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EDAPHIC PROPERTIES AND ABOVEGROUND STANDING PHYTOMASS OF *CRESSA CRETICA* L. POPULATIONS IN WATERLOGGED INLAND HALOCATENA OF TANDO MUHAMMAD KHAN, DISTRICT HYDERABAD (SINDH), PAKISTAN

D. Khan[1] and M.Q. Channa[2]

[1]*Government National College, Shaheed-e-Millat Road, Karachi, Pakistan*
[2] *WAPDA, Hyderabad (Sindh), Pakistan*

ABSTRACT

Two populations of *Cressa cretica* L. in waterlogged highly saline alluvial plains of Shah Farid and Buleri Shah Karim localities in Tando Muhammad Khan area, district Hyderabad, Sindh were studied for their edaphic characteristics and aboveground standing biomass after around three months of summer rains. The plant growth at Buleri Shah Karim was monospecific. At Shah Farid, *C. cretica* was subordinated by *Aeluropus lagopoides (L.)* Trin. (% IVI: 16.93). The mean height of *Cressa* was recorded as 0.11± 0.08m - reaching up to c 0.20 m in height. The density of *C. cretica* in these sites varied from 20 to 504 shoots.m^{-2} - averaging to around 175 shoots.m^{-2}. The soil associated with these populations was fine-textured alluvium and basic in reaction. The finer fraction was probably the montmorillonite type of clay that exhibited cracks on drying due to shrinkage. The soil of Buleri Shah Karim locality was comparatively more saline in surface and subsurface samples (mean EC: 25.88 ± 7.32 dS.m^{-1}) than those of Shah Farid soil (mean EC: 10.93 ± 0.92 dS.$m^{-1}$and had higher amounts of Na, and Cl and SO_4 and other ions and SAR values. These soils had low amounts of K and P. The aboveground dry phytomass (AGDP) of the sites under study amounted to 84.48 ± 11.82 g.m^{-2} in Buleri Shah Karim locality and 113.6 ± 13.32 g.m^{-2} at Shah Farid locality with an overall mean: 99.04 g.m^{-2}. It extrapolated to around 1000 kg.Ha^{-1} on dry weight basis which is quite low in magnitude, presumably due to grazing.

Key Words: *Cressa cretica L*., Edaphic Characteristics, salinity and waterlogging, aboveground standing phytomass, Inland salt marsh, Sindh

INTRODUCTION

Cressa cretica L. [vernacular: Oin (Sindhi), Rudranti, Rudanti (Hindi)] is a thermo-cosmopolitan halophyte forming populations of variable sizes in coastal as well as inland salinity-affected areas. It is a well-known medicinal antifungal plant (Satakopan and Karandikar, 1961; Pirzada *et al.*, 2009). It is reported to occur as weed in sunflower (Qureshi and Memon (2008) and wheat crop (Jakhar *et al*. (2005). It is an indicator of dry salty and sandy habitat – particularly abundant near sea coasts and salt range and is locally used as tonic and camel fodder (Austin and Ghazanfar, 1979). Khan and Aziz (1998) have reported that growth and reproduction of *C. cretica* are significantly affected by potassium and nitrogen deficiency. Agha (2009) has described productive relations of *C. cretica* from the Clifton coast of Karachi. Edaphic relations and aboveground standing biomass of *C. cretica* from its two large inland populations in waterlogged highly saline alluvial plains of Shah Farid and Buleri Shah Karim localities, in Tando Muhammad Khan area, district Hyderabad, Sindh, have been investigated in the present studies.

MATERIALS AND METHODS

FIELD METHODS

The populations of *C. cretica* in waterlogged highly saline alluvial plains of Shah Farid and Buleri Shah Karim localities in Tando Muhammad Khan area, district Hyderabad, Sindh (Fig. 1 A and B) were sampled for density estimation by twenty 50 x 50 cm quadrates placed randomly in the field after around three months of summer rains.

Aboveground standing biomass was determined on the basis of twenty 25 x 25 cm quadrates selected randomly. The phytomass within quadrates was harvested at ground level (Green, 1959). The biomass of each species was kept separately in cotton bags quadrate- wise. It was dried at 80^{o}C and weighed. Any shoot of *C. cretica* arising from the ground independently was counted as one individual and in case of the the sod-forming, *Aeluropus lagopoides (L.)* Trin. - any portion of plant possessing an independent shoot and root was considered as an individual following the practice of Singh and Yadava (1974). The importance value index (IVI) of species was calculated following Curtis and Mc Intosh (1951).

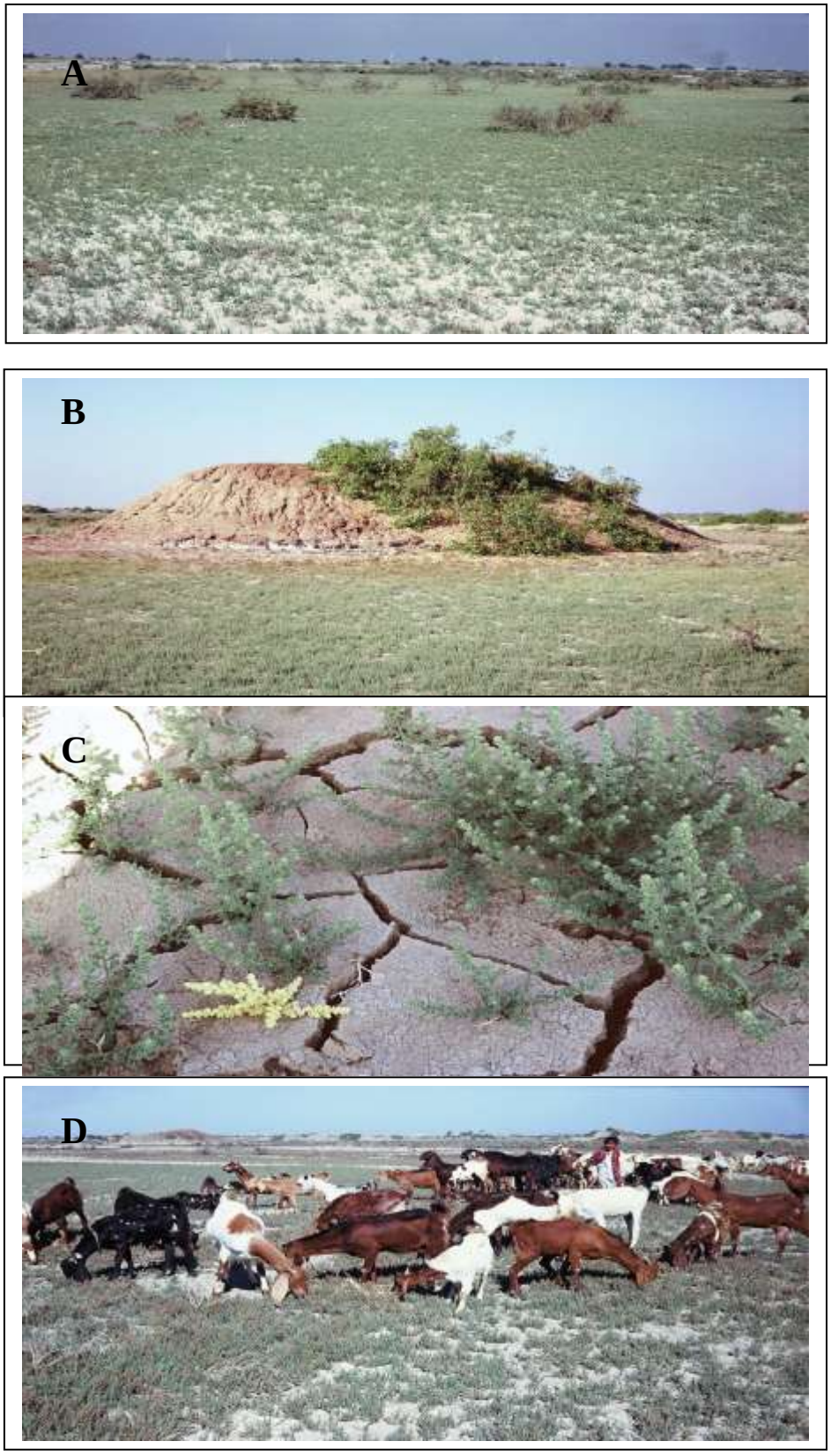

Fig. 1. Almost pure populations of *Cressa cretica* in Buleri Shah Karim (A) and Shah Farid (B) localities of Tando Muhammad Khan area, district Hyderabad, Sindh after around 90 days of rains. *Salvadora persica* is seen partially covering the mound (B). Bushes in (A) are *Tamarix aphylla*.

A mutant of *C. cretica* (C) lacking chlorophyll and prostrate on the ground. Seven such individuals were seen in the population shown at B.

The cracks in the soil indicated to the montmorilllonite type of clay which makes fissures when subject to drying and evaporation of the accumulated water.

Goats are seen grazing *C. cretica* in the study area (D) particularly during winter as opined by the locals.

The litter was very meager at these sites except some broken stems under hoofs of goats. The litter may have decomposed after rains.

SOIL ANALYSIS

Soil samples were collected from two points in each sample fields up to a depth of 60 cm divisible in three portions i.e., from surface to 15 cm, from 15 to 30 cm and from 30 to 60 cm depths. The portion of soil sample finer than 2 mm was used for chemical and physical determinations. Soil texture was determined hydrometrically. pH was determined by glass electrode pH meter. Na and K were determined by flame photometric method. The soluble ions like Ca^{++} + Mg^{++}, HCO_3, Cl^-, and $SO4^{--}$ were determined by the methods of USDA (1954). Electrical conductivity (ECe) was measured by electrical conductivity meter. The measurements of ions as well as pH and ECe were made using saturated soil extract. Phosphorus was estimated by the method of Olsen *et al.* (1954).

RESULTS AND DISCUSSION

The plant growth at Buleri Shah Karim (population A) was monospecific – constituted by *C. cretica* alone (% IVI: 100). No other species was recorded from this site except two individuals of *Alhagi maurorum* Baker and a few shrubs of *Tamarix aphylla* (L.) Karst. in this site interspersed at distance which were not included in the sampling. At Shah Farid (Population B), *C. cretica* (% IVI: 83.07) was subordinated by *Aeluropus lagopoides (L.)* Trin. (% IVI: 16.93), a short halophytic grass. Buleri Shah Karim population was more closed (plant cover: 8650 $m^2.Ha^{-1}$) than Shah Farid population (plant cover: 5031 $m^2.Ha^{-1}$). *C. cretica* is rated as poikilohydric plant that resurrects dramatically from dry-dead state to normal on hydration as it possesses two types of stems: 1. aboveground, 2. belowground (stolon). Stolon sprouts miraculously in favourable conditions in deserts (Sen, 2009). It is, therefore a perennial plant but in Blato area of Croatia, it is reported to behave as a therophyte (Milović and Marković (2003). The density of *C. cretica* in the sites in hand varied from 20 to 504 shoots.m^{-2} - averaging to around 175 shoots.m^{-2}. The mean height of *Cressa* was recorded as 0.11± 0.08m - reaching up to c 0.20 m in height. High to very high plant density in herbaceous communities is frequently reported in literature. *Cyperus bulbosus – Cressa cretica-Aeluropus lagoipoides* community is reported to reach 101.41 ± 24.82 individuals.m^{-2} in a desert land of western Gujrat, India (Panchal and Pandey (2002). *C. cretica* exhibited its density varying from 0.35 to 291.m^{-2} (averaging to 73.6 shoot.m^{-2}) in three differentially saline coastal communities of Karachi (Khan *et al*., 1999). *Tragus roxburghii*, a small graminoid, has been reported to exhibit exceptionally high density (1327 plants.m^{-2}) in a monocotyledonous community dominated by *Lasiurus scindicus* and *Cenchrus setigerus* on biomass basis in a dry sandy desert site after summer rains (Khan *et al*., 2000).

The soil associated with *C. cretica* was fine-textured alluvium and basic in reaction - more basic at Buleri Shah Karim than that at Shah Farid locality (Table 1). The soil was siltloam to clayloam in Shah Farid and loam to siltloam in Buleri Shah Karim as descended from surface to deeper layers. The finer fraction was probably the montmorillonite type of clay that cracks into hard clods on drying due to shrinkage. On rains such soils at first allow water to penetrate rapidly due to cracks. But later, because of expansion due to swelling, the soil closes up and becomes impervious to water with the result of surface accumulation of water (Brady, 1974). The sites under study thus get inundated with water in rainy season. The plant growth was seen to be more conspicuous in ditches and depressed areas as also reported by Milović and Marković (2003) to be related with the longer period of moisture availability. The phenomenon of surface salinity and sodicity was prominent in the sites (Table 1) which is generally true for most of the arid-saline areas where either the run-off collected in the basin evaporates with heat or the capillary fringes of the underground water comes in direct contact with the superficial layer due to water-logging that evaporates leaving behind salts in the upper layer of the soil.

The soils associated with the populations were differentially saline. Soil of Buleri Shah Karim locality was comparatively more saline (mean EC: 25.88 ± 7.32 dS.m-1) than Shah Farid soil (mean EC: 10.93 ± 0.92 $dS.m^{-1}$and had higher amounts of Na, and Cl and SO_4 and other ions and SAR values. Both soils were, however, deficient in potassium (0.56 – 1.35 meq/L in lower layers of soil and 0.74 – 1.25 meq /L in surface soils) and phosphorus (6 – 10 ppm in lower layers of soil and 9 – 13 ppm in the superficial soil). According to available literature, the most important edaphic factors affecting the distribution and structure of *C. cretica* communities are reported to be salinity, moisture and fine fractions of the soil (El-Ghani, 2000). Panchal and Pandey (2002) has reported phosphorus as low in amount as 0.0011 ± 0.00012 % in the soil associated with a *Cyperus* community in which *Cressa* was the second dominant species. *C. cretica* has been reported to optimally grow at EC: 25.0 $dS.m^{-1}$ (Dagar, 1998). *C. cretica* and *A. lagopoides* are known halophytes from maritime, deltaic (sand formation) and inland saline areas (Khan, 1987; *Zahran et al.*, 1990; Al-Turki, 1997; Asri and Ghorbandi, 1997; Abd El-Ghnai, 2000; Milović and Marković, 2003). It occurs almost throughout Mediterranean region *(Pignatti, 1982; Greuter et al., 1986)* The occurrence of *A. maurorum* in highly saline soil, of course, sporadically, may be attributed to its growth after rains

when salinity gets diluted. It is considered to be an alien plant to dry salt marsh (Zahran, 1967) and it extends its root to several meters and reaches soil layers which are less saline and persistently wet (Kassas, 1955). *C. cretica* has salt-secreting glands (Chaudhry *et al.* (1966). There are some reports that C. cretica is fed to cattles after washing.

Table 1.Average soil characteristics of *two C. cretica* sites (in Shah Farid and Buleri Shah Karim localities, respectively) near Tando Muhammad Khan, Hyderabad district, Sindh.

Soil Parameters	Mean ± SE*	
	Shah Farid Locality	**Buleri Shah Karim Locality**
Sand (%)	a. 32 b. 24 c. 10	a. 40 b. 14 c. 20
Silt (%)	a. 67 b. 37 c. 40	a. 44 b. 40 c. 56
Clay (%)	a. 1 b. 40 c. 50	a. 16 b. 46 c. 24
S.P. (%)	a. 68.5 ± 6.50 b. 75.0 ± 6.0 c. 67.5 ± 12.5	a. 73.0 ± 3.0 b. 70.5 ± 15.5 c. 76.5 ± 4.5
EC ($d.Sm^{-1}$)	a. 12.45 ± 2.55 b. 9.25 ± 0.25 c. 11.10 ± 1.10	a. 24.4 ± 1.6 b. 39.5 ± 26.5 c. 14.0 ± 0.0
pH	a. 7.75 ± 0.05 b. 7.80 ± 0.10 c. 8.05 ± 0.35	a. 8.35 ± 0.05 b. 8.20 ± 0.0 c. 8.40 ± 0.20
$Ca^{++} + Mg^{++}$ (meq/L)	a. 85.0 ± 21.50 b. 57.0 ± 1.50 c. 66.3 ± 9.75	a. 52.25 ± 10.25 b. 83.5 ± 48.51 c. 35.0 ± 2.0
Na^{+} (meq/L)	a. 39.5 ± 4.0 b. 35.5 ± 4.0 c. 45.0± 1.0	a. 191.75 ± 26.25 b. 739.0 ± 211.0 c. 105.0 ± 2.0
SAR	a. 6.1 ± 0.17 b. 6.7 ± 0.84 c. 7.9 ± 0.43	a. 38.61 ± 8.99 b. 43.88 ± 21.15 c. 25.15 ± 1.23
K^{+} (meq/L)	a. 0.74 ± 0.17 b 0.61 ± 0.06 c. 0.56 ± 0.15	a. 1.25 ± 0.17 b. 1.35 ± 0.39 c. 0.86 ± 0.15
HCO_3^{-}	a. 3.13 ± 0.63 b. 3.13 ± 0.63 c. 3.75 ± 0.0	a. 3.75± 0.0 b. 3.75 ± 1.25 c. 3.13 ± 063
Cl^{-} (meq/L)	a. 83.75 ± 12.5 b. 83.13 ± 0.6 c. 97.13 ± 18.1	a. 118.75 ± 12.50 b. 313.25 ± 240.70 c. 101.88 ± 9.40
SO_4^{--} (meq/L)	a. 37.63 ± 27.6 b. 6.25 ± 2.5 c. 9.13 ± 7.1	a. 122.0 ± 4.0 b. 78.13 ± 23.1 c. 35.0 ± 10.0
P (ppm)	a. 13.00 ± 1.0 b. 10.0 ± 0.0 c. 10.0 ± 0.0	a. 9.0 ± 0.0 b. 6.0 ± 0.0 c. 6.0 ± 0.0
Texture	a. Silt loam b. clay loam c. Silt clay	a. Loam b. Silt Clay c. Silt loam

a, surface sample (0-15 cm deep), b, middle layer sample (15-30cm); c, lower layer

Table 2. Aboveground standing phytomass (g.m^{-2}) in *Cressa cretica* populations in Shah Farid and Buleri Shah Karim localities near Tando Muhammad Khan, Hyderabad district, Sindh.

Obs. (#)	**Shah Farid Locality**		
	Biomass (g.m^{-2})		Total aboveground standing phytomass (g.m^{-2})
	Cressa cretica	*Aeluropus lagopoides*	
1	91.2	-	91.2
2	51.2	-	51.2
3	88.0	-	88.0
4	129.6	-	129.6
5	59.2	-	59.2
6	-	17.6	17.6
7	67.2	-	67.2
8	68.2	-	68.8
9	-	57.8	57.8
10	219.2	-	219.2
11	73.6	84.8	158.4
12	70.4	-	70.4
13	32.0	48.0	80.0
14	60.8	-	60.8
15	172.8	-	172.8
16	112.0	-	112.0
17	19.2	-	19.2
18	72.0	-	72.0
19	88.0	-	88.0
20	6.4	-	6.4
Mean (g.m^{-2})	74.08 ± 12.29	10.40 ± 5.37	**84.48 ± 11.82**

Obs. (#)	**Buleri Shah Karim Locality**
	Aboveground Standing phytomass (g.m^{-2})
	*C. cretica (Pure Population)**
1	153.6
2	136.0
3	139.2
4	136.0
5	259.2
6	174.4
7	136.0
8	80.0
9	78.4
10	137.6
11	48.0
12	48.0
13	43.2
14	107.2
15	144.0
16	102.4
17	86.4
18	160.0
19	102.4
20	-
Mean	**113.60 ± 13.32** (g.m^{-2})

*, Two individuals of *Alhagi maurorum* were also seen in this population.

Aboveground standing phytomass (Kg.Ha^{-1}). DW	**Shah Farid Locality** (*C. cretica – A. lagopoides* mixed population)	**Buleri Shah Karim locality** (*C. cretica* pure population)
	884.80 ± 118.16	**1136 ± 133.16**

The aboveground dry phytomass (AGDP) of the sites under study amounted to 84.48 ± 11.82 g.m^{-2} in Buleri Shah Karim locality and 113.6 ± 13.32 g.m^{-2} at Shah Farid locality (Table 2) (mean: 99.04 g.m^{-2}). It extrapolates to around 1000 kg per Ha on dry weight basis which is quite low in magnitude. It may be attributed to grazing. Khan *et al.* (1999) reported the aboveground biomass contributed by *C. cretica* to be around 123g.m^{-2} in a stand of

vegetation comprising *A. lagopoides (*c 58% of community biomass*), C. cretica* (c 36% of community biomass) and *S. arabicus* (c. 6% of community biomass).

The litter component in these populations was practically non-existent (7.22 ± 2.29 $g.m^{-2}$) except some plant parts broken under hooves of the goats and trampling by the shepherds or other human beings. There were, however no signs of cutting for fodder or other purposes.

Agha (2009) has reported aboveground biomass of *Cressa cretica* to be maximally around $20g.m^{-2}$ in September 1997-98 and maximally $34g.m^{-2}$ in August, 1998-99 in a coastal population of *C. cretica* in Karachi where maximum EC (1:10 (W/V) - soil: water solution) not more than 6.37 $dS.m^{-1}$ was ever recorded during two-year study. These values of AGDP are much lower in comparison to our data. The amount of dead biomass in this maritime population couldn't come up ever more than $5g.m^{-2}$. It is obviously certain that this population must have been much poor in plant growth and / or density and that is why its net primary productivity has not been more than 175 $mg.m^{-2}.day^{-1}$ any time during the two years of study and belowground biomass could never exceed the value 2.8 $g.m^{-2}$.

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