Growth Analysis of Wheat (*Triticumaestivum* L.) Genotypes Under Saline Condition

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ABSTRACT Growth of eight wheat genotypes was assessed during 2010-11 under different levels of saline condition *i.e.*3, 6, 9 and 12 dsm^{-1}.The wheat genotypes differed significantly for emergence, leaf area, relative growth rate and net assimilation rate. The emergence stage the least affected genotype was K9006, whereas other genotypes K9644, K9465, HD2733, and HD2329 were severely affected by salinity. Emergence of seed, leaf area, relative growth rate and net assimilation rate was reported maximum in genotypes K9006, K8434; KRL1-4 and K88. Genotypes K9644 and K9465 showed salinity sensitive.

Key Words: Wheat, saline condition, growth; RGR, NAR.

INTRODUCTION:

Growth is a vital function of plants and indicates the gradual increase in number and size of cells. The processes of growth and development are considered to begin with germination, followed by large complex series of morphological and physiological events (Ting, 1982). Along with other favorable environmental conditions, adequate availability of essential elements increases the growth. The presence of salts in the irrigated systems of arid and semi-arid regions is among the important factors affecting the availability of water and essential nutrients to plants by osmotic stress. Salinity checks the availability of nutrients and reduces growth (Zalba and Peinemann, 1998). Growth parameter such as germination, leaf area, relative growth rate and net assimilation rate are very important to assess the growth and are affected by salinity. Significant reduction in vegetative growth of wheat genotypes has been observed under saline conditions (Nassem*et al.,* 2000). The reduced growth may be due to slow rate of cell division, elongation and differentiation that resulting reduced number of cells of small size. Even prolonged lower salt levels can influence the growth of crops and cause significant reduction in seedling growth of crops and cause significant reduction in seedling growth (Zeng and Shannon, 2000). El-Hendawy*et al., (*2005) reported that growth of salt tolerant wheat genotypes affected by salinity was primarily due to decline in photosynthetic capacity rather than a reduction in leaf area, whereas net assimilation rate was more important factor in determining relative growth rate of moderately tolerant and salt sensitive genotypes. The genetic diversity for growth between and within crop species gives economic stability and enables to choose the crops and their genotypes that are adopted for a region or the specific field conditions.

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The genotypes having balanced vegetative growth under salt accumulation is increasing in irrigated agricultural systems and salt-tolerant genotypes showing adequate vegetative growth would provide a solution to the continuation of agriculture under conditions of increasing salinity (Loomis and Connor, 1992). Large seedling leaves and high growth rate of wheat, barley and other crops genotypes indicate an absolute salt tolerance and are desirable parameters for screening purposes (Rawson *et al.,* 1988). The present study was initiated to analyze the growth of wheat genotypes under saline conditions.

MATERIAL AND METHOD:

Eight wheat genotypes (KRL1-4, K8434, K88, K9644, K9465, K9006, HD 2733 and HD 2329) differing in their tolerance to salinity were evaluated at different levels of salt stress *i.e.* EC 3, 6, 9 and 12 dsm^{-1} in addition to control. Soils samples were collected from Research Farm Janta P.G. College Ajeetmal, Auraiya (U.P.). The samples are air-dried, pulverized and sieved in laboratory to make homogenous mixture. 120 clay pots of 12 inch size were selected and thoroughly washed. The inner portion of pot was lined with polythene sheet to check loss of water as well as other elements. Pots are divided in to 24 groups for five treatments including control. The pots were arranged to completely randomized design with three replication of each treatment. A basal dose of N at 100 mg/kg soil as urea, P_2O_5 at 90 mg/kg as single super phosphate and K at 120 mg/ kg as potassium sulphate were mixed in to soil prior to seed sowing. The remaining N was applied after first irrigation. In each pot 15 seeds were shown and thinned to five uniform plants/pot after seedling emergence at crown root stage. After completion of emergence, data on seedling emergence was taken.

Leaf area per plant:

Leaf area per plant calculated by formula suggested by Yoshida *et al.,* 1969. Functional leaf *i.e.* green leaves were counted on main shoot as well as the other tillers of the tagged plant. Total length and width of flag leaf was multiplied by total number of leaves on the plant, then again multiplied by factor of 0.67 for leaf area per plant.

Relative growth rate and Net assimilation rate:

To record RGR and NAR of the plant were cleaned and oven dried at 70^0C for 48 h. Following formulae proposed by Gardner *et .al.,* (1985) were used to calculate RGR and NAR.

$$RGR = \frac{l_nW_2 - l_nW_1}{T_2 - T_1}$$

Where: W_2 and W_1 was the dry weight of plant and T_2 and T_1 was times of sampling.

$$NAR = \frac{W_2 - W_1}{T_2 - T_1} \times \frac{l_nLAI_2 - l_nLAI_1}{LA\ l_2 - LAI_1}$$

Where:

W_1= Dry weight of first harvest

W_2 = Dry weight of second harvest

l_n = Natural logarithm

LAI_1 = Leaf area index at second harvest and

T_2-T_1 = Time interval between two harvests.

RESULTS AND DISCUSSION:

Germination percent (Table 1) of wheat genotypes was not affected by salinity at EC 3 dsm^{-1}. Further, increased salinity levels reduced germination percent by 40 % (at 10 DAS) and 28 % (at 15 DAS).Varieties K9006, K8434, KRL1-4, K88 and HD 2233 exhibited better tolerance against higher levels of salinity. Delayed and reduced germination percent seem to be due to less absorption of water from soil which resulting in increasing osmotic pressure of soil water due to higher amount of salt present in the soil solution. Similar finding were also reported by earlier by Khatkar and Kuhad (2000) in wheat, Shirazi (2001) Lallu and Dixit (2005) in mustard and Bera*et al., (*2006) in chickpea. In case of tolerant genotypes accumulation of osmotically active substances such as sugar, organic acid, proline, glycine, K^+, and Cl^- which provide nutrient acquition, ion selectivity and osmotic adjustment to salinity. Leaf area (Table 1) was minimum at 25 DAS thereafter; it increased at 75 DAS and after that it reduced. Leaf area increased significantly at EC 3 dsm-1 over control. However, increasing levels of salinity a significant reduction was noticed at 25 DAS (by 27.37 %) , 75 DAS (by 27.45 %) and 90 DAS (by 26.61 %). Maximum leaf area was recorded in genotype K9006 followed by K8434, KRL1-4, K88, HD2733. However the lowest values of RGR were found in K9644. The low area in salinity sensitive genotypes may be due to senescence of leaves enhanced by salinity. The fallen leaves reduced the number of intact green leaves hence leaf area was decreased. Salinity reduces the number of total green leaves in wheat (Pervaiz *et al*., 2002). Similar finding were also reported by earlier Sharma and Garg, 1985, Afria*et al*., 1998 and Khatkar and Kuhad, 2000. Wilting of leaves was also observed in salinity sensitive genotypes and temporary wilted leaves contributed to lower leaf area. The genotypic variations in retain leaf relative water contents might be another reason for differences in leaf area among the wheat genotypes. In salinity tolerant genotypes have a capacity to vigorous growth and continual replacement of lost leaves results in dilution of salt concentration in the plant system. Tolerant genotypes can be minimize salt uptake, potential salt load per unit new growth and provide better water use efficiency. Value of Relative growth rate (Table.1) was maximum in between 30-60 DAS but it declined abruptly in between 60-90 DAS. Levels of salinity from 6 dsm^{-1} to 12 dsm^{-1} showed a significant reduction by 3.87 % (between 30-60 DAS) and 5.46 % (in between 60-90 DAS). Genotype K9006 produced maximum value of RGR, while genotype K9644 gives lowest value of RGR. Relative growth rate of wheat was decreased by salinity due to unavailability of certain nutrients to plant roots. The altered /reduced supply of certain plant nutrients might be due to cause of low RGR. As described earlier, salinity enhanced wilting and senescence of leaves. Less interception of light caused a decrease in photosynthetic efficiency and hence decreases in photosynthetic efficiency resulting decreased relative growth rate (Datta, 1994; Khatkar and Kuhad, 2000). Shah and Gupta (1998) noted that RGR was partially checked by salinity due to accumulation of Na^+ and Cl^- ion. Higher salinity affects RGR by decrease turgor pressure and wall extensibility (Peter *et al.,* 1998). Tolerant genotypes have a capability to dilute the sodium salt from the root zone, due presence of osmotically active substances such as proline, cl^- and K^+ion. The net assimilation rate (Table 1) was maximum in between 30-60 DAS over 60-90 DAS. Varying levels of salinity significantly increased NAR value up to 3 dsm^{-1}; beyond this a reduction was noticed by 21.73 % (between 30-60 DAS) and 31.57 % (in between 60-90 DAS). Varieties K9006, K8434, KRL1-4, and K88 were found to be superior in this regard. The minimum values were found in genotype K9644. The lower NAR value might be due to restricted availability of essential nutrients and decreased photosynthetic efficiency (Datta, 1994). Another reason might be more drain on photosynthetic material in the salinity sensitive genotypes to continue their life cycle, which resulted less biomass production, hence less net assimilation rate. Salinity tolerant genotypes had a capability to better nutrient and water absorption which provide maximum leaf area resulted increased NAR better accumulation of photo- assimilate in plant.

CONCLUSION:

The wheat genotypes showed changed salt sensitivity behavior for emergence, leaf area. Relative growth rate and net assimilation rate were reliable indicators to differentiate wheat genotypes for salt tolerance. Wheat genotypes showing low emergence under saline condition compensated the loss by an increase in subsequent growth during later stages.

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Genotypes/ Salinity levels (EC dsm-1)	Germination (%) DAS		Leaf area(cm^{-2})			Relative growth rate (between DAS)		Net assimilation rate (between DAS)	
	10	15	25	75	90	30-60	60-90	30-60	60-90
KRL 1-4									
control	62.90	89.20	42.20	560.50	520.80	98.05	38.58	0.53	0.44
3	63.40	90.10	44.10	572.20	534.90	99.88	38.15	0.58	0.46
6	51.80	75.30	35.20	490.30	486.80	98.70	37.98	0.46	0.41
9	38.40	62.50	35.10	419.80	432.60	97.22	36.10	0.44	0.33
12	28.50	61.40	29.10	381.80	381.50	95.40	35.25	0.37	0.27
Mean	49.00	75.10	36.54	484.76	471.32	97.85	37.41	0.47	0.38
K8434									
Control	63.20	88.50	44.40	353.89	432.40	98.85	39.30	0.56	0.47
3	63.80	89.30	46.20	570.00	540.30	99.88	39.42	0.59	0.48
6	52.00	80.40	38.00	528.30	488.20	98.68	37.80	0.48	0.39
9	39.00	72.70	35.20	472.20	415.20	96.90	36.82	0.45	0.34
12	27.40	61.30	28.40	391.50	390.30	95.83	36.70	0.39	0.28
Mean	49.08	78.44	38.44	500.18	473.28	98.02	38.00	0.49	0.39
K88									
Control	62.10	91.10	38.10	519.00	510.20	97.00	38.65	0.52	0.44
3	63.50	92.20	40.30	529.30	515.30	99.85	39.20	0.54	0.47
6	51.50	73.40	37.80	493.40	470.30	97.00	36.80	0.44	0.38
9	38.50	61.50	33.00	451.50	425.80	97.35	36.30	0.41	0.34
12	27.30	49.00	13.10	388.00	382.80	94.80	35.30	0.37	0.27
Mean	48.58	73.44	34.46	476.24	460.88	97.46	37.25	0.46	0.38
K9644									
Control	61.40	90.00	35.20	539.20	534.40	97.81	37.82	0.48	0.40
3	62.20	91.50	37.10	557.50	543.30	98.95	39.15	0.53	0.46
6	51.20	70.50	31.00	461.40	440.60	97.20	36.60	0.48	0.37
9	37.70	60.10	29.20	389.00	346.80	94.90	35.80	0.42	0.32
12	29.90	48.10	22.10	305.50	306.70	92.91	34.70	0.36	0.25
Mean	47.88	72.04	30.92	450.32	414.36	96.35	36.81	0.45	0.36
K9465									
Control	62.40	91.50	40.60	570.00	515.30	98.96	38.70	0.49	0.42
3	63.20	92.30	42.20	580.30	524.80	99.84	39.90	0.51	0.45
6	50.50	70.40	31.10	466.50	437.30	97.40	36.58	0.47	0.38
9	38.40	60.10	30.00	352.60	366.50	95.50	35.10	0.43	0.32
12	27.00	48.10	21.80	310.60	309.50	92.31	34.50	0.35	0.26
Mean	48.22	72.04	33.14	455.98	430.68	96.80	36.95	0.45	0.36
K9006									
Control	60.60	90.50	45.30	560.00	530.40	98.91	39.15	0.55	0.46
3	61.20	91.40	47.10	568.70	543.80	99.82	39.25	0.58	0.48
6	59.30	81.60	38.40	531.20	458.80	98.84	38.90	0.46	0.39
9	50.60	74.10	36.20	470.00	440.70	97.40	36.88	0.44	0.35
12	40.50	62.20	29.50	398.00	380.60	96.20	36.40	0.38	0.29
Mean	53.96	79.96	39.30	505.58	476.26	98.14	38.11	0.48	0.39
HD2733									
Control	61.50	91.80	36.40	542.20	499.80	98.80	38.90	0.52	0.45
3	62.40	92.60	39.20	560.00	510.50	99.40	39.42	0.54	0.49
6	51.20	71.70	36.00	481.70	467.60	98.30	37.40	0.47	0.38
9	38.60	60.90	33.10	432.60	433.90	97.30	35.20	0.43	0.33
12	27.50	48.50	26.20	362.30	362.80	93.50	34.80	0.37	0.25
Mean	48.30	73.10	34.18	475.76	454.93	97.46	37.14	0.46	0.38
HD 2329									
Control	62.00	91.70	42.60	572.50	536.70	98.88	39.05	0.52	0.43
3	63.20	92.40	44.50	588.50	546.30	99.65	39.12	0.54	0.45
6	50.50	71.60	32.00	501.00	442.60	98.05	36.80	0.44	0.35
9	38.40	60.00	28.70	371.50	372.40	95.10	35.50	0.41	0.31
12	27.00	48.21	22.70	312.50	315.30	92.80	34.85	0.37	0.24
Mean	48.22	72.78	34.10	469.21	442.66	96.89	37.05	0.46	0.38
S	1.05	1.97	0.83	14.27	15.06	2.04	0.93	0.015	0.017
G	1.33	2.50	1.05	18.06	19.05	2.58	1.18	0.020	0.022
CD at 5% (S x G)	2.97	5.60	2.35	40.38	42.60	5.77	2.65	0.044	0.049

Table: 1. Effect of salinity on germination, leaf area, relative growth rate and net assimilation rate in different genotypes of wheat.