The Pharma Innovation Journal 2022; 11(2): 2042-2046

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(2): 2042-2046

www.thepharmajournal.com
Received: 02-12-2021
Accepted: 06-01-2022

Subhita Kumari
Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan, India

BL Yadav
SKNAU, Jobner, Rajasthan, India

Pankaj Kumar Kanswa
SKRAU, Bikaner, Rajasthan, India

Corresponding Author:
Subhita Kumari
Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan, India

Effect of sodic water, biofertilizer and phosphorus on nutrient content and uptake of summer mungbean

Subhita Kumari, BL Yadav and Pankaj Kumar Kanswa

Abstract
A pot experiment was conducted to asses the effect of phosphorus management in summer mungbean irrigated with sodic water during 2013. Three levels each of sodic water (control, 3.0 and 6.0 mmol/L), and phosphorus (control, 15 and 30 mg/kg of soil, were tested in complete randomized design with three replications. The results indicated that application of dual inoculation of PSB+VAM and phosphorus 30 mg/kg of soil significantly increased the content and uptake of N, P, K, Ca and Mg and irrigation water having RSC 1.0 mmol/L significantly increased the content and uptake of N and Na. However, content of Na decreased with the application of dual inoculation of PSB+VAM and content and uptake of P, K, Ca and Mg decreased with the application of irrigation water having RSC 1.0 mmol/L.

Keywords: Mungbean, phosphorus, PSB, VAM and RSC

Introduction

In many arid and semi-arid regions, use of saline and sodic water for irrigation in the absence of appropriate soil-water-crop management practices, often leads to the builds-up of salinity and sodicity in the soil profile which adversely affect the crop productivity and soil properties. The use of sodic water for irrigation adversely affects productivity of soil by influencing the uptake of nutrients and many soil properties Chauhan *et al.*, (1988) [5]. Such waters usually have sodium carbonate as a predominant salt. The prolonged use of such water immobilizes soluble calcium and magnesium in the soil by precipitating them as carbonates consequently the concentration of sodium in the soil solution and exchangeable complex increases and leads to the development of sodic conditions. The increased exchangeable sodium percentage (ESP) and pH of soil resulting from the long term use of sodic water leads to break down of soil structure due to swelling and dispersion of clay particles.

Responses of crops to P application on sodic soils have been reported by several workers Tomar *et al.* 1996 [39] and Yadav *et al.* 2009 [41] and it has been suggested that plants grown on saline and sodic soils may have higher P requirements than normal soils because the work against the osmotic force on absorption, translocation and accumulation of inorganic ions may be accomplished at the expense of phosphate energy, phosphorilated intermediates could act as carrier or trapping agents of anions and cautions and inorganic phosphates are components of buffer system of plants Pattanayak *et al.* 2009 [22].

Material and Methods

A pot experiment was conducted in Cage House of Department of Plant Physiology, S.K. N. College of Agriculture, Jobner during 2013 in a Complete Randomized design (CRD) with three replications. The soil was loamy sand in texture, alkaline in reaction (pH 8.10), organic carbon (1.85g/kg), low in nitrogen (128 kg/ha), medium in available phosphorus (20 kg P_2O_5/ha) and potassium (146 kg K_2O/ha) content. Bulk density, particle density, Na, Ca, Mg, CEC, exchangeable Na and ESP (1.50 Mg m-3, 2.60 Mg m-3, 9.60 me/L, 1.2 me/L, 6.8 cmol (P^+) kg/soil, 0.65 cmol/kg and 9.55, respectively) of experimental soil. The different RSC water was prepared artificially by dissolving required amount of $NaHCO_3$, NaCl, Na_2SO_4, $CaCl_2$ and $MgCl_2$ in base water (control). The tap water was used for first irrigation in all the pots and later on crop was irrigated 6 times with water of varying RSC during experimentation as per treatment and also three levels of phosphorus (control, 15 and 30 mg/kg of soil).

Results and Discussion

N and Na content in grain and straw increased significantly with increasing level of RSC water, while P, K, Ca and Mg content decreased significantly. The increased in N content in grain with increasing level of RSC waters may be attributed to a less production of crop resulting in higher concentration of N in plant (Table 1, 2, 3 and 4). According to Strogonov and Okinia (1961) [35], the N taken up by plants is not utilized and gets accumulated in organs as protein and not available for plant growth, leading to increased content of N in grain and straw. The results find support from the work of Singh *et al*. (1994) [31] Saini (1997) [27], Jatav (2000) [14], Yadav (2001) [42] and Sharma (2003) [30].

Contrary to N content, P content in grain and straw decreased due to application of different level of RSC in irrigation water. This might be due to the fact that RSC rich waters had increased the ESP and pH of soil. The higher sodicity of the soil could have decreased the mobility of P due to presence of CO_3^{2-} ions. At higher pH the proportion of HPO_4^{2-} and PO_4^{3-} have increased over $H_2PO_4^-$. The OH^- ions, thus, decrease the availability of P to the plant. The physiological availability of P in alkali soil is a function of pH and it decreased as the pH increase over the alkaline range (Pratt and Thorne, 1948, Sauchelli, 1995 and Dubey *et al*., 1993) [24, 29, 6]. Further, the decrease in K content in grain and straw of mungbean due to RSC rich waters might be due to the antagonistic effect of excess Na on the absorption of K by plant (Dwivedi and Burrows 1979) [7]. The ability of the crop to grow under high Na saturation is due to the toxic effect of Na itself and K deficiency caused by antagonistic effect between Na and K. This can be explained on the basis of hypothesis of Heimann (1958) [13], who was of the view that Na-K relationship may be synergistic or antagonistic depending upon the ratio between them. A number of subsequent studies have established that increasing sodicity decreased the K and Ca concentration and increased Na concentration in tissue (Cachoro *et al*., 1994 and Garg and Gupta, 1997) [3, 10].

The Ca and Mg content in both grain and straw decreased significantly with increasing level of RSC in irrigation water. This may be due to the fact that the increase in external Na concentration may displace Ca from the binding sites on the outer surface of plasma membrane of the root cell or more likely from interacellular membrane which decreased the availability of Ca to plants (Lynch and Lanchli, 1985) [18]. Ca is strongly competitive with Mg and binding site on the root plasma membrane appear to have less affinity for highly hydrated Mg^{2+} than for Ca^{2+} in sodic condition. Therefore, high concentration of Na usually result in decreased Ca along with marked reduction in Mg (Hansen and Munns, 1988) [11]. Ca induced Mg deficiency had also been observed in *Citronella Jawa* by Singh *et al*. (1994) [31]. These result also get support from the findings of Sudhakar *et al*. (1990) [36], Rengel (1992) [26] and Essa (2002) [8] and Prasad *et al*. (2010) [23].

Inoculation of biofertilizers significantly increased the content and uptake of N, P, K, Ca and Mg and decreased the content of Na by mungbean (Table 1, 2, 3 and 4). It could be attributed to better root growth due to increased availability of P by PSB + VAM besides secretion of growth promoting substances (Totawat *et al*., 2000) [40]. VAM increased nutrient uptake (Chaturvedi *et al*., 1987) [4] through a reduction of the distance that nutrients must diffused to plant roots (Somani, 2002) [33] by accelerating the rate of nutrient absorption and nutrient concentration at the absorption surface (Bowen *et al*., 1975) [2] and finally be chemically modifying the availability of nutrients for uptake by plants through mycorrhizal hyphae (Somani., 2004) [34].

The nutrient content and uptake by crops were enhanced when the seeds were inoculated prior to sowing which can be described to the increased specific activities of isocitric and malic dehydrogenase, the source of electrons for fixation (Kurtz and Larue, 1975) [17], creating a better nutritional environment. Interactive effect of two or more organisms and increased uptake of phosphorus due to solubilization effect of two or more organisms and increased uptake of phosphorus due to solubilization effect of phosphate solubilizing bacteria or better uptake under VAM treated pots was also reported by Tarafdar and Rao (1997) [38], Rao (1998) [25] and Saini *et al*. (2004) [28]. These findings are in confirmation with findings of Kundu and Gaur (1980) [16], Frieties *et al*. (1982) [9] and Meshram and Shende (1982) [21] and Hazarika *et al*. (2000) [12]. N, P, K, Mg and Ca content in grain and straw, increased significantly with the increase in the level of phosphorus up to 30 mg P kg-1 soil.

The increase in N content might be due to well-developed root system which might have increase the availability of phosphorus to soil microbs which leads to increased multiplication of *Rhizobium* bacteria and which in turn resulted in increased atmospheric N_2-fixation by better utilization of soil nitrogen (Tandan, 1991) [37]. The increased availability of P status in soil increased the nutrient content both macro and micro with P fertilization could be attributed to the balanced nutrient status of soil which was deficient in N and P and medium in K. The greater availability of improved the plant root system which resulted in greater K accumulation in the crop (Table 1, 2 and 3). These results are in the line with findings of Agarwal (1997) [1], Kumawat *et al*. (1998) [15], Meena and Agarwal (1999) [20] and Singh *et al*. (2009) [31]. K, Ca and Mg content in grain and straw increased significantly, while, Na decreased significantly with increasing level of phosphorus (Table 4). The Na^+ ion react with soil-P and get precipitate in their insoluble form (Na-phosphate) by which availability of Na to plant become very less with increasing level of phosphorus. Na^+ cation may also replaced by $H_2PO_4^-$ anion from exchangeable site by which a decrease in Na absorption occur by plants ultimately Ca, Mg content increase and Na content decrease in grain and straw (Manchanda *et al*., 1991) [19].

Table 1: Effect of different RSC water, biofertilizer and phosphorus on N content (%) and uptake (mg/pot) in grain and straw

Treatments	N content		N uptake	
	Grain	Straw	Grain	Straw
RSC water				
S_0	3.045	0.779	13.73	4.87
S_3	3.260	0.820	12.26	4.71
S_6	3.387	0.869	10.50	4.45
S.Em+	0.010	0.009	0.17	0.07
CD (P=0.05)	0.028	0.026	0.47	0.19
Biofertilizer				

No inoculation	3.041	0.775	9.34	3.92
PSB	3.260	0.820	12.26	4.71
PSB + VAM	3.395	0.877	15.11	5.45
S.Em+	0.010	0.009	0.17	0.07
CD (P=0.05)	0.028	0.026	0.47	0.19
P level (mg P kg^{-1} soil)				
P_0	3.042	0.776	9.28	3.93
P_{15}	3.260	0.820	12.10	4.69
P_{30}	3.390	0.872	15.12	5.41
S.Em+	0.010	0.009	0.17	0.07
CD (P=0.05)	0.028	0.026	0.47	0.19

Table 2: Effect of different RSC water, biofertilizer and phosphorus on P content (%) and uptake (mg/pot) in grain and straw

Treatments	P content		P uptake	
	Grain	Straw	Grain	Straw
RSC water				
S_0	0.512	0.154	2.334	0.970
S_3	0.480	0.140	1.825	0.810
S_6	0.422	0.125	1.323	0.645
S.Em+	0.001	0.002	0.024	0.015
CD (P=0.05)	0.003	0.007	0.068	0.042
Biofertilizer				
No inoculation	0.420	0.123	1.321	0.631
PSB	0.480	0.140	1.825	0.810
PSB + VAM	0.513	0.155	2.338	0.977
S.Em+	0.001	0.002	0.024	0.015
CD (P=0.05)	0.003	0.007	0.068	0.042
P level (mg P kg^{-1} soil)				
P_0	0.421	0.124	1.315	0.637
P_{15}	0.479	0.139	1.820	0.806
P_{30}	0.514	0.156	2.347	0.981
S.Em+	0.001	0.002	0.024	0.015
CD (P=0.05)	0.003	0.007	0.068	0.042

Table 3: Effect of different RSC water, biofertilizer and phosphorus on K content (%) and uptake (mg/pot) in grain and straw

Treatments	K content		K uptake	
	Grain	Straw	Grain	Straw
RSC water				
S_0	0.794	1.270	3.588	7.892
S_3	0.754	1.250	2.844	7.141
S_6	0.695	1.228	2.160	6.246
S.Em+	0.003	0.006	0.039	0.077
CD (P=0.05)	0.008	0.018	0.111	0.220
Biofertilizer				
No inoculation	0.701	1.228	2.187	6.224
PSB	0.754	1.250	2.844	7.141
PSB + VAM	0.795	1.271	3.595	7.909
S.Em+	0.003	0.006	0.039	0.077
CD (P=0.05)	0.008	0.018	0.111	0.220
P level (mg P kg^{-1} soil)				
P_0	0.698	1.230	2.163	6.236
P_{15}	0.752	1.249	2.835	7.157
P_{30}	0.793	1.269	3.594	7.886
S.Em+	0.003	0.006	0.039	0.077
CD (P=0.05)	0.008	0.018	0.111	0.220

Table 4: Effect of different RSC water, biofertilizer and phosphorus on Ca, Mg and Na content (%) in grain and straw

Treatments	Ca		Mg		Na	
	Grain	Straw	Grain	Straw	Grain	Straw
RSC water						
S_0	0.245	0.730	0.126	0.084	0.336	0.489
S_3	0.236	0.670	0.124	0.082	0.359	0.537
S_6	0.210	0.610	0.116	0.080	0.393	0.568
S.Em+	0.001	0.002	0.001	0.003	0.003	0.004
CD (P=0.05)	0.003	0.005	0.002	NS	0.009	0.011

Biofertilizer						
No inoculation	0.211	0.620	0.118	0.079	0.391	0.580
PSB	0.236	0.670	0.124	0.082	0.359	0.537
PSB + VAM	0.249	0.730	0.126	0.085	0.336	0.481
S.Em+	0.001	0.002	0.001	0.003	0.003	0.004
CD (P=0.05)	0.003	0.005	0.002	NS	0.009	0.011
P level (mg P kg^{-1} soil)						
P_0	0.210	0.622	0.118	0.080	0.390	0.579
P_{15}	0.233	0.665	0.123	0.082	0.363	0.537
P_{30}	0.248	0.723	0.125	0.084	0.335	0.478
S.Em+	0.001	0.002	0.001	0.003	0.003	0.004
CD (P=0.05)	0.003	0.005	0.002	NS	0.009	0.011

References

1. Agarwal HR. Effect of irrigation, phosphorus and sulphur on funugreek (*Trigonella foenum-graecum* L.). Ph.D. (Ag.) Thesis, RAU, Bikaner. (Raj.), 1997.
2. Bowen GD, Bevege DI, Mosse B. The phosphate physiology of *vesicular arbuscular mycorrhizas*. In *Endomycorrhiza*, Eds. Sanders, F.E., Mosse, B. and Tinker, P.B. Academic Press, London, 1975, 241-260.
3. Cachoro R, Ortiz A, Cerda A. Implications of calcium nutrition on the response of *Phaseolus vulgaris* to salinity. PIant and Soil. 1994;159:205-212.
4. Chaturvedi C, Sharma AK, Singh R. Plant growth responses to *vesicular-arbuscular mycorrhiza* (VAM) in chickpea *(Cicer arietinum*). In: Mycorrhiza Round Table, proceedings of a workshop (13-15 March), New Delhi, 1987, 402-409.
5. Chauhan RPS, Bhudayal, Chauhan CPS. Effect of residual sodium carbonate in irrigation water on soil and bread wheat (*Triticum aestivum* L.). Indian Journal of Agricultural Science. 1988;58:454-458.
6. Dubey SK, Sinha AK, Yadav BR. Effect of sodic waters and applied phosphorus on uptake of phosphorus and grain yield of green gram. Journal of the Indian Society of Soil Science. 1993;41:205-209.
7. Dwivedi CA, Burrows I. Plant Physiology in a decade of Research CSSRI (ICAR) Karnal, 1979, 115.
8. Essa TA. Effect of soil salinity on yield and quality of soybean. Journal of Agronomy and Crop Science. 2002;138:86-93.
9. Frieties JL, De M, De RE, Rocha PAA, Pereira, Dobereiner J *et al*. Mate tria organicae inoculacao con *Azospirillum* as incorporacao de N pelo milho, Pesquisa Agropecuaria Brasileira. 1982;17:1423-1432
10. Garga GK, Gupta IC. Physiology and salt tolerance of arid zone gops-II clusterbean, Current Agriculture. 1997;21:23-24.
11. Hansen EH, Munns DN. Effect of $CaSO_4$ and NaCl on mineral content of *Leucaena leucocephala*. Plant and Soil. 1988;107:101-105.
12. Hazarika DK, Das KK, Dubey NL, Phookan AK. Effect of vesicular arbushcular mycorrhizal (VAM) fungi and *rhizobium* on growth and yield of green gram (*Vigna radiata* L.). Journal of Mycology and Plant Pathology. 2000;30:424-426.
13. Heimann H. Irrigation with saline water and the ionic environment. *Potassium Symposium* Abstract. 2000;1958:173-220.
14. Jatav MK. Efficiency of zinc and iron application on the performance of wheat in treated sodic soil, irrigated with saline sodic water. M.Sc. (Ag.) Thesis, MPUAT, Udaipur, 2000.
15. Kumawat SK, Agarwal HR, Pareek RG. Effect of row spacing and phosphorus levels on fenugreek (*Trigonella fenum-graecum* L.) with and without *Rhizobium* inoculation. Annals of Biology. 1998;14:161-164.
16. Kundu BS, Gaur AC. Establishment of nitrogen-fixing and phosphate-solubilizing bacetia in rhizosphere and their effect on yield and nutrient uptake of wheat crop. Plant and Soil. 1980;57:223-230.
17. Kurtz WGW, Larue TAG. Effect of nitrogen source and carbon metabolism by *Azotobacter vinelandii* sp. grown in chemostat and batch culture. Canadian Journal of Microbiology. 1975;21:738-741.
18. Lynch J, Lauchli A. Salt stress distribute the calcium nutrition of barley (*Hordeum vulgare* L.). New Physiology. 1985;99:345-354.
19. Manchanda HR, Sharma SK, Mor RP. Relative tolerance of pulses for chloride and sulphate salinity. Indian Journal of Agricultural Sciences. 1991;61:20-26.
20. Meena NL, Agarwal HR. Effect of irrigation, phosphorus and sulphur on quality and nutrient uptake in fenugreek (*Trigonella foenum graecum* L.), 4th Agricultural Science Congress. 1999 Feb;173:325.
21. Meshram SU, Shende ST. Response of maize to *Azotobacter chroococcum.* Plant and Soil. 1982;69:265
22. Pattanayak SK, Suresh Kumar P, Tarafdar JC. New vista in phosphorus research. Journal of the India Society of Soil Science. 2009;57:536-545.
23. Prasad A, Chattopdhyay, Chand S. Effect of zinc sulphate and farm yard manured on lemongrass (*Cymbopogan flexuous*) under sodic water irrigation. Journal of the Indian Society of Soil Science. 2010;58:315-322.
24. Pratt PF, Thorne DW. Sodicity and availability of phosphate in sodium and calcium system. Soil Science. 1948;13:213-217.
25. Rao DLN. Microbiological processes. In: Agricultural Salinity Management in India. (N.K. Tyagi and P.S. Miinhas, Ed.), Central Soil Salinity Research Institute, Karnal, India, 1998, 125-143.
26. Rengel Z. The role of calcium in salt toxicity in plant cell and environment. 1992;15:625-632.
27. Saini VK. Screening of foxtailmillet (*Setaria italica L.*) genotypes tolerant to high RSC water on Haplustalf. M.Sc. (Ag.) Thesis, RAU, Bikaner, 1997.
28. Saini VK, Bhandari SC, Tarafdar TC. Comparison of crop yield, soil microbial C, N and P, N-fixation, nodulation and mycorrhizal infection in inoculated and non-inoculated sorghum and chickpea crops. Field Crop Research. 2004;89:39-47.
29. Sauchelli V. Phosphate in agriculture. Reinhold publishing corporation, New York, 1995.
30. Sharma GK. Role of soil applied gypsum in reducing

toxic effects of boron and SAR of irrigation water on wheat under sodic soil. Ph.D. Thesis, RAU, Bikaner, 2003.
31. Singh DP, Pal B, Gill HS. Effect of sodic irrigation water on nutrient and oil content of palmarosa. Journal of the Indian Society of Soil Science. 1994;42:355-337.
32. Singh M, Kumar R, Panwar BS. Effect of phosphorus on fodder yield, uptake and its critical limits in soils for Indian mustard. Forage Research. 2009;35:23-26.
33. Somani LL. Phosphatic biofertilizers - Agrotech Publishing Academy, Udaipur, 2002.
34. Somani LL. Handbook of Biofertilizer. Agrotech Publishing Academy, Udaipur, 2004, 1168.
35. Strogonov BP, Oknina EZ. Study on the dormancy of plant under condition of irrigation with sodic solution. Fiziol Research. 1961;8:79-85.
36. Sudhakar C, Reddy PS, Veeranjanellu K. Effect of salt stress on dry matter production and mineral content during early seedling growth of horse bean and greengram. Journal of Plant Physiology and Bio-chemistry. 1990;17:88-89.
37. Tandon HLS. Fertilizer equivalent of FYM, green manures and biofertilizers. Fertilizer News. 1991;36:69-79.
38. Tarafdar JC, Rao AV. Response of arid legumes of VAM fungal inoculation. Symbiosis. 1997;22:265-274.
39. Tomar RAS, Nemdeo KN, Raghu JS. Efficacy of phosphatase solubilizing bacteria and biofertilizer with phosphorus on growth and yield of gram (*Cicer arietinum*). Indian Journal of Agronomy. 1996;40:412-415.
40. Totawat KL, Somani LL, Singh R, Singh G. Integrated nitrogen management in maize - wheat cropping sequence on haplustalfs of sub-humid southern plain of Rajasthan. In : Proceeding of International Conference on Managing Natural Resources for Sustainable Agricultural Production in the 21st Century, New Delhi. 2000;3:923-924.
41. Yadav BK, Niwas R, Yadav RS, Tarafdar JC. Effect of *Chaetomium globosum* inoculation and organic matter on phosphorus mobilization in soil and yield of clusterbean. Annals of Arid Zone. 2009;48:41-44.
42. Yadav BS. Effect of organic manure and inorganic fertilizers on yield of wheat. International Conference on Natural Farming and Ecological Balance, CCS HAU, Hissar, India, March. 2001;132:7-10