SOME ECOLOGICAL STUDIES ON *ATRIPLEX CRASSIFOLIA* C.A. MEY AROUND LAHORE

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Sociological and autecological investigations were carried out about *Atriplex crassifolia.* Association *Atriplicetum crassifolia* was classified from waste lands around Lahore using Zurich Montpellier School of Thought. It was seen that character species was dominant and abundant on soils having EC 2.3 - 5.3 dS m^{-1} and soil moisture contents 8.34 - 16.35%. The results were compared by growing the test species in greenhouse at different salinity levels.

INTRODUCTION

The relationship of vegetation and soil characteristics is so interdependent that they become indicative of each other. A habitat under existing environment would permit plants adaptation to the surrounding conditions. Thus, the soil plant relationship becomes so intimate that plants reflect the ecological conditions of the inhabited area. The study of plant species growing in an area may provide useful information regarding the degree of salinisation and soil deterioration. Such information is helpful in more effective planning of practical uses and reclamation of salt affected soils.

Workers such as Gale and Mayber (1970), Wallace *et al.* (1982) and Soufi and Wallace (1982) investigated that *Atriplex* species are inhabitants of high saline and dry conditions. Although, their is variability among the different species in respect of salt tolerance yet their study may prove useful to indicate the salient soil features of that area. *Atriplex crassifolia,* a member of family chenopodiaceae is a wild, annual and palatable plant native to arid and semi-arid parts of the Punjab. The plant is quite common on soils which are xerohaline.

The present study is also a part of the research program to determine the relationship with physical and chemical characteristics of saline, saline-sodic and sodic soils and problems associated with management and utilization of such soils with the sociological and ecological studies of halophytic vegetation of this area.

MATERIALS AND METHODS

Field work: The field work was carried out around Lahore during 1988. The data were collected by recording the cover abundance value on the 10 points domin scale of all the plants within homogeneous plots of *Atriplex crassifolia* stands wherever seen. The size of quadrat (2 x 2 m) was based on the minimal area determination. The field data were tabulated on the basis of constancy and dominance. Community association and subassociation were given according to the code of phytosociological nomenclature (Berman, 1976). Eighteen soil samples were collected from rootzone from different quadrats with different cover abundance of test species and analysed.

Plant Growth Experiments

1. Germination: Seeds were collected from wastelands near Jallo Park, Lahore. Seed

germination was studied in sterilised petridishes at different salinity levels (0, 0.5, 1.0, 1.5, 2.0, 2.5 and 3.0%) that were prepared by dissolving calculated amount of NaCl in distilled water. Emergence of radicle was taken as indication of seed germination. Percentage germination in each salinity level was calculated.

2. Growth measurements: Plants were grown in plastic pots each with 2 kg soil. Different salinity levels were prepared by adding calculated amount of NaCl in air dried soil. Six seeds were sown in each pot. Only three plants were kept in each pot after the establishment of seedling. The plants were irrigated with distilled water whenever required. These were harvested 9 weeks after germination, washed with distilled water and dried with tissue paper. Fresh and oven dry weights of shoots and roots were recorded. Then oven-dried and dry weights were taken. Other morphological features such as shoot length, root length, number of leaves, second leaf area and second internode length were also recorded.

3. Soil and plant analysis: Soil samples used in the experiment were analysed for lime, organic matter, pH, EC of saturated soil extract, Na^+, K^+, Ca^{2+}, Mg^{2+}, CO_3^{2-}, HCO_3^-, Cl^- and SO_4^{2-} as described by Richards (1954) and Allen (1974). Plants grown in the greenhouse were analysed for Na^+, K^+, Mg^{2+}, Ca^{2+} and Cl^-.

RESULTS

Field studies: The community associates and companion species association *Atriplicetum crassifoliae* are shown in Table 1. This table shows that *Suaeda fruticosa* is a differential species of this community type. *Suaeda fruticosa* has lower cover and frequency, however, it becomes abundant wherever the salt concentration arises and *A. crassifolia* is decreased. The other associated species with constancy class III and IV are Chenopodium *(album x murale)* and *Cynodon dactylon* which form sub-associations of association *Atriplicetum crassifoliae.* The association *Atriplicetum crassifoliae,* therefore, has been divided into 3 sub-associations namely sub-association typicum, chenopoditosum and Cynodactosum dactylae. The soil characteristics of association are given in Table 2. This table shows that character species is dominant at moderate salinity (EC 2.3 - 5.3 dS m^{-1}) and moderate soil moisture (8.34 - 16.35%). The cover abundance of this species is low at high salinity. Similar results were obtained by growing the test species in culture media (soil) with added salts.

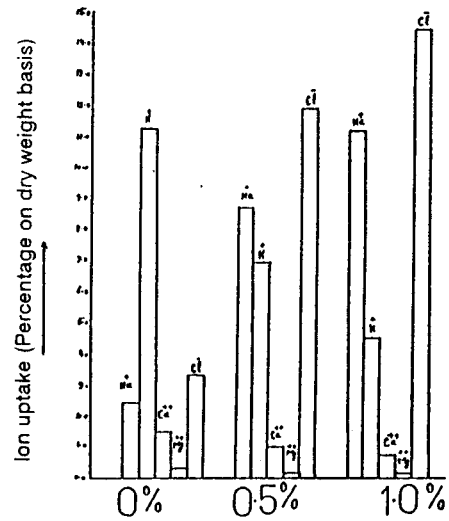

Fig. 1. Percentage germination of *Atriplex crassifolia* at different salinity levels (Vertical bars show standard error).

Seed germination and growth measurements: The results of seed germination are shown in Fig. 1 which shows that the percentage germination decreased progressively with increase in salinity level. In control (0%) and 0.5% NaCl treatments germination started after 24 hours and maximum

Table 2. Relationship between percentage cover of Atriplex crassifolia and its relation with some of the soil characteristics

Percentage cover (on domin scale)	EC M MOH/CM (of saturated soil extract)	Text class	Percentage moisture
10	2.30	Loam	14.68
9	5.30	Sandy loam	16.35
8	4.60	Silt loam	9.35
8	1.90	"	9.33
8	4.50	"	8.34
8	1.90	Sandy loam	2.51
7	7.20	Sandy loam	7.12
5	5.60	Loam	5.00
5	17.50	"	3.09
3	23.00	Sandy loam	6.95
3	14.00	Silt loam	4.49
6	0.65	Sandy loam	2.00
4	1.15	Silt loam	4.40
4	1.30	"	21.95
4	0.85	Sandy loam	25.50

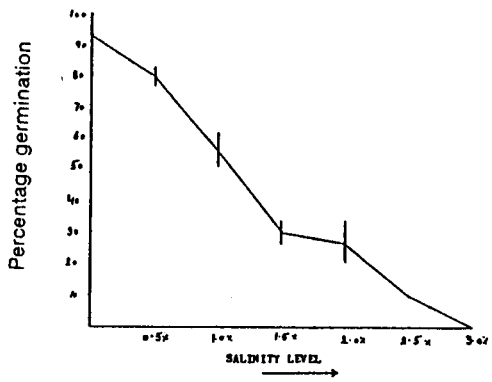

Fig. 2. Mineral composition of dry shoot of *Atriplex crassifolia* in relation to NaCl salinity.

germination (93.3 and 80.0%, respectively) was obtained after three days, respectively. In 1% added NaCl treatment, germination started after 48 hours and maximum germination (56.6%) was obtained after 7 days. In 1.5%, 2.0% and 2.5% salinity levels, germination started after three days and became constant (30.0%, 26.6% and 10%, respectively) after 9 days. There was no germination in 3% salinity level. Analysis of soil samples used in the experiment is shown in Table 3. No plant growth was seen in 1.5% and higher salinity levels.

Growth measurements of various growth parameters are shown in Table 4 which expresses the mean of 9 (3 + 3 +3) plants grown in each salinity level. Growth was maximum in 0.0% salinity level (EC 2.82 dS m^{-1}), while higher salinity levels inhibited the growth. Reduction in shoot

Table 1. Association *Atriplicetum crassifoliae,*

Sub-association *Atriplicettosum crassifolia,* Sub-association *Chenopodetosum* and Sub-association *Cynodetosum dactyale*

Running quadrat No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
Releve Code No.	RF_2	JT_1	JF_2	JRS	JT_2	RF_3	JT_3	RP_2	GT_4	JT_2	RT_2	RGS_1	JT_5	JT4	JT8	RGS2	RP1	JP1	RF4	J
Area of Quadrat m^2	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	
No. of species	8	9	7	11	7	7	5	7	5	13	5	6	13	11	11	11	10	8	6	
Percentage cover	100	100	100	75	100	90	65	85	35	70	80	75	75	60	65	70	90	75	80	
Atriplex crassifolia	10	9	9	8	8	8	7	7	7	8	8	8	8	6	4	5	4	5	3	
Suaeda fruticosa					3				+											
Chenopodium (album x murale)									3	4	5	5		3	5	4	5	3	3	
Cynodon dactylon	3	3	4	5	3	3		3	3	6	3			1		3	5	3	3	
Meliotus alba				1			2			3			3	3	1		3			
Conyza bonariensis	2	1								5						3	5	2		
Coronopus didymus	3	3				3				3				3			3	4	3	
Sonchus asper	1		3							4					3					
Sisymbrium irio	2	2	4										3	3		3			3	
Cenchrus pennisetiformis						3		4		4				4		5	6			
Dicanthium annulatum				3	3									1						
Achyranthes aspera				2	3								3		3					
Cannabis sativa		+	3							4		3	3	3						
Medicago polymorpha				3													+			
Solanum nigrum			2	+								1	1		+	1				
Imperata cylindrica							4							6	3	4		3		
Malvestrum coromendelianum			3																	
Rumex dentatus	1																			
Qalis corniculata		1								3			1						2	
Abutilon indicum							3	3					3							
Chenopodium album								3							+					
Callium aparine	3	3	3													3	3			
Alhaji maurorum		3						3						3						
Spergula arvensis		3								3			3		2					

Also *Inula vestita* in JT_2-3; JT_4-3; *Lagger aurita* in R_3-3; JT_4-3, *Euphorbia halioscopia* in NC_2-3; *Fumaria indica* in JT_5-3, JT_8-5; *Chenopodium murale* in RP_2-3, JT_6-3; *Amaranthus viridis* in RGS_1-+, RF_1-1; *Ricinus comm* in RF_3-4; *Urena lobata* in GT_4-5, RT_2-4; *Digitaria stricta* in GT_3-3; *Panicum antidotale* in RT_3-4, GT_3-3; *Trianthema monogyna* in GT_3-4; *Phalaris minor* in RP_1-2; *Prosopis juliflora* in RF_3-6 and *Phyla nodiflora* in GT_2-8 *Veronica didyma* in JT_2- 3; JT_5-3; *Eleusine compressa* in RT_5-8, RT_6-3; *Saccarum munja* in GT_2-3, GT_4-4.

11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
RT_2	RGS_1	JT_5	JT4	JT8	RGS2	RP1	JP1	RF4	JT6	RP3	JP3	JP4	NC2	RT5	RT6	RT7
4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
5	6	13	11	11	11	10	8	6	4	7	14	10	9	5	6	7
80	75	75	60	65	70	90	75	80	45	85	100	55	65	95	55	60
8	8	8	6	4	5	4	5	3	4	6	4	3	5	6	5	6
													5			
5	5		3	5	4	5	3	3								
3			1		3	5	3	3		7	8	5	3		5	4
		3	3	1		3				3	5	3	2			1
					3	5	2				3	1	3			1
			3			3	4	3		3	2					5
				3								3				
		3	3		3			3		3			2			3
			4		5	6			5			3				
			1							3	2					1
		3		3						1		+				
	3	3	3													
						+					2		+			
	1	1		+	1						2					
			6	3	4		3		4							
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		1						2			3					
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henopodium murale in RP_2-3, JT_6-3; *Amaranthus viridis* in RGS_1-+, RF_1-1; *Ricinus communis* in RC_1-1, RGS_2-4; *Malva parviflora* in RF_2-3, JP_3-2; *Sporobolus arabicus* GT_3-4; *Phalaris minor* in RP_1-2; *Prosopis juliflora* in RF_3-6 and *Phyla nodiflora* in GT_2-8; *Anagallis arvensis* in JRS-3, JP_3-3; *Convolvulus arvensis* in JRS-2, RT_6-3;

Table 3. Soil analysis after the addition of sodium chloride (average of three replicates)

Salinity level	Texs class	Electrical conductivity m moh cm^{-1}	pH	Per cent organic matter	Per cent $CaCO_3$	Cations m.eq l^{-1}				Anions m.eq l^{-1}				SAR	ESP
						Na^+	Ca^{++}	Mg^{++}	K^+	CO_3^-	HCO_3^-	Cl^-	SO_4^-		
0.0%	Silt loam	2.82 ± 0.045	7.66 ± 0.024	6.73 ± 0.25	3.66 ± 0.17	12.75 ± 1.5	6.0 ± 0.87	19.0 ± 6.3	4.02 ± 0.31	Absent	4.7 ± 0.57	8.83 ± 0.77	14.63 ± 1.45	4.29 ± 1.55	4.47 ± 2.0
0.5%	"	18.33 ± 0.40	7.43 ± 0.03	6.97 ± 0.09	4.83 ± 0.45	133.0 ± 3.21	7.4 ± 0.39	49.6 ± 3.25	4.36 ± 0.54	"	5.16 ± 0.44	166.0 ± 2.85	12.0 ± 1.04	24.93 ± 0.67	26.2 ± 0.05
1.0%	"	33.66 ± 0.88	7.3 ± 0.0	6.83 ± 0.05	3.85 ± 0.17	293.0 ± 5.69	9.7 ± 0.75	65.6 ± 3.29	4.1 ± 0.22	"	4.83 ± 0.17	315.0 ± 7.58	16.83 ± 1.83	47.8 ± 0.68	40.9 ± 0.53

length as compared to control was 45.6% in 0.5% treatment and 74.0% in 1.0% treatment. Reduction in biomass production was 73% in 0.5% NaCl treatment and 82% in 1.0% salinity level. Fresh and dry weight of the shoot and root was also affected in the same way. Lower leaf shedding was not seen in 0.0% treatment while in 0.5% and 1.0% treatments average leaf fall was 2.0 and 3.5 leaves $plant^{-1}$.

Mineral composition of plants: Mineral composition of the plant shoots grown in greenhouse is shown in Fig. 2. At low salinity, absorption of K^+ was greater than that of Na^+ but sodium uptake and accumulation increases progressively with increase in salt content of root medium and that of K^+ decreased in the same proportion. The absorption of Ca^{2+} and Mg^{2+} was affected at higher salinity levels while Cl^- uptake increased with increase in salinity level.

DISCUSSION

The association *Atriplicetum crassifoliae* was abundant on the fringes of saline soil. The character species was dominant in the soils where salt concentration was between 2.8 - 5.3 dS m^{-1}. At a very high salt concentration (EC = 23 dS m^{-1}), its constancy and dominance was considerably reduced (Table 2). The differential species of this association, *Suaeda fruticosa* was sparsely present. The companion species were *Chenopodium (album x murale) Cynodon dactylon, Melilotus alba, Coronopus didymus, Conyza bonariensis, Sonchus asper, Sisymbrium irio, Cenchrus pennisetiformis, Dicanthium annulatum, Achyranthus aspera, Cannabis sativa, Medicago polymorpha, Solanum nigrum, Imperata cylindrica, Anagalis arvensis, Malvestrum coromandelianum, Rumax dentatus, Oxalis corniculata, Abutilon indicum, Chenopodium album, Convolvulus arvensis, Gallium aparine,*

Table 4. Growth measurements plant^{-1} at harvest at different salinity levels (means of 9 plants)

	Salinity level (%)		
	0.0	0.5	1.0
Shoot length (cm)	15.3 ± 1.77	8.2 ± 0.47	3.98 ± 0.28
Root length (cm)	11.43 ± 1.00	4.33 ± 0.38	3.24 ± 0.13
Leaves	12.33 ± 0.99	8.22 ± 0.8	6.22 ± 0.56
Second internode (mm)	5.77 ± 0.85	3.55 ± 0.40	2.07 ± 0.46
Second leaf area (cm^2)	30.9 ± 0.89	16.96 ± 0.65	7.37 ± 0.30
Fresh plant weight (mg)	1927.55 ± 293.23	513.9 ± 23.2	338.4 ± 13.68
Fresh shoot weight (mg)	1847.66 ± 222.5	502.31 ± 24.15	334.76 ± 13.6
Fresh root weight (mg)	79.88 ± 18.7	10.94 ± 2.00	3.66 ± 0.23
Biomass (mg)	17347.95	4625.1	3045.6
Dry shoot weight (mg)	226.33 ± 24.45	47.66 ± 2.50	29.81 ± 1.06
Dry root weight (mg)	25.47 ± 4.13	3.74 ± 0.44	1.75 ± 0.148
Salt tolerance index (%)	100	20.4	12.53

Alhaji maurorum, Veronica didyma, Spergula arvensis, Eleusine compressa, Saccharum munja, Inula vestita, Laggera aurita, Euphorbia helioscopia, Fumaria indica, Chenopodium murale, Amaranthus viridis, Ricinus communis, Malva parvilora, Sporobolus arabicus, Urena lobata, Digitaria stricta, Panicum antidotale, Trianthema monogyna, Phalaris minor, Prosopis juliflora and *Phyla nodiflora.*

In terms of syntaxonomy, the community was classified in the alliance *Atriplicetum crassifoliae* of the order *Atriplicetalia, Littoralis,* the class *Cakiletea maritimae* and is one of the component of salt desert vegetation types described by Chapman (1974). The type of soil on which this community type grows is saline characterised by EC 4 dS m^{-1}, ESP less than 15 and pH less than 8.5 (Waisel, 1972). The associated soils of this community were similar in terms of EC, pH and ESP but association was more prominent on slightly saline soils. The height and vigour of test species was maximum up to 5.3 dS m^{-1} salinity and minimum on highly saline soils (23.0 dS m^{-1}). This showed that *A. crassifolia* was a marginally saline species. Studies on the effect of different salinity levels of NaCl on seed germination showed that the percentage germination decreased and was delayed and decrease in germination was due to the effect of NaCl on imbibition of seeds. Allen *et al.* (1986) showed that salinity inhibited the germination of alfalfa seeds through its effects on imbibition of seeds.

Productive capacity dropped in more or less linear progression with increase in salinity in rootzone. Premature chlorosis and abscission of salt saturated leaves which has been proposed by Albert (1975) as salt regulation mechanism was also significant in case of *A. crassifolia*, since leaf fall increased with increase in salt contents of root medium. Sodium concentration in plant shoot increased with increase in salinity while K^+ concentration decreased progressively. Wallace *et al.* (1982) found an in-

crease in Na^+ concentration in shoot of *A. polycarpa* and *A. canescens* with increase in salt concentration. Calcium and magnesium contents decreased with increase in salinity. Mahmood and Malik (1986) reported that Ca contents decreased in shoot and root of *A. undulata* in response to higher root medium salinity. Chloride contents were also increased with increase in salinity. Shannon *et al.* (1981) reported that increased soil salinity increased Cl^- contents in stem and leaves of Australian Channel millet. Aslam *et al.* (1987) observed increase in Cl^- concentration in *Echinochloa* with increase in rootzone salinity.

In conclusion, *Atriplex crassifolia* was abundantly found on slightly saline soils while at higher salinity levels, it becomes less abundant. Germination and growth studies showed that maximum germination was observed in non-saline conditions and maximum growth in slightly saline conditions. Thus, *A. crassifolia* is slightly salt tolerant.

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