Agriways 3 (2) : 71-75 (2015)

ISSN: 2321-8614 (Print)
ISSN: 2454-2318 (Online)

GROWTH, YIELD AND BIOCHEMICAL PARAMETERS OF GREEN GRAM (VIGNA RADIATA) AS INFLUENCED BY SALINE WATER

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ABSTRACT

An experiment was conducted during 2008 at Kanpur, India. To evaluate the effect of saline water irrigation on growth, yield and biochemical parameters of green gram(*Vigna radiata* L. Wilczek) genotypes. Results revealed that irrigation with lower saline water (3dsm^{-1}) did not affect the growth and yield of green gram. Higher saline water irrigation reduced chlorophyll content and potassium content in leaves and protein content in seed. However, sodium and Na^+: K^+ ratio increased with increasing levels of saline water (>3 dsm^{-1}). Variety K92-140 showed maximum reduction in all above mentioned parameters. K-851, T-44, KM-1284 and K-92-220 showed hardness against higher levels of irrigation with saline water.

Key Words **: Green gram, Potassium, Protein, Saline water, Sodium**

Soil and water salinity in the arid regions are continuously increasing (Rus *et al.*, 2002). Globally, more than 770,000 km^2 of the lands are affected by secondary salinization, 20% of the irrigated areas and about 2% of the agricultural lands (FAO, 2000). About 30 % of irrigated areas are affected by salts in different degrees. Salinity is a major abiotic factor limiting plant growth and grain yield (Shahid *et al.,*2011; Kumar *et al.,* 2012). Higher levels of salinity decreased seedlings dry weight (Lallu *et al.,* 2009). Salinity induces osmotic and toxic effects which result in decreases growth, yield, photosynthesis, respiration, nutritional deficiencies and protein synthesis (Kumar *et al.,* 2012). Excessive irrigation increased accumulation of salts on the soil surface due to increased evaporation (Dagar *et al.,* 2004).Salinity increases bud necrosis under mild stress and decline in growth, yield and loss in quality under severe conditions (Walker *et al.,* 2002). Higher levels of ESP increased the Na content and decreased K, Ca and P content in plant (Charian and Reddy, 2000). The accumulation of cations (Na^+ and K^+) was greater under salinity stress condition (Upreti and Murti, 2010). Protein content was decreased under higher levels of salinity (Shitole and Dhumal, 2011).

Green gram (*Vigna radiata* L. Wilczek) is one of the new hopes of the developing countries to make available nutrients for every one where people are suffering a lot from some kind of a big shortage of the elementary components of the nutrition particularly the protein. It is a *Kharif* summer pulse crop with a short duration (60-90 days) and high nutritive value. The purpose of this research was to evaluate the adaptive responses of five green gram cultivars to different salty irrigation water regimes and determine more tolerant cultivars under these conditions.

A pot experiment was conducted during (2008) *Kharif* at the pot yard of Department of Crop Physiology, C.S. Azad University of Agriculture and Technology, Kanpur (Uttar Pradesh), India. There were five levels of saline water irrigation and five varieties of green gram selected for the study (Table 1). The treatments are as follows. The crop seed accession was collected from Indian Institute of Pulse Research, Kanpur. Seventy five earthen pots were selected and lined with polythene to check out side salt and loss of water. The soil of the experimental pot was collected from 0-15 cm depth from research farm. The collected soil samples were air dried, pulverized under shade, stubble and other inert materials removed. Seeds were sterilized by dipping in 10% sodium hypochlorite solution for 10 minutes, and then rinsed with sterilized distilled water and air dried at the ambient temperature of 32°C in the laboratory. Eight seeds pot^{-1} were sown but after 15 days of germination, the plants were thinned to five. The experiment was laid out in completely randomized block design with three replications. A recommended dose of NPK (20:60:40 kg ha^{-1}) was applied. Irrigation, weeding, plant protection measures were taken as per the requirement of the crops. The saline irrigation water was prepared adding NaCl. The saline water levels developed were as follows**:**

1 mole of NaCl = 58.5 g NaCl dissolved in 1 liter

1 mole m^{-3} = 0.0585 g NaCl dissolved in 1 liter

10 ml m^{-3} (1 dsm^{-1}) = 0.00585 g NaCl dissolved in 1 liter water

For 3 dsm^{-1}:30 ml m^{-3} (3dsm^{-1}) = 0.00585 x 30 g NaCl/pot^{-1}

For 6 dsm^{-1}:60 ml m-3 (6dsm^{-1}) = 0.00585 x 60 g NaCl pot^{-1}

For 9 dsm^{-1}:90 ml m^{-3} (9 dsm^{-1}) = 0.00585 x 90 g NaCl pot^{-1}

For 12 dsm^{-1}:120 ml m^{-3} (12 dsm^{-1}) = 0.00585 x 120 g NaCl pot^{-1}

Total chlorophyll (total Chl), chlorophyll a (Chl a), and chlorophyll b (Chl b) contents were determined according to the method of Torrecillas *et al. (*1984). Leaf tissues (200 mg) were kept in 5 ml of acetone at 4°C in dark. After 72 hours the optic density of the extract was measured at 665 nm and 649 nm. Total Chl, Chl-a andChl-b contents were calculated according to the following equations and expressed as mgg^{-1} fresh weight (FW).

Chlorophyll a= 11.63 x (OD665) – 2.39 x (OD649)

Chlorophyll b= 20.11 x (OD649) – 5.18 x (OD665)

Total chlorophyll= 6.45 x (OD665) + 17.72 x (OD649)

Protein percent in grain was estimated by method suggested by Lowery *et al.,*(1951). Sodium and potassium was estimated by method suggested by Wolf (1982). The collected data of different observations were statistically analyzed by the procedure described by Panse and Sukhatme (1976).

Plant height increased by salinity up to the level of 3 dsm^{-1}, beyond (above 6 dsm^{-1}) that a significant reduction was noted by 12.74% at 15 days after sowing (DAS), and 14.72% at 45 DAS at 12 dsm^{-1} (Table 1). Among varieties lesser reduction was noted in K-851 in comparison to other varieties. Minimum plant height was recorded in variety K-92-140. Variety K-851 produced maximum leaf area, while lowest leaf area was noticed in variety K-92-140. Dry weight was minimum at 15 DAS and maximum at 45 DAS. The total dry weight increased about four times from 15 to 45 DAS. Increase in the level of salinity above 3 dsm^{-1} showed a drastic reduction at 15DAS (9.94%) and at 45 DAS (7.22%).Variety K-851, T-44, KM-1284 and K 92-220 accumulated maximum dry weight, while variety K-92-140 showed poor performance. Adverse effect of salinity on the above parameters might be due to fewer uptakes of water and nutrients from the growing media due to higher concentration of salts present in the root zone, which may causes imbalances in osmotic pressure. Reduced growth under salt stress might be due to reduced transport of essential nutrient to the shoot (Kumar *et al.,* 2012).Reduction in dry matter accumulation in plant seems to be due to increasing

Table 1 : Effect of saline water on growth parameters, chlorophyll content, protein content, sodium content, potassium content, sodium, potassium ratio and grain yield of different genotypes of green gram

Genotypes/ Saline water irrigation levels (EC dsm-1)	Plant height (Cm) DAS		Leaf area (cm^2) DAS	Number of branches DAS		Dry weight (g) DAS		Chlorophyll content (mgg-1)		Protein content (%)	Sodium content (%)	Potassium content (%)	Sodium: potassium ratio	Grain yield (g)
	15	45	30	15	45	15	45	15	45					
K92-140														
Control	7.96	33.88	23.00	2.10	4.47	1.61	6.23	2.33	2.55	21.37	1.25	2.30	0.54	3.44
3	8.01	34.80	25.00	2.75	5.12	1.71	7.03	2.42	2.35	21.45	1.27	2.33	0.54	3.92
6	7.93	33.38	22.00	1.95	4.25	1.60	6.18	2.30	2.24	21.32	1.63	2.27	0.71	3.31
9	7.91	32.17	21.00	1.90	4.00	1.55	6.10	2.25	2.21	21.25	1.85	2.22	0.83	3.21
12	7.89	31.11	20.00	1.85	3.90	1.50	6.00	2.24	2.15	21.27	2.10	2.20	0.95	3.12
Mean	7.94	33.06	22.20	2.11	4.34	1.594	6.308	2.30	2.24	21.33	1.62	2.26	0.71	3.40
K92-220														
Control	8.00	35.03	23.30	2.65	5.00	1.66	7.18	2.41	2.38	22.20	1.28	2.35	0.54	3.92
3	8.09	35.92	25.30	2.70	5.80	1.70	8.23	2.45	2.63	21.25	1.28	2.43	0.52	4.25
6	8.03	33.50	22.50	2.65	4.85	1.55	7.10	2.36	2.31	21.50	1.27	2.30	0.55	3.78
9	8.00	31.21	20.00	2.55	4.70	1.50	7.00	2.34	2.27	21.15	1.81	2.22	0.81	3.45
12	7.98	30.22	20.00	2.52	4.62	1.50	6.93	2.31	2.22	21.00	2.12	2.19	0.95	3.30
Mean	8.02	33.17	22.22	2.61	4.99	1.582	7.28	2.37	2.36	21.42	1.55	2.29	0.67	3.74
KM-1284														
Control	8.00	34.18	22.00	1.95	4.55	1.60	6.35	2.48	2.64	20.70	1.28	2.41	0.53	3.54
3	8.04	35.97	24.30	2.04	5.25	1.63	7.25	2.55	2.78	20.45	1.28	2.49	0.51	4.10
6	7.95	32.90	22.00	1.85	4.35	1.52	6.42	2.46	2.56	20.62	1.56	2.37	0.65	3.38
9	7.93	31.01	18.00	1.80	4.20	1.50	6.15	2.42	2.52	20.35	1.80	2.32	0.77	3.30
12	7.93	29.87	18.00	1.75	4.10	1.44	6.10	2.41	2.45	20.32	2.08	2.26	0.92	3.18
Mean	9.97	32.78	20.86	1.90	4.49	1.54	6.45	2.46	2.59	20.48	1.60	2.37	0.67	3.50
T 44														
Control	8.10	35.53	24.00	2.75	5.10	1.68	7.30	2.52	2.43	20.05	1.26	2.50	0.50	4.10
3	8.12	36.60	25.00	2.80	5.85	1.75	8.35	2.57	2.55	22.60	1.27	2.56	0.49	4.45
6	8.07	33.93	23.00	2.64	4.92	1.70	7.15	2.48	2.37	22.80	1.65	2.45	0.67	3.89
9	8.01	31.71	22.00	2.62	4.70	1.65	7.10	2.47	2.31	22.45	1.63	2.43	0.67	3.55
12	8.00	30.73	21.00	2.60	4.65	1.63	7.04	2.45	2.25	22.41	1.75	2.35	0.74	3.35
Mean	8.06	33.70	23.00	2.69	5.04	1.682	7.38	2.49	2.38	22.06	1.51	2.45	0.61	3.86
K-851														
Control	8.14	35.74	25.00	2.80	5.45	1.75	7.35	2.71	2.65	22.10	1.28	2.52	0.51	4.22
3	8.18	36.96	26.00	2.85	6.25	1.80	8.45	2.76	2.85	21.20	1.28	2.56	0.50	4.60
6	8.10	34.08	24.00	2.68	5.10	1.75	7.28	2.65	2.64	21.10	1.30	2.45	0.53	4.00
9	8.01	32.09	23.00	2.65	4.90	1.65	7.24	2.63	2.55	22.85	1.45	2.45	0.59	3.65
12	7.99	34.78	22.00	2.53	4.71	1.65	7.14	2.60	2.52	20.71	1.80	2.42	0.74	3.55
Mean	8.08	34.13	24.00	2.70	5.28	1.720	7.49	2.67	2.64	21.59	1.42	2.48	0.57	4.00
S	0.726	0.441	0.634	0.093	0.177	0.045	0.206	0.037	0.29	0.158	0.027	0.023	0.008	0.080
V	0.726	0.441	0.634	0.92	0.177	0.045	0.206	0.37	0.29	0158	0.027	0.023	0.008	0.080
CD (P=0.05)	NS	NS	NS	0.209	NS	NS	NS	NS	0.65	0.356	0.062	NS	0.19	NS
S x V														

S=Saline water, V= Varieties

levels of salinity (Lallu *et al.,* 2009 and Upreti and Murti, 2010).Under condition of salinity tolerance, vigorous growth and continual replacement of lost leaves result in dilution of salt concentration in plant system. Tolerant genotypes can minimize salt uptake reducing potential salt load per unit of new growth and provide better water use efficiency (Upreti and Murti, 2010).

Chlorophyll content was maximum at 3 dsm^{-1} at 15 and 45 DAS, while lowest was recorded at higher levels of saline water irrigation (12 dsm^{-1}) (Table 1). Among variety K 851 had highest value of chlorophyll. However, variety K92-140 contained minimum chlorophyll in leaves. Reduction in chlorophyll accumulation might be due to higher expansion of biomass leading to reduction in chlorophylase enzymatic activities. Similar results have also been reported by Shahid *et al.,*(2011) and Kumar *et al.*,(2012).

Protein percent in grain were increased with increasing levels of saline water irrigation levels up to 9 dsm^{-1}, beyond which it was reduced (Table 1). Variety T 44 accumulated highest protein content, followed by K851, K92-220, K92-140 and KM 1284.These finding also corroborated the work of Shitole and Dhumal, 2011.

Significant enhancements in sodium accumulation were noted with increasing levels of saline water irrigation (Table 1). The maximum sodium was found in variety K92-140(1.62) and minimum in K 851 (1.422). Potassium content decreased with increased levels of saline water. Variety K 851 accumulated maximum potassium, while K92-140 showed poor result (Table 1). Na^+: K^+ ratio enhanced at 6, 9 and 12dsm^{-1}, while it showed decreasing trend at 3 dsm^{-1} over the control. Variety K 851 had lowest Na^+: K^+ ratio, while variety K92-140 showed highest Na^+: K^+ ratio. The increase in sodium and decrease in potassium might be due to excessive accumulation of sodium in the root zone by saline water, which disturbs cationic balances resulting in high osmotic pressure. The uptake of water and nutrient depressed in saline medium due to increased osmotic pressure of soil and toxicity of the salts to the root zone disturb the growth, chlorophyll, protein and K^+ accumulation of the plant/ crops. Similar results were reported by Upreti and Murti (2010) and Upreti *et al.* (2012).

Salt tolerant variety had a higher synthesis/ accumulation capability of chlorophyll, protein, proline, glycine, higher potassium and lower sodium, which maintained the osmotic potential of soil water resulting in increased absorption of water and nutrients leading increased biomass accumulation.

It can be concluded that saline water irrigation had a significant drastic effect on growth and development of green gram. The growth and development of green gram is proportional to the concentration of toxic salts within the root zone. The genotypes that had well maintained the beneficial ions (K^+, Cl^-, P^+) in their tissues, exhibited the excellent performance in term of high plant biomass, photosynthetic activities, higher chlorophyll, higher protein and cations. So it can be extracted that potassium and sodium ions have a strong correlation with the tolerance potential of green gram. These studies also proved that chlorophyll, protein, Na, K and Na: K ratios are the useful screening tools for salt tolerance. Variety K 851, T 44 and KM 1284 exhibited better tolerance to saline water irrigation in the study. However, the results need confirmation by further experimentation.

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