_1 = total dry matter at successive stages, t_2 and t_1 = time interval $\log_e A_2$ and $\log_e A_1$ = natural log differences in leaf area.

The increasing levels of soil sodicity significantly decrease relative growth rate (RGR) and net assimilation rate (NAR) of different pea genotypes (Table 1). The highest RGR and NAR values were computed in control for all the three genotypes, afterwhich genotypes showed continuous decrease in RGR and NAR upto 30 ESP.

Table 1. Effect of varying levels of sodicity on relative growth rate [mg g^{-1} d^{-1}] and net assimilation rate [mg m^{-2} d^{-1}] of pea genotypes at different growth stage.

	30-45 d after sowing ESP levels					45-80 d after sowing				
Genotypes	0	20	25	30	Mean	0	20	25	30	Mean
Relative growth rate (pooled data for 1990-91 and 1991-92)										
Rachna	0.042	0.034	0.027	0.021	0.031	0.0064	0.0060	0.0053	0.0049	0.0057
NDP-2	0.043	0.032	0.024	0.016	0.028	0.0061	0.0059	0.0052	0.0041	0.0053
NDP-7	0.043	0.032	0.027	0.017	0.030	0.0064	0.0061	0.0053	0.0042	0.0053
Mean	0.043	0.033	0.026	0.018		0.0063	0.0060	0.0053	0.0044	
C.D. at 5 %	V = 0.00080					V = 0.00013				
	T = 0.00093					T = 0.00015				
	V × T = 0.0016					V × T = 0.00027				
Net assimilation rate (pooled data for 1990-91 and 1991-92)										
Rachna	0.673	0.507	0.409	0.271	0.465	0.156	0.138	0.127	0.080	0.125
NDP-2	0.662	0.471	0.203	0.128	0.366	0.177	0.144	0.100	0.054	0.118
NDP-7	0.659	0.491	0.390	0.162	0.426	0.165	0.155	0.125	0.069	0.128
Mean	0.665	0.490	0.334	0.187		0.166	0.146	0.117	0.068	
C.D. at 5 %	V = 0.0019					V = 0.00085				
	T = 0.0022					T = 0.00098				
	V × T = 0.0038					V × T = 0.0017				

Net assimilation rate varied from 0.128 to 0.673 during first growth period (30-45d after sowing) while its values ranged from 0.054 to 0.177 during second growth period (45-80d after sowing). Among different genotypes, NDP-2 showed maximum reduction in RGR and NAR at 30 ESP level at both the stages. Reduction in relative growth rate and net assimilation rate with increasing soil ESP showed that dry matter production per unit time and per unit leaf area were badly affected by sodium stress.

The rate of dry matter production per unit time and per unit leaf area were relatively higher upto flowering stage, beyond which it showed decreasing trends, probably because of decrease in photosynthetic area and rate. Downton (1974) reported decrease in carbohydrate concentration by 20 - 40% in grapevine leaves at 75 mM NaCl, showing that the reduced growth was due to reduction in photosynthesis, which was resulted from decrease in chlorophyll content and CO_2 assimilation. The different pea genotypes significantly differed in their grain yield per plant, irrespective of ESP levels. Of course, each level of ESP showed decrease in grain yield as compared to control treatment (Table 2). The maximum per cent reduction in grain yield (51%)

Table 2. Effect of varying levels of sodicity on grain yield [g] of pea genotypes. (Pooled data for 1991 and 1992).

	ESP levels				
Genotypes	0	20	25	30	Mean
Rachna	0.042	0.034	0.027	0.021	0.031
NDP-2	0.043	0.032	0.024	0.016	0.028
NDP-7	0.043	0.032	0.027	0.017	0.030
Mean	0.043	0.033	0.026	0.018	
C.D. at 5 %	V = 0.00080				
	T = 0.00093				
	V × T = 0.0016				

was recorded in NDP-2 at 30 ESP. The reduction of yield under increasing levels of sodicity might be due to reduction in cell division and cell differentiation. The affected N uptake and lesser availability of water during the period of cell differentiation at higher ESP level, which adversely affected the flowering, might be another reason (Hartman and Pantetsos 1961). In addition, adverse effects of salt stress on photosynthesis and translocation of metabolites to the reproductive sink could be some of possible reasons for lower yield. Reduction in yield under salt stress condition was also reported by Abrol and Bhumbla (1979) in pulses, Singh and Abrol (1983, 1985, 1986) in pea, groundnut and soybean, respectively.

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