Rapeseed responses to salinity under elevated atmospheric CO2 concentration.

Abbas Dehshiri[1]

Sayed Ali Mohammad Modares Sanavi[2]
[1]Seed and plant certification and registrarion (spcri), karj, Iran.
[2]College of Agriculture, Tarbiat Modares University, Tehran, Iran

Abstract:

Carbon dioxide (CO_2) concentration of the global atmosphere has increased during the last decades and is expected to influence on crop production. In order to evolution the effects of increasing atmospheric CO_2 concentration on rapeseed salinity tolerance a factorial experiment was conducted at the greenhouse of Tarbiat Modares University at 2010. The experiment was consists of measuring the tolerance of three cultivars of rapeseed at four levels of salinity and three levels of atmospheric CO_2 concentration. A completely block design arrangement in factorial was used in this experiment. Three levels of atmospheric CO_2 concentrations (350, 700 and 1050 μmol mol^{-1}), four levels of salinity (0, 5, 10 and 15 $dS.m^{-1}$) were exerted on three rapeseed cultivars including Okapi (tolerant), Zarfam (moderately sensitive), and RGS (sensitive). Three level of CO_2 concentrations were been considered as three environments that experiments carried out in them. Results indicated that level of 1050 μmol mol^{-1} CO_2 concentration had highest effect on shoot fresh and dry weight, leaf dry weight, plant height and leaf area, but no effect on grain yield. level of CO_2 concentration had no significant effect on chlorophyll content. Effects of salinity on cultivars Characteristics varied in levels of CO_2 concentrations and significant different observed in leaf fresh and dry weight, shoot fresh and dry weight and electrolyte leakage. electrolyte leakage increase with salinity but was lowest in level of 1050 μmol mol^{-1} CO_2 concentration and highest in 350 μmol mol^{-1} . this study showed that elevated CO_2 can partially ameliorate some of adverse effects of salinity on vegetative growth but no grain yield.

Key words: Salinity, Rapeseed cultivars, Atmospheric CO_2 Concentration, Plant Characteristics.

Materials and methods

Experiment was conducted at the greenhouse of Tarbiat Modares University at 2010.

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Experiment was conducted in three growth chambers with 9 meters long, 2 meters width and 2.5 meters height. each chamber was made of nylon. Top of Chamber covered by nylon about 20 cm away from the high walls So that establishing a free exchange of moisture and temperature, and the air inside the chamber be relatively static and prevent it turbulence. One chamber was supplied with normal air(Ambient CO_2 concentration), second with 700 μmol mol^{-1} (Twice concentration of CO_2) and third with 1050 μmol mol^{-1} (three times concentration of CO_2). CO_2 was supplied with capsules. CO_2 Manometer installed on capsule and using pneumatic hose (8 × 10 mm). The flow of gas was regulated using pressure gauge, solenoid valve, and flow meter.

Results and Discussion

The results of variance analysis of data showed that cultivars have significant differences in most traits (table 1). The difference in total plant fresh weight, leaf area, leaf dry weight, root dry weight, number of leaves and branches, leaf chlorophyll content and chlorophyll fluorescence was quite significant. Salt treatment has quite significant effect on all measured traits. Air concentrations of carbon dioxide has quite significant effect on plant fresh weight, leaf area and dry weight, root dry weight, plant height, membrane stability and chlorophyll fluorescence parameters and significant effect on shoot dry weight and leaf fresh weight (Table 1). InTwice concentration of CO_2 with increasing salinity levels, plant fresh weight and shoot dry weight reduced in Zarfam and Okapi but has not significantly changed in RGS003 (Table 5). Considering that RGS003 is spring type and reproductive growth stage early is over. So during this process temperature was lower and conditions was more appropriate for photosynthesis and the use of excess CO_2 and photosynthetic surplus materials So twice normal concentration could reduce the effects of salinity and fixed plant fresh weight and shoot dry weight in RGS003. But Zarfam and Okapi had a longer growing period and reproductive stages and seed formation coincided with increased temperature, and excess CO_2 in these circumstances has not been able to reduce the effect of salinity. Many plants when conditions are cold and wet tolerate salinity better than hot and dry conditions. Under hot and dry conditions with increasing salinity yeild will be decreased faster compared with wet and cool conditions. mainly due to reduced ion accumulation or improve plant water relations in the wet and cold conditions. (Omami, 2005). inTwice concentration of CO_2, with increasing levels of salinity, chlorophyll levels in all three cultivars increased. Given that between chlorophyll and total plant fresh weight of plant there is negative correlation,this probably is due to reduce development of cells and more elusive chlorophyll per unit leaf area. Leaf relative water content decreased in all three varieties that show twice concentration had no effect on the relative leaf water content. Chlorophyll fluorescence (FV / FM) was constant in Okapi , decreased in Zarfam and increased in RGS003, indicating efficiency of photosynthesis is different in cultivars. Grain yield remained unchanged in the three cultivars and twice concentration of CO_2 has no effect on yield. Membrane stability decreased in all three cultivars. In three times concentration of CO_2 with increasing salinity levels,decrease of plant fresh weight and shoot dry weight was high in Okapi, mild in Zarfam and unchanged in RGS003, indicates RGS003 better use of increased CO_2 concentration. Genetic capacity for use of photosynthetic substances in terms of increased CO_2 to maintain increased photosynthesis is very important (Drake et al., 1997). Chlorophyll in all three cultivars increased. As was stated before, increasing salinity has been increased chlorophyll and increased CO_2 concentration has not been able to affect it. Relative leaf water content with increasing salinity has declined in the Okapi but no significant difference in RGS003and Zarfam that show Okapi is the most sensitive in this case. Chlorophyll fluorescence (fv / fm) in the three different levels of salinity has remained stable and reflect the effect of increased CO_2 concentration on the reduction of chlorophyll fluorescence due to salinity. Leaf area decreased in all three varieties and membrane stability decreased in Okapi and was stable in RGS003. Three times concentration could prevent reduce of membrane stability duo to salinity in RGS003. But this effect is not seen in Zarfam and Okapi. Growth rates decreased by salinity greatly varies depending on plant species and to a lesser extent depending on the cultivar. Severity of the salinity response changes to interactions with environmental factors such as relative humidity, temperature, radiation and air pollution (Omami, 2005).

Interactions of cultivar × Salt × CO_2 concentration shows the effect of salinity on the characteristics and features of cultivars in different levels of carbon dioxide has been different. The differences in traits such as leaf dry weight, root dry weight and membrane ion leakage was significant (Table 1). Membrane ion leakage with increasing salinity levels increased. But this increase was minimum in three times concentration and was maximum in normal concentration. high Ion concentrations may be disrupt cell membranes and in interfering with the balance of solutes and absorption of mineral elements show symptoms of shortage of food similar to what occurs in the absence of salinity (Omami, 2005).In normal concentration of CO_2 in all three varieties with increasing salinity levels, plant fresh weight, leaf area and stability of membranes decreased and chlorophyll levels increased and relative leaf water content did not change.

Table 1. Analysis of variance for characteristic in rapeseed cultivars under salinity and CO_2 treatments

S.O.V	d.f	(MS) Stem dry weight	Fresh leaf weight	leaf area[1]	Leaf dry weight[1]	Root dry weight
CO_2(C)	2	17.4*	27.74*	24789.53**	1.97**	265.86**
E_a	6	2.5	4.87	4325.49	0.112	4.97
Variety (V)	2	13.6	1505.98**	347679.25**	20.21**	551.66**
Salinity(S)	3	143.5**	278.48**	108921**	1.016**	250.06**
(C × V)	4	2.8	51.20**	11590.2**	0.62**	78.88**
(S × C)	6	6.7	8.65	3722.85	0.22*	22.24*
(S × V)	6	15.3**	79.25**	15513**	0.13	30.27**
(S× C × V)	12	7.9	34.80 *	9559.74**	0.94**	38.59**
Experimental Error	66	4..93	7.62	3114.21	0.10	8.63
C.V (%)		21.75	17.89	17.98	16.81	17.04

S.O.V	d.f	(MS) Leaf per plant	Branch.plant-1	Grain yield	Memberan ion leaching	Plant dry weight
CO_2(C)	2	14.9259	0.1944	199841.44**	500694.27**	8260127.14**
E_a	6	10.57	1.41	25645.14	191183.591	4095511.14
Variety (V)	2	106**	4.11**	37927.67	80594.89	1329790.34*
Salinity(S)	3	78.13**	9.19**	193181.51**	1.2107	19902856.15**
(C × V)	4	6.315	0.35	6531.28	170649.61**	2815940.57**
(S × C)	6	4.27	0.49	15440.57	42250.14	697109.2
(S × V)	6	16.76**	1.48*	45406.85*	102375.61**	1689575.82**
(S× C × V)	12	9.07	0.29	11227.01	138076.85**	2278375.98**
Experimental	66	5.62	0.569	15799.41	28245.5	3805489
C.V (%)		12.98	17.98	17.16	18.10	16.35

S.O.V	d.f	(MS) chlorophyll (SPAD)	relative water content	Plant height	Fresh plant weight	FV/FM
CO_2(C)	2	25.18**	57.47	440/0648**	910.36**	0.186**
E_a	6	17.73	56.01	81.48	221.16	0.0083
Variety (V)	2	189.23**	277.00	10.48	1493.2**	0.0073*
Salinity(S)	3	927.93	1355.54**	5079.96**	5750.35**	0.0114**
(C × V)	4	5.89	166.49	81.36	101.34	0.0033
(S × C)	6	28.37	272.40	61.32	178.34	0.0036
(S × V)	6	19.66	328.94*	529.22**	525.03**	0.0018
(S× C × V)	12	20.34	20./87	43.32	205.75	0.0022
Experimental Error	66	15.07	139.37	45.85	157.07**	0.0019
C.V (%)		7.23	17.48	6.15	16.35	7.13

*, **: Significant at 5% and 1% probability levels, respectively

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