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EARLY SUCCESSION ON AN ABANDONED FIELD IN PESHAWAR, PAKISTAN

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Abstract

The initial stages of secondary succession on an abandoned field in Peshawar were studied. *Cyperus rotundus* was the pioneer species which dominated the old field in the first autumn. In summer, *Conyza bonariensis* shared the dominance with *C. rotundus.* The spring vegetation was dominated by *Coronopus didymus.* Of the total 45 species recorded in four seasons, only 13.3 percent inhabited the site the year around, whereas 53.3 percent were found to be exclusively confined to spring season. In the second autumn of abandonment, *Amaranthus viridis* became a codominant with *C. rotundus.*

Introduction

The cultivation not only destroys the vestiges of pre-existing vegetation but also creates an atmosphere conducive to the growth of crop plants and the weeds equally. Sometimes the arable land has to be abandoned due to one or the other reason resulting in the initiation or secondary succession. The annual weeds arrive first which are followed by perennials (Root & Wilson, 1973). The pioneer community, in an abandoned field, tends to be related to the characters of the last crop (Booth 1941) and its composition and duration is determined by the behaviour of the dominants (Olmsted & Rice, 1970). The pioneers grow fast and can withstand longer periods of drought (Crafton & Wells, 1934). The slow-growing species, therefor, fail to establish before the year following the abandonment. The pace of succession is governed by a number of factors, viz. methods of cropping (Clements, 1938), seed supply (Runyon, 1936), burning (Booth, 1941) and the drought (Weaver & Albertson, 1940).

A long term research project was initiated to study the pattern of secondary succession on a crop field measuring about 30 x 40 m which was abandoned in summer, 1975 after remaining in cultivation for over 50 years. The last crop grown was that of wheat and the chemical fertilizers came into use only 10 years before the abandonment, The soil is silty with silt 48.8%, clay 46.8% and sand 4.4%. The field is located at a distance of about 5 km west of Peshawar Cantonement and about 0.5 km west of the campus of the University of Peshawar. The latitude 34° north passes along its southern border whereas 71° 28′ east longitude traverses the area. A number of observations on the vegetation were taken in different seasons. But unfortunately 15 months after the abandonement, a housing scheme launched in the area disturbed our programme. The original plan of study thus had to be modified and the study accordingly restricted to the observatiosns recorded in the first 15 months of abandonement.

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Materials and Methods

The vegetation was sampled in 0.2 x 0.5 m quadrats laid systematically. The information on the community attributes was gathered and the relative and the importance values of the species were calculated according to Cox (1967). Daubenmire s method was used to measure the canopy (Daubenmire, 1959).

The coefficient of community was calculated according to Motyka *et al.* (1955) and Culberson (1955). The techniques employed for the determination of the texture and $CaCo_3$ content of the soil were those of American Society for Testing Materials (1964) and Jackson (1962) respectively.

The geology and the climate of Peshawar has already been discussed (Chaghtai *et al.*, 1978); The study period spreads over 15 months and the sampling was done five times in four different seasons.

The nomenclature followed for the plants is that of Stewart (1972).

Results and Discussion

Although the four seasons are not sharply marked in the subcontinent, yet for the sake of convenience the vegetation is named here after the season in which sampling was done. Of the 45 species recorded in four seasons, about 13.3 percent inhabited the area the year around; whereas 53.3 percent were found confined to spring season alone.

Autumn '75, Vegetation

First sampling was done in early September when the tinge of summer has almost faded. *Cyperus rotundus* dominated the scene showing importance value higher than any leading dominant inhabiting the area any time of year (Table 1). It seems to be pioneer plant of such an area which is very open and the conditions with regard to temperature and soil moisture are very harsh (Richardson, 1963); under these conditions *C. rotundus* outcompetes all other species. All along the southern boundry wall, a small strip of land remained shaded and *C. rotundus* was found almost completely missing from here. *Conyza bonariensis,* another important pioneer plant, found it convenient to invade the area because of its openness. *Cynodon dactylon* could not flourish well largely because of the disturbance of soil. The source of the seedlings of *Melia azedarach* and *Eucalyptus* sp. seems to be the tall trees growing nearby.

Winter Vegetation:

The second sample was taken in mid November. The vegetation was found abeyant and only those species flourished which could endure low temperature and prolonged drought. The vegetation in fact looked like a mere extension of the autumn vegetation; only the dominants were changed. The two vegetations have a very high valure for the coefficient of community

and shared 78.5 percent species between them suggesting a high degree of similarity between the two (Table 2). By and large, the species of autumn retained the occupancy in winter with the exception of three insignificant ones.

C. bonariensis, which was not so significant in autumn vegetation gained prominence and dominated the scene (Table 3). *Pluchea lanceolata*, a perennial herb which was present all around the field when it was in cultivation, encroached upon the abandoned land and became a co-dominant in the absence of any potential competitor in the prevailing harsh environment. *C. bonariensis* took the lead not because of its increased activity but solely because of the elimination of *C. rotundus*, the powerful leading dominant and competitor of the autumn vegetation. The diminution of *C. rotundus* in winter resulted in the increase of relative values of the commumity attributes which ultimately enhanced the importance value of *C. bonariensis* shooting it into lead. The same may hold good for *Amaranthus viridies*

Rumex dentatus sprouted from underground tuberous stem in early winter but was very scarce. By mid winter even before the rain, some very important species of spring which ushered in were *Coronopus didymus, Fumaria indica, Silybum marianum, Euphorbia helioscopia* and *E. prostrata.*

Xanthium strumarium which was very rare in the research area and was not hit by the quadrats was noticed growing frequently in the surrounding land; but in January before winter rains, it disappeared from the surrounding lands too. *Verbena officinalis* also declined in late January. *Chrozophora obliqua* disappeared completly.

In late February, *A. viridis* was noticed at the verge of disappearance; the growth stopped and the plants became deformed andstunted. *Withania somnifera* was quite healthy and was doing well. *C. bonariensis* was found dried, disseminules dispersed but the old stumps showed the signs of sprouting.

Spring Vegetation

The spring vegetation largely comprising the annuals reached the acme in early April and in fact represented a distinct vegetation type which was further confirmed by a very low value for the coefficient of community and a further lower percentage of the species shared by the winter and the spring vegetations (Table 2). The vegetation was dominated by *Coronopus didymus* with *C. bonariensis* as codominant (Table 4). The number of species recorded here was found to be the highest of all times i.e. 34 and it was largely due to abundant soil moisture a more favourable regime of temperature. The variety of species had largely been increased because of the provision of more niches, but the pressure on the environmental variables had reduced the importance values of the dominants.

The absolute values for density and frequency of *C. bonariensis* were far greater than the winter vegetation whereas the coverage value was lower in the former than the latter; this showed that the big old specimens of *C. bonariensis* had disappeared and, in their stead, young plants had started sprouting either from the old stocks or the disseminules. *C. bonariensis*

remained largely confined to open and exposed places and seemed to flourish well close to *C. didymus.*

The dominance of *C. didymus* may be attributed to the highest values for all community attributes (Table 4). The species, at the same time of sampling, was represented by fully grown specimens and thus was casting maximum shade on the soil.

Some rare plants which were not hit in the quadrats were *Withania somnifera, Silybum marianum, Eruca sativa, Anethum graveolens, Torilis leptophylla, Brassica campestris, Ammi visnaga* and *Avena sativa.*

By the middle of May, soil became considerably dry and the temperature had also risen. *Alyssum desertorum, Melilotus indicus, C. didymus, Sisymbrium irio, Ranunculus arvensis* and *Eragrostis cilianensis* matured and consequently disappeared; they were soon followed by *Koeleria sp., Phalaris minor, Polygonum plebejum* and *Lepidium sativum.* All old specimens of *A. viridis* still lingered on, yet the new plants got established from disseminules in open places.

Summer Vegetation

In the middle of June, the ramnants of spring vegetation disappeared alomst completely. The temperature has risen and soil became dry. Low coefficient of community for the spring and the summer vegetations hints at the great dissimilarity the two vegetations exhibit (Table 2).

C. rotundus once again came into prominence largely because of its ability of coping with the harsh summer conditions (Table 5). The competition with other species had also been reduced and it despite being dominant here, possessed a low importance value in comparison with two autumn communities and the reason being the low values for all the community attributes in general and the canopy-coverage in particular. The burnt and dessicated specimens of *C. rotundus* scattered all over the area further hint at the low values of the community attributes. It was found more abundant on exposed places.

The importance value of *C. bonariensis*, the codominant, is higher than the spring vegetation although many young individuals which got established in spring could not survive. It is a pioneer spedies and with the stabilization of the vegetation it would fade out gradually. *V. officinalis* remained confined to shady places alone. The young specimens of *A. viridis* were noticeably abundant in the surrounding lands but were almost completely missing from the research area.

Autumn 76, Vegetation

The autumn vegetation in the second year of abandonment did not seem to show much change in species composition from the autumn vegetation of the preceding year; and the total number of species supported by the two communities also remained almost unchanged (Table 1 & 6). The two vegetations shared 70.5 percent of species and a higher coefficient of

community i.e. 74 percent further confirmed that a higher degree of similarity did exist between the two. (Table 2). *C. rotundus*, which dominated the autumn vegetation of the first year of abandonment exclusively, had to share the lead equally with *A. viridis* that came from behind in the second year of abandonment. In the first year, *A. viridis* invaded the site through seeds. At the time of smapling the species was represented by comparatively smaller specimens which were sporadic in distribution. The following year, the colonizer persisted as a perennial, produced seeds from which younger plants developed. The young plants were more evenly distributed because of more congenial conditions of shade and moisture. The importance value of *C. bonariensis* has greatly been reduced as it failed to hold the gains made earlier, firstly because of being outcompeted by *A. viridis* and secondly due to reported autotoxicity of the decaying roots of the first generation of *C. bonariensis* which inhibit a second generation (Oosting, 1942). *A. viridis* flourished well in moist places but was found missing from the places where other herbs formed dense canopy. *Euphorbia prostrata*, a new comer to the community, was found doing well in shade.

Some rare plants which were not hit by the quadrats are: *Cajanus cajan, Digera muricata, Calotropis procera, Withania coagulans, Cenchrus ciliaris, Euphorbia helioscopia, Silybum marianum, Malva parviflora, Chenopodium album, Alyssum desertorum, Melia azadarach, Morus alba* and *Portulaca oleracea*. Two of these plants namely *W. coagulans* and *C. album* were the remnants of the summer vegetation. Some were new comer which dared to invade the site but could not come into prominence in the first year.

Seasonality of the Dominant Species

Cyperus rotundus invaded the field in autumn, soon after abandonment, and dominated it exclusively in ths absence of any potential competitor. The importance value of this species was highest of any leading dominant species inhabiting the site any time of the year (Fig. 1). It disappeared almost completely from winter vegetation and reappeared in spring but failed to make significant gains because of less favourable regimes of temperature and soil moisture coupled with greater shade cast by other species. In harsh summer when the temperature was high and soil was depleted of moisture, *C. rotundus* once again jumped into prominence. In the second autumn of abandonment it made some more gains as compared to summer vegetation but failed to attain such a high degree of dominance as it had had in the vegetation of previous autumn and the main cause of this setback seemed to be relatively greater competition it had to face from fellow inhabitants in the second autumn. The chief competitor appeared to be *Amaranthus viridis* which could not get a foothold in the first autumn probably because of early arrival of *C. rotudus*. Contrary to this *C. rotudus* and *Conyza bonariensis* did not seem to interfere with each other as the periods of their maximum growth did not coincide. The two species dominated the summer vegetation collectively but the importance value of each species was far lesser than when they dominated separately. They seem to possess non-overlapping niches. In autumn, *C. bonariensis* declined greatly but it came back in winter to dominate the vegetation exclusively. In second autumn, it could not contribute significantly to the vegetation largely because of severe competition from *A. viridis*.

Coronopus didymus, a spring annual with a limited ecological amplitude, dominated the spring vegetation alone. The spring vegetation with the exception of six common species which

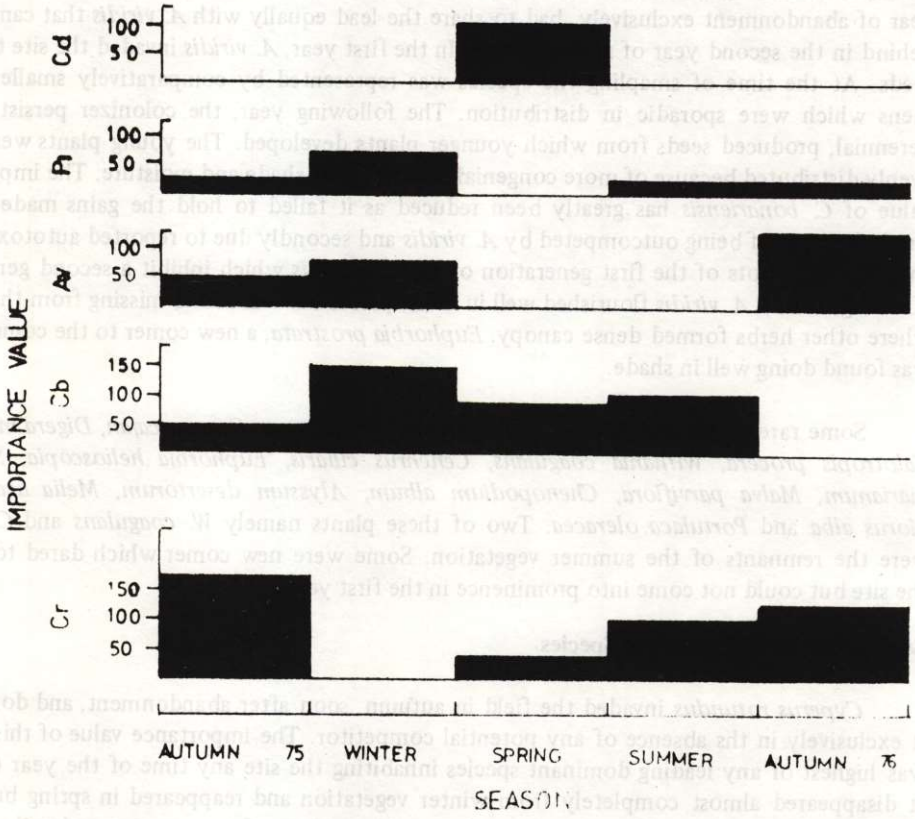

Fig.1. Seasonal activity of the dominants (Cr, Cyperus rotundus; Cb, Conyza bonariensis; Av, Amaranthus viridis; Pl, Pluchea lanceolata & Cd, Coronopus didymus)

is shared with the vegetations of other seasons approached to be quite distinct. It comprised annuals which complete their life cycles within a short span of time when the temperature and moisture regimes of the environment are conductive to their growth. Unlike the vegetation of other seasons, it did not blend with the vegetation of the next season, i.e. summer. The vegetation sampled in autumn, winter and the summer did not differ in physiognomy but differed in the dominants alone. The importance values of the dominants fluctuated with the seasonal changes in temperature and soil moisture.

TABLE 1

Phytosociological attributes of the autumn, 75 vegetation. (CC, canopy-coverage; RCC, relative canopy-coverage; D, density; RD, relative density; F, frequency; RF, relative frequency; and IV, importance value) (T = trace).

Species	CC	RCC	D	RD	F	RD	IV
Cyperus rotundus	361.6	72.6	69.3	67.7	0.86	37.4	177.7
Conyza bonariensis	85.6	17.2	14.2	13.9	0.39	17.0	48.1
Amaranthus viridis	22.8	4.6	9.5	9.3	0.46	20.0	33.9
Pluchea lanceolate	20.9	4.2	5.4	5.3	0.27	11.7	21.2
Convolvulus arvensis	1.3	0.3	1.0	1.0	0.08	3.5	4.8
Verbena officinalis	1.9	0.4	0.7	0.7	0.05	2.2	3.3
Tribulus terrestris	1.3	0.3	0.5	0.5	0.03	1.3	2.1
Chrozophora obliqua	0.9	0.2	0.3	0.3	0.03	1.3	1.8
Morus alba	0.3	0.1	0.3	0.3	0.03	1.3	1.7
Cynodon dactylon	0.5	0.1	0.3	0.3	0.02	0.9	1.3
Withania somnifera	0.6	0.1	0.2	0.2	0.02	0.9	1.2
Melia azedarach	0.2	T	0.2	0.2	0.02	0.9	1.1
Eucalyptus sp.	T	T	0.2	0.2	0.02	0.9	1.1
Achyranthes aspera	0.2	T	0.2	0.2	0.02	0.9	1.1

TABLE 2

The matrix of values of coefficient of community and percentage values of common species given in parentheses.

	Autumn, 75	Winter	Spring	Summer
Winter	61 (78.5)			
Spring	34 (20.0)	20 (18.4)		
Summer	69 (47.0)	54 (46.6)	36 (24.3)	
Autumn, 76	74 (70.5)	38 (62.5)	27 (19.5)	42 (44.4)

TABLE 3

Phytosociological attributes of the winter vegetation.

Species	CC	RCC	D	RD	F	RF	IV
Conyza bonariensis	68.6	63.4	9.8	42.8	0.35	33.3	139.5
Pluchea lanceolata	24.2	22.4	6.5	28.4	0.22	20.9	71.7
Amaranthus viridis	12.5	11.5	4.6	20.1	0.32	30.5	62.1
Verbena officinalis	1.1	1.0	0.5	2.2	0.05	4.8	8.0
Withania somnifera	T	T	0.3	1.3	0.03	2.8	4.2
Eucalyptus sp.	T	T	0.3	1.3	0.03	2.8	4.2
Cyperus rotundus	0.7	0.6	0.5	2.2	0.01	0.9	3.7
Chrozophora obliqua	0.6	0.5	0.1	0.4	0.01	0.9	1.8
Convolvulus arvensis	0.2	0.2	0.1	0.4	0.01	0.9	1.5
Tribulus terrestris	T	T	0.1	0.4	0.01	0.9	1.3
Morus alba	T	T	0.1	0.4	0.01	0.9	1.3

Table 4

Phystosociological attributes of the spring vegetation.

Species	CC	RCC	D	RD	F	RF	IV
Coronopus didymus	56.7	41.8	325.0	38.4	0.96	15.6	95.8
Convza bonariensis	22.7	16.7	266.6	31.5	0.86	13.9	62.1
Cyperus rotundus	10.2	7.5	73.7	8.7	0.59	9.6	25.8
Melilotus indicus	9.1	6.7	39.0	4.6	0.51	8.3	19.6
Koeleria sp.	7.9	5.8	47.0	5.5	0.47	7.6	18.9
Sonchus oleraceus	8.0	5.9	12.9	1.5	0.50	8.1	15.5
Sisymbrium irio	3.2	2.4	7.0	0.8	0.31	5.0	8.2
Eragrostis cilanensis	1.7	1.2	15.0	1.8	0.21	3.4	6.4
Pluchea lanceolata	3.1	2.3	5.8	0.7	0.19	3.0	6.0
Convolvulus arvensis	1.6	1.2	2.3	0.3	0.16	2.6	4.1
Verbena officinalis	1.3	0.9	7.2	0.8	0.14	2.3	4.0
Amaranthus viridis	0.7	0.5	15.5	1.8	0.10	1.6	3.9
Polygnum plebejum	1.3	0.9	7.2	0.8	0.12	1.9	3.6
Euphorbia helioscopia	0.8	0.6	2.1	0.2	0.15	2.4	3.2
Anagallis arvensis	0.5	0.4	1.4	0.2	0.09	1.5	2.1
Fumaria indica	0.9	0.6	0.9	0.1	0.08	1.3	2.0
Ranunculus arvensis	0.6	0.4	6.5	0.8	0.04	0.6	1.8
Cynodon dactylon	1.0	0.7	2.1	0.2	0.04	0.6	1.5
Phalaris minor	0.4	0.3	1.8	0.2	0.06	0.9	1.4
Oenanthe javanica	T	T	0.2	T	0.2	0.3	0.3
Medicage polymorpha	0.6	0.4	1.2	0.1	0.04	0.6	1.1
Lepidium sativum	0.6	0.4	0.6	T	0.04	0.6	1.1
Malva parviflora	0.1	T	0.6	T	0.05	0.8	0.9
Chenopdium album	T	T	0.6	T	0.06	0.9	0.9
Capsella hursa-pastoris	0.4	0.3	0.6	T	0.06	0.9	0.9
Cerastium fontanum	T	T	0.6	T	0.04	0.6	0.6
Rumex dentatus	T	T	0.4	T	0.04	0.6	0.6
Morus alba	0.3	0.2	0.2	T	0.02	0.3	0.5
Alyssum desertorum	0.3	0.2	0.2	T	0.02	0.3	0.5
Stellaria media	T	T	0.2	T	0.02	0.3	0.3
Bromus japonicus	T	T	0.2	T	0.02	0.3	0.3
Gnaphalium leuto-album	T	T	0.2	T	0.02	0.3	0.3
Coriandrum sativum	T	T	0.2	T	0.02	0.3	0.3
Lathyrus aphaca	T	T	0.2	T	0.01	0.2	0.2

Table 5

Phytosociological attributes of the summer vegetation.

Species	CC	RCC	D	RD	F	RF	IV
Cyperus rotundus	20.2	23.8	19.2	38.2	0.52	33.5	95.5
Conyza bonariensis	23.7	27.9	15.7	31.2	0.42	27.1	86.2
Pluchea lanceolata	16.4	1.2	5.8	11.5	0.27	17.4	30.1
Lepidium sativum	15.9	18.7	3.2	6.4	0.07	4.5	29.6
Verbena officinalis	4.6	5.4	4.2	8.3	0.12	7.7	21.4
Amatanthus viridis	2.1	2.5	0.5	1.0	0.03	1.9	5.4
Cynodon dactylon	1.0	1.2	0.7	1.4	0.02	1.3	3.9
Ammi visnaga	0.5	0.6	0.3	0.6	0.03	1.9	3.1
Convolvulus arvensis	0.3	0.3	0.3	0.6	0.03	1.9	2.8
Withania somnifera	0.2	0.2	0.2	0.4	0.02	1.3	1.9
Chenopodium album	T	T	0.2	0.4	0.02	1.3	1.7

Table 6

Phytosociological attributes of the autumn, 76 vegetation.

Spedies	CC	RCC	D	RD	F	RF	IV
Amaranthus viridis	341.0	42.4	90.7	47.6	0.96	32.0	122.0
Cyperus rotundus	399.0	49.7	81.0	42.5	0.88	29.3	121.5
Pluchea lanceolata	29.4	3.6	7.4	3.9	0.38	12.7	20.2
Convolvulus arvensis	8.0	1.0	2.9	1.5	0.17	5.7	8.2
Euphorbia prostrata	3.5	0.4	1.9	1.0	0.14	4.7	6.1
Conyza bonariensis	4.5	0.5	1.7	0.9	0.10	3.3	4.7
Tribulus terrestris	6.8	0.8	1.2	0.6	0.07	2.3	3.7
Verbena officinalis	5.2	0.6	1.0	0.5	0.07	2.3	3.4
Leptochloa panicea	1.8	0.2	0.9	0.5	0.07	2.3	3.0
Echinochloa colonum	0.3	T	0.5	0.3	0.05	1.7	2.0
Morus alba	1.3	0.2	0.3	0.1	0.03	1.0	1.3
Cynodon dactylon	1.3	0.2	0.3	0.1	0.02	0.7	1.0
Withania somnifera	0.6	T	0.2	0.1	0.02	0.7	0.9
Eucalyptus sp.	0.6	T	0.2	0.1	0.02	0.7	0.9
Achyranthes aspera	T	T	0.2	0.1	0.02	0.7	0.8

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