

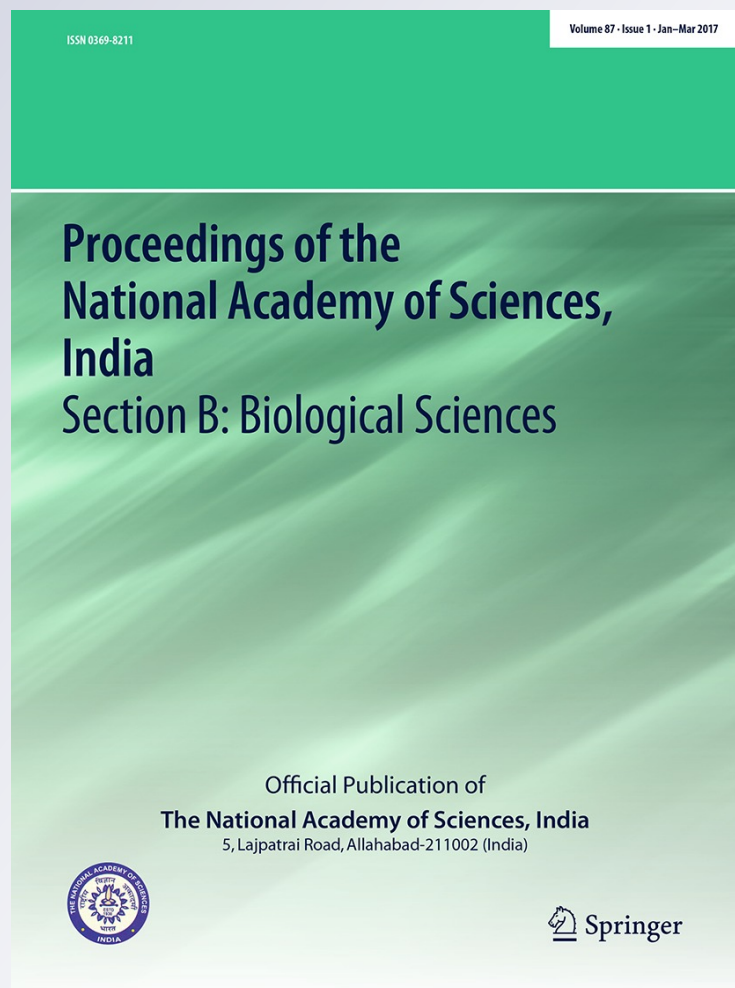
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Agronomic Performance and Nutrient Accumulation Behaviour in Groundnut-Cluster Bean Cropping System as Influenced by Irrigation Water Salinity

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Abstract Varied levels of salinity in irrigation water remained a serious issue to shrink agricultural productivity in Saurashtra region of Gujarat. Groundnut, being a prominent crop in this zone, suffered to quite an extent due to induced salinity. In the present study, the authors have simulated a field condition where four different saline water of EC_{iw} of 0.5, 2.0, 4.0, 6.0 $dS\ m^{-1}$ were used for irrigation in groundnut (rainy/*kharif*)–cluster bean (summer) rotation. Both the crops were assessed by their respective growth and yield traits. A marked decrease was observed in seedling emergence, plant height, root length and pod yield at highest salinity, EC_{iw} 6.0 $dS\ m^{-1}$ whereas the same trend was noticed for plant height, dry weight of plant and final plant stand for cluster bean in the next season. However, pod yield of both the crops did not decrease up to EC_{iw} 2.0 $dS\ m^{-1}$. The ionic imbalance in different plant parts is another major impact of salinity. Na showed enhanced accumulation in plant parts where groundnut roots accumulated 42.0 and 75.4 % higher than shoots and kernels, respectively at highest EC_{iw} ; while other nutrients (N, P, Ca, K) showed a declining effect with increasing salinity.

Keywords Salinity · Legume · Crop growth · Pod yield · Sodium · Potassium

Introduction

Soil salinity is one of the most serious forms of land degradation affecting approximately 10 % of the total land surface of the globe. The problem occurs in varying intensities in more than 100 countries [1]. In arid and semi-arid regions, saline irrigation induced secondary salinization which poses a great threat to the sustainable productivity. The introduction of canal irrigation and seepage resulted in rise of water table within 1.5–2.0 m depths in large areas. Under perennial irrigation systems salt (chlorides, sulphates and bicarbonates of sodium) build up in soils increased depending on their nature and concentration, which further may be aggravated through conjoint effects of increasing water demand and climate change like rise in sea level [2].

Groundnut (*Arachis hypogaea* L.) is an important oil-seed crop in India which is cultivated in 5.5 Mha with an average productivity of 1723 $kg\ ha^{-1}$ and production of 9.5 MT. The crop has N-fixation ability that is more pertinent in countries like India, where most of soils of different states are N-starved. Groundnut fodder is another useful by-product, but its crop is sensitive to salinity than many cereals. Farmers of Saurashtra usually grow groundnut as a rainy/*kharif* season crop and keeping the same land fallow in rabi-summer season due to non-availability of good quality water for irrigation [3]. But there is a possibility to raise some other crops using mild to moderate saline water by selecting a suitable salt-tolerant crop species. It provides three-way benefits: efficient utilization of rainfall, enhanced total productivity of same piece of land and increased economic returns to farmers. Keeping this in view cluster bean or guar (*Cyamopsis tetragonoloba* L.) has been grown as a succeeding crop in the experimental plots using saline irrigation water spanning

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the late rabi (winter)-summer period. Cluster bean is an seasonal legume and the source of guar gum. It has been found as a very hardy crop that withstands high temperature, moderate salinity and drought conditions, often used to replenish soil fertility by symbiotic nitrogen fixation in crop rotation in arid and semi-arid regions of western India (Gujarat and Rajasthan) [4].

As Saurashtra region of Gujarat is widely affected by soil salinity, and more often by the induced salinity through poor quality irrigation water, the present study will give an insight of the potentiality and productivity of rainy (*kharif*) groundnut–summer cluster bean rotation. By assessing several agronomic parameters (from germination to pod yield) the tolerance of this legume–legume rotation (one oilseed, another vegetable) were investigated at different salinity levels. Apart from this, the changes in contents of nutrients (N, P, K, Ca and Na) at various plant parts (root, shoot and kernels) for both crops were also ascertained.

Material and Methods

Experimental and Treatment Details

A field study was conducted at experimental farm of Directorate of Groundnut Research, Junagadh (70°36'E longitude and 21°31'N latitude at an altitude of 60 m above mean sea level), Gujarat during 2012–2013 at a permanent site having different levels of in-built soil salinity developed throughout a decade. The main objective was to assess the performance of groundnut-cluster bean cropping system in calcareous saline black clay soils under different saline irrigation water. The experimental soil was shallow, very dark grey, clay in texture, calcareous underlain by weathered or hard miliolitic limestone. Soil was low in available nitrogen (N) and phosphorus (P₂O₅) and medium in available potassium (K₂O) with pH 7.8–8.0, EC 0.5–1.0 dS m⁻¹, 3–6 % CaCO₃ content and 0.5–0.75 % soil organic carbon. The experiment, consisting of four salinity levels of irrigation water [0.5 (control), 2.0, 4.0 and 6.0 dS m⁻¹] was laid out in a randomized block design with three replications.

Groundnut (Var. TG 37A) was sown in the last week of June during 2012, while the next crop, cluster bean (Var. Pusa Bahar) was raised (February, 2013) on the same site after harvesting of groundnut under different salinity levels of irrigation water. The experiment was in randomized block design. The gross plot size was 20 m². Each salinity treated plot was separated from each other by putting a 250-micron polythene sheet up to 60 cm soil depth in different channels surrounding the various treated plots. Bunds of each plot were raised to the height of 30 cm and width of 30 cm with the objective to absorb maximum rain water in the plot. Three irrigations were applied for *kharif* groundnut

whereas five irrigations were applied for summer cluster bean at a soil depth of 10–15 cm. The recommended doses of fertilizers were applied for groundnut (12.5 kg N + 40 kg P₂O₅) and cluster bean (25 kg N + 50 kg P₂O₅ + 25 kg K₂O) per hectare through urea and di-ammonium phosphate, while other management practices were adopted as per the standard recommendations. The simulated water salinity levels of 2, 4 and 6 dS m⁻¹ were achieved by adding 1.3, 2.6 and 3.9 kg commercial sodium chloride salts per 1000 L of water, respectively.

Growth and Yield Observations

The growth observations for *kharif* (rainy) groundnut were started from the germination at different intervals (7, 8, 9, 10, 13 DAS) and the counts were represented as percentage (percentage of germinated plants with respect to total seeds sown). The mean days to 50 % flowering was observed to show the changes occurred by water salinity. At harvest, mean values of plant height (cm), root length (cm), final plant stand (no.) and branches/plant were observed. Among the yield attributing characters, observations on 100-pod weight (g) and 100-kernel weight (g) were taken after harvesting. Shelling out-turn (%) was calculated as (kernel weight/pod weight) × 100. Pod and haulm yields (kg ha⁻¹) were enumerated from yields of each treatment and converted to per hectare basis.

For next season summer cluster bean crop growth parameters viz. plant height (cm), root length (cm), dry plant weight (g) and final plant stand (no.) and yield (fresh pod and dry fodder yield, kg ha⁻¹) were recorded to study the changes brought by irrigation water salinity. All the observations were taken by mean values of randomly selected five plants during harvesting while the yields were calculated based on per plot. Whole plants with undisturbed root systems were carefully dug out from the upper 20 cm soil layer; the loose soil adhered to the roots was cleaned and root length was measured by the use of scale.

Measurement of Soil Salinity

Soil samples were taken at 15 cm soil depth periodically during the crop growth cycle from both groundnut and cluster bean crops at monthly intervals and analyzed for EC_e and pH (saturated extract of 1:2.5 soil:water ratio) by electronic Hanna make portable combined pH/EC/TDS meter (model HI 991301).

Analysis of Plant Nutrients

Nitrogen in plant samples was determined in Kjeldahl system by distillation with 40 % NaOH and 20 mL of distilled water for 4 min from the H₂SO₄-digested samples

(0.5 g) at 390 °C for 2 h. The released NH₃ was absorbed in 4 % boric acid containing mixed indicator (methyl red + bromocresol green) and titrated against standard H₂SO₄. For rest of elements (P, K, Ca, Na), plant samples were digested using tri-acid and diluted up to 100 mL. From each digested plant part K, Ca, Na and soil Na content were directly estimated by Flame photometer, whereas P was estimated by standard protocol of yellow colour vanadomolybdate method following the absorbance measured in a spectrophotometer at a fixed wavelength of 420 nm.

Statistical Analysis

Experimental data were analyzed by standard statistical methods [5]. Analysis of variance was carried out using MS-Excel based software where least significant difference was computed to test the significant differences between treatment means at 5 % probability ($P = 0.05$).

Results and Discussion

Root Zone Soil Salinity

The change in the soil salinity build up during groundnut-cluster bean system was monitored at monthly intervals for both the seasons. The initial salinity level before the monsoon rain (prior *kharif*) was 2.75–8.80 dS m⁻¹, which was significantly reduced to 2.29–6.14 dS m⁻¹ at the end of *kharif* season. This may be due to leaching of salts from the root zone by rainfall (340.8 mm) received during the rainy the season (July–September 2012). The extent of rainfall and its distribution was also recorded throughout both the seasons (Fig. 1). No direct relationship was observed in air and soil temperature with soil salinity build up but it had direct relationship with amount and distribution of rainfall during the crop growth period. However, the salinity which varied from 1.92 to 4.02 dS m⁻¹ at the time of sowing of summer cluster bean in the month of February, 2013 was increased to a level of 2.78–8.68 dS m⁻¹ at the time of harvest (May 2013) (Fig. 2). This may be due to no rainfall during growth period and also due to application of supplemental irrigation of saline water which resulted in accumulation of salt during the summer season. The increase in soil salinity at root zone affects water absorption, which results in stunted plant growth and reduces the yield significantly [6]. Sodium content in soil also changed significantly after harvest of *kharif* groundnut and summer cluster bean by application of four levels of saline irrigation (Fig. 3).

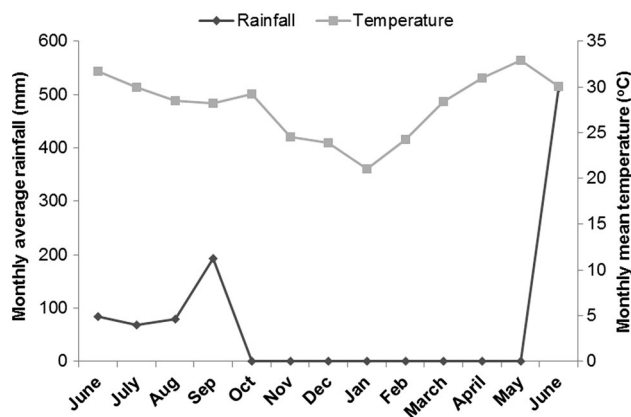


Fig. 1 Monthly weather condition during the seasons of experimentation (June 2012 to June 2013)

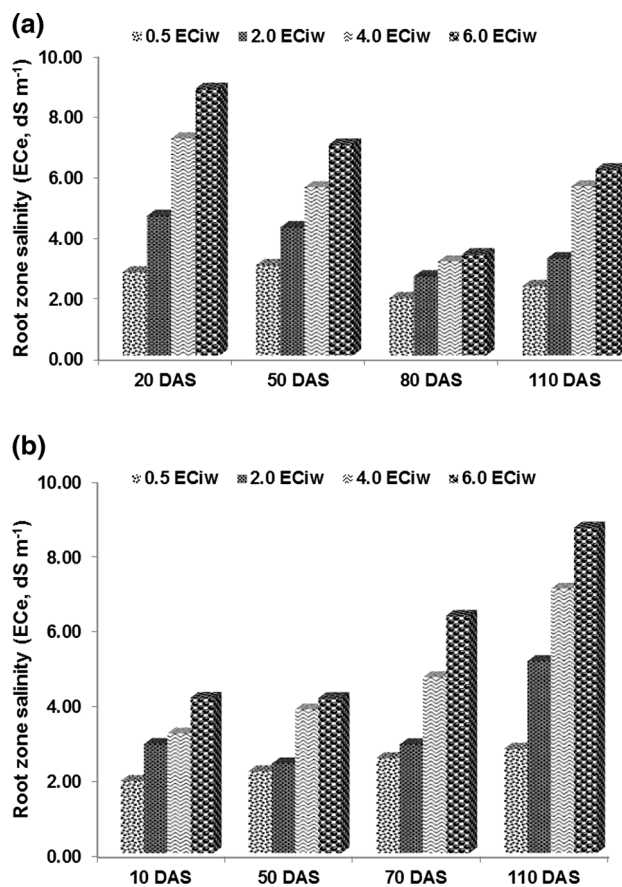


Fig. 2 Root zone soil salinity (EC_e) build-up in successive crop growth stages in four different saline irrigation water levels (EC_{iw}) in a groundnut (*kharif*, 2012); LSD_{p=0.05} 0.5EC_{iw}: 2.3, 2.0 EC_{iw}: 2.2, 4.0 EC_{iw}: 0.5, 6.0 EC_{iw}: 1.1 and b cluster bean (summer, 2013); LSD_{p=0.05} 0.5EC_{iw}: 0.49, 2.0 EC_{iw}: 0.38, 4.0 EC_{iw}: 0.9, 6.0 EC_{iw}: 2.1

Seedling Emergence

It is evident that final seedling emergence of groundnut was delayed and decreased with increase of soil and water

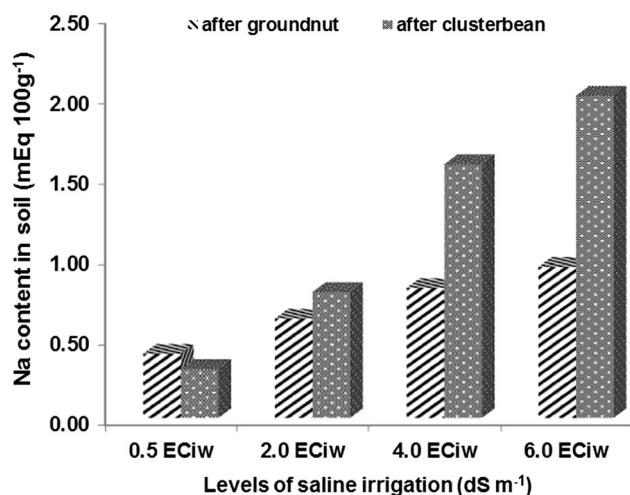


Fig. 3 Changes in sodium content in soil after groundnut (*kharif*, 2012) and clusterbean (summer, 2013) in four different saline irrigation water levels (EC_{iw}); LSD_{p=0.05} 0.27 and 0.42 after groundnut and clusterbean, respectively

salinity (Table 1). The germination percentage decreased significantly with higher salinity levels as it varied to a large extent, from 33 % at 0.5 EC_{iw} (soil EC_e 2.75 dS m⁻¹) to 1.9 % at 6.0 EC_{iw} (soil EC_e 8.80 dS m⁻¹) during initial days (up to 7 DAS) and 86.3 % at 0.5 EC_{iw} (soil EC_e 2.75 dS m⁻¹) to 53.3 % at 6.0 EC_{iw} (soil EC_e 8.80 dS m⁻¹) in a few days later (at 13 DAS). A perusal of data indicated the fastest seedling emergence rate per day over salinity regimes in groundnut was recorded in the order of EC_{iw} 0.5 > 2.0 > 4.0 > 6.0 dS m⁻¹, which dictates the dominance of salinity over seed germination. In control, fastest seedling emergence and slowest seedling emergence were recorded at 6.0 dS m⁻¹. These results indicated that the germination was delayed under high salinity stress by 5–6 days during rainy (*kharif*) season. A few previous studies on salinity have also highlighted the same [3, 6–8].

Effect on Growth Parameters, Yield and Yield Attributes

Groundnut

All the growth parameters in groundnut decreased linearly with increase in both water (EC_{iw}) and soil salinity (EC_e). Plant height, number of branches per plant, and root length showed significant reduction beyond EC_{iw} 2.0 dS m⁻¹, whereas days to 50 % flowering showed significant increase beyond 2.0 dS m⁻¹. Although no difference was observed for the counts of final plant stand and remained non-significant up to 6.0 and 6.14 dS m⁻¹ water and soil salinity, respectively during *kharif* season. It indicated that pod yield of groundnut was affected due to proportionate decrease in all growth parameters, in accordance with previous results [6, 9].

The yield attributes did not show any decreasing trend up to EC_{iw} 2.0 and EC_e 3.21 dS m⁻¹. The same trend also followed for pod yield but these parameters declined significantly beyond EC_{iw} 2.0 dS m⁻¹, except the shelling out-turn (Table 1). However, the haulm yield started to reduce significantly since beginning of salt stress in soil with saline irrigation water. The per cent reduction in pod and haulm yield at 6.0 dS m⁻¹ were 81.8, 80.7, 71.0 %, and 66.9, 56.2, 48.2 % over control, 2.0 and 4.0 dS m⁻¹, respectively. These results are in accordance with previous reports [3, 6, 10]. Hence, water salinity up to 2.0 dS m⁻¹ (soil EC_e 3.21 dS m⁻¹) can be safely used for realizing optimum pod and haulm yield of groundnut in calcareous black clay soil.

Cluster Bean

The plant height of cluster bean decreased with the increase in water and soil salinity from 0.5 to 6.0 and 2.75 to 8.80 dS m⁻¹ in the next summer season, respectively

Table 1 Effect of water salinity on periodic germination, growth, yield and yield attributing characters of groundnut

Water salinity (dS m ⁻¹)	Periodic germination (%)					Days to 50 % flowering	Growth parameters at harvest					Weight (g)		Yield (kg ha ⁻¹)	
	Days to germination						Plant height (cm)	Branches/plant	Root length (cm)	Final plant stand (%)	Shelling out-turn (%)	100- Pod	100- Kernel	Pod	Haulm
	7	8	9	10	13										
0.5	33.0	58.4	68.3	80.7	86.3	23.6	46.7	4.6	9.1	76.2	67.9	85.6	37.5	1632	2599
2.0	23.0	45.9	61.9	78.6	81.9	24.7	40.1	4.3	9.0	72.9	69.3	89.1	37.3	1536	1959
4.0	3.4	17.0	33.1	56.2	68.6	28.3	31.2	3.9	7.9	64.8	58.5	74.4	31.6	1024	1657
6.0	1.9	6.0	13.9	29.3	53.3	30.7	23.8	3.8	7.6	49.3	56.5	51.6	23.4	297	859
SEm±	3.8	5.9	3.3	3.3	3.8	0.5	1.8	0.2	0.3	5.6	3.1	3.1	1.6	89.2	33.0
LSD (P = 0.05)	13.1	18.8	11.4	11.6	13.3	1.8	6.2	0.5	1.1	NS	NS	10.7	5.6	308	114
CV (%)	30.0	25.8	18.1	11.3	9.2	2.6	8.4	11.2	14.3	11.4	13.3	7.4	7.8	16.5	10.1

Table 2 Effect of water salinity on growth, yield and nutrient contents in plant parts of cluster bean

Water salinity (dS m ⁻¹)	Plant height (cm)	Root length (cm)	Dry plant weight (g)	Yield (kg ha ⁻¹)		Final plant stand	Nutrient concentration (%) in different plant parts									
				Dry fodder	Fresh pod		Nitrogen		Phosphorus		Potassium		Sodium		Calcium	
							Shoot	Root	Shoot	Root	Shoot	Root	Shoot	Root	Shoot	Root
0.5	85.87	18.93	36.26	2064	9455	280	0.72	0.75	0.06	0.06	0.71	0.22	0.34	0.77	9.63	5.68
2.0	72.67	18.47	24.02	1595	9197	215	0.62	0.66	0.05	0.05	0.63	0.22	0.64	0.76	9.14	5.56
4.0	66.20	17.47	19.94	1142	7770	204	0.58	0.64	0.05	0.05	0.51	0.15	0.80	0.88	8.66	4.84
6.0	56.40	16.07	13.56	503	5003	123	0.59	0.45	0.05	0.05	0.35	0.12	1.11	0.99	7.50	4.77
SEm±	3.78	1.50	1.55	98	418	15.31	0.03	0.05	0.01	0.01	0.05	0.01	0.09	0.04	0.41	0.14
LSD (P = 0.05)	13.07	NS	5.36	339	1448	52.99	0.10	0.16	NS	NS	0.18	0.04	0.32	0.13	1.40	0.48
CV (%)	9.31	14.69	11.44	13	9	12.92	8.36	12.76	23.07	19.50	16.26	12.01	22.33	7.66	8.05	4.59

(Table 2). However, significant reduction in plant height was recorded at highest level of water and soil salinity while the root length did not show any difference with varying salinity level. The per cent reduction in plant height as observed at EC_{iw} 6.0 dS m⁻¹ were 52.3, 28.9 and 17.4 % over control, 2.0 and 4.0 dS m⁻¹, respectively. Further, results indicated that the recorded growth and yield attributes viz. dry weight per plant, dry fodder yield and final plant stand decreased significantly from the beginning of the salinity stress. Fresh pod yield showed no significant changes up to EC_{iw} 2.0 dS m⁻¹ (soil EC_e 4.61 dS m⁻¹) but reduction started thereafter. The per cent reduction in fresh pod yield at 6.0 dS m⁻¹ was 89.0, 83.8 and 55.3 % as compared to the control, 2.0 and 4.0 dS m⁻¹, respectively. Fresh pod yield at 2.0 dS m⁻¹ did not differ significantly with that at control (0.5 dS m⁻¹). Thus it indicated water salinity up to 2.0 dS m⁻¹ (soil EC_e 4.61 dS m⁻¹) can be safely used for the benefit of farmers to get higher fresh pod yield during summer season. Due to the summer season the salinity build up in root zone was higher at the same EC_{iw} (2.0 dS m⁻¹) of previous *kharif* (rainy) season but cluster bean was found to be more tolerant to salinity than groundnut as evident from the results.

Effect of Salinity on Nutrients Concentrations in Plant Parts

Groundnut

Different salinity levels influenced the nutrient compositions in different plant parts of groundnut (Table 3). The Na accumulation in different parts of groundnut increased with successive increase in the salinity levels in irrigation water. Significant increase started in shoot beyond EC_e 3.21 and EC_{iw} 2.0 dS m⁻¹ in soil and water, respectively.

The per cent increase observed for Na concentration at 6.0 dS m⁻¹ were 32.0, 47.1, 47.8 in root, 14.3, 45.5, 70.0 in shoot and 30.0, 41.7, 58.8 in kernel over control, 2.0 and 4.0 dS m⁻¹, respectively, similar to the previous research findings [11–13]. High Na content generally disrupts the nutrient balance, thereby causing specific ion toxicity despite disturbing osmotic regulation [14]. In this study, the highest Na accumulation was observed in roots of groundnut; while the lowest accumulation was found in kernel. Similar to the findings, Nedjimi and Daoud [13] and Tuncturk [15] also noted increased sodium concentration in shoot, root leaf and pod of other crops under salinity stress. Na accumulation in roots of groundnut was higher at a magnitude of 66.7, 73.1, 67.7, 42.0 % and 80.6, 80.8, 82.4, 75.4 % than shoots and kernels with respect to four salinity levels, respectively. The results showed that, K accumulation in the various parts of groundnut was significantly affected by salinity, except kernels. Different level of salinity had significant effect on K content of the plant parts of groundnut and increasing salinity levels decreased K content of all the plant parts. While the highest K accumulation was observed in the control application, the lowest K accumulation was determined in EC_{iw} 6.0 dS m⁻¹. Among the plant parts a reverse trend was observed in case of K than Na. More K accumulated in kernels; while the lowest K was determined in roots. The K accumulations in kernels of groundnut were 58.0, 69.7, 79.7 and 82.1 % higher than roots in four different EC_{iw} levels, respectively. The overall trend indicated that K accumulation was higher in aerial parts (shoot and kernel) of groundnut as compared to the root in contrast to Na. This clearly showed the antagonistic effect of Na and Ashraf [16] summarized that glycophytes can use both ion exclusion and inclusion mechanisms in response to saline substrates. The mechanism that is used depends on the pattern of ion distribution between the leaf and on ion

Table 3 Effect of water salinity on major nutrient contents in plant parts of groundnut

Water salinity (dS m ⁻¹)	Nutrient concentration (%) in different plant parts														
	Nitrogen		Phosphorus			Potassium			Sodium			Calcium			
	Shoot	Kernel	Root	Shoot	Kernel	Root	Shoot	Kernel	Root	Shoot	Kernel	Root	Shoot	Kernel	
0.5	1.68	4.08	0.12	0.25	0.83	0.29	0.72	0.69	0.36	0.12	0.07	4.1	5.0	5.6	
2.0	1.69	4.12	0.11	0.28	0.83	0.20	0.65	0.66	0.52	0.14	0.10	3.7	5.5	5.6	
4.0	1.77	3.24	0.14	0.37	0.83	0.14	0.58	0.69	0.68	0.22	0.12	3.4	6.7	5.7	
6.0	1.95	3.31	0.09	0.32	0.81	0.12	0.46	0.67	0.69	0.40	0.17	2.7	7.5	5.7	
SEm±	0.28	0.09	0.01	0.03	0.04	0.02	0.03	0.02	0.04	0.02	0.01	0.203	0.14	0.18	
LSD (<i>P</i> = 0.05)	NS	0.3	NS	NS	NS	0.06	0.10	NS	0.14	0.06	0.03	0.70	0.47	NS	
CV (%)	3.8	9.1	37.8	27.1	14.4	21.1	27.1	10.7	19.9	46.7	21.6	17.4	17.0	8.7	

compartmentation within the cell [17]. In saline soils, salinity causes not only high Na⁺ and Cl⁻ accumulation in plants, but it can also influence the uptake of essential nutrients such as K⁺ and Ca²⁺ due to the effect of ion selectivity [18, 19]. The basis of cellular K⁺ versus Na⁺ discrimination is difficult to establish at the whole plant level because various transporters involved in K⁺ transport are differently regulated in various organs and tissues and such regulation also strongly depends on plant age [20, 21]. Many studies have shown that K⁺ concentration in plant tissues get reduced as Na⁺ salinity or Na⁺/Ca²⁺ ratio in the rooting media get increased [22].

The results showed that, Ca accumulation was significantly affected by salinity in the various plant parts of groundnut, except kernels. Increasing salinity decreased Ca content of root with concomitant increase in shoot. P and N content showed non-significant changes in the groundnut plant parts, however significant reduction in N content was recorded in kernels. It has been noticed that the excess Na⁺ in shoot tissues of groundnut under salt stress does not move to flower rather a portion to the kernel. In contrast, K⁺ and Ca²⁺ move from shoot tissues to all reproductive organs including flowers with being the highest to the kernels [23].

EC_{iw} 6.0 dS m⁻¹ produced the highest Na/K ratio in shoots, roots, leaves and kernels of the groundnut. The highest Na/K accumulation ratio was recorded in roots of groundnut; while the lowest ratio was found in pods. Transport of K⁺ to the aerial parts of the groundnut shoot, leaves and kernels was significantly reduced with increased salinity while successive increase in Na/K ratio was observed. This implies a competition between Na and K absorption in groundnut plant, resulting in antagonism [24]. Hence the reduction in K content due to excess Na is likely to be the result of the competitive intracellular influx of both ions [25]. It is generally accepted that increased K/Na selectivity and reduced Na translocation from roots to other aerial parts contributes the overall salt tolerance in glyco-phytes [26, 27].

Cluster Bean

By studying the mineral composition of cluster bean, it was found that, concentrations of different nutrients (N, P, K, Ca) in shoot and root were continuously decreased with increase in water and soil salinity (Table 2). However, Na concentration in these plant parts significantly increased with increase in water and soil salinity. K and Ca concentration is higher in shoot over root but the reverse trend was noticed for Na, while N and P showed almost similar trend in shoots and roots of cluster bean.

Increasing salinity decreased N and K content of shoot and root up to EC_{iw} 6.0 dS m⁻¹ but P content was not significantly affected by the increase of the different EC_{iw} levels. Many investigators reported that, increasing salt concentration in irrigation water decreased nitrogen content of the plant tissues [28, 29]. The obtained results also showed that Na and Ca content were affected reciprocally by salinity. Ca percentage was gradually decreased by increasing irrigation water salinity up to its highest level while Na percentage increased linearly with salinity. Similar kinds of observations were noted by previous workers on different crops [29].

Conclusion

The present study concludes that cluster bean can be successfully grown as a succeeding crop in rotation with *khariif* groundnut in spite of elevation in root zone salinity during summer. However both the crops can sustain their agronomic efficiency up to EC_{iw} 2.0 dS m⁻¹ and showed a declining trend of plant height, pod and fodder yields beyond this level. Highest irrigation salinity (EC_{iw} 6.0 dS m⁻¹) not only hampered the growth and yield attributes but a deleterious effect was observed in terms of nutrient distribution in different plant parts. Results indicated that Na accumulation was higher in roots of

groundnut and cluster bean while K and Ca accumulation followed a reverse trend with increase in EC_{iw} and were found to be higher in aerial parts (shoots and kernels) of both the crops. Further excess Na^+ replaced the K^+ and Ca^{2+} ions by creating a nutrient imbalance in different plant parts. Reduction in N content in groundnut kernels under higher EC_{iw} indicates the altered food values in pods. The results emanated from the study give an insight of the hazards of induced salinity faced by the crops in terms of yields and nutrient accumulation behavior.

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