Phytosociological analysis of weed communities in Saurashtra

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This paper reports the distribution and inter-species association of 40 commonly occurring winter-season weed taxa of Saurashtra, India. The data presented here is the result of a 3- year consecutive field-survey that include more than 350 fields at 38 different locations having a wide range of soil characteristics, climatic variabilities, geomorphological differences and biotic influences. The data were analysed in an attempt to distinguish the natural groups of weed taxa. The association analysis and cluster analysis indicated that the natural grouping of weed species were associated with different soil types. The 40 species were divided into five groups. Group I and II were found to be distributed over all the six soil types. Group III, IV and V were predominantly associated with the medium black, shallow black and alluvial soils, respectively.

Key-words: Weeds, Phytosociology, association, cluster analysis, Saurashtra (India).

INTRODUCTION

ONE of the most important problems in the field of agriculture is weed management. Since the losses caused by weeds depend upon the nature of/and intensity of weed infestation, a knowledge of weed species commonly associated with different crops and physical site characters of a region is very important for an effective weed control programme. The objectives of the present study were to investigate the relationship among the 40 common winter season weeds of Saurashtra (India) and to relate the occurrence of such species with different soil types.

Phytosociological analysis of plant communities helps to compare areas and in relating vegetational variations to environmental factors. There are many factors which cause the plants of different taxa to grow far apart or close together (Dale 1977, 1985). It is possible to determine characteristic association of species which repeat frequently. Plant communities are characteristic of the specific environment (Dale *et al.* 1965) such as soil and/or the associated climate in which they are found. The analysis of phytosociological structure is based on the co-occurrence of various weed species.

MATERIALS AND METHOD

Saurashtra is the western peninsular part of Gujarat State lying between lat. 20° 42′ and 23° 33′ N and long. 69° 04′ and 72° 18′ E. It has an area of 60,160 Km^2. After a preliminary survey throughout Saurashtra, 38 locations were selected representing different soil types, cropping patterns and different climatic set-up. The climatic condition ranges from arid and semiarid to marginal and subhumid types (Pandeya *et al.* 1967). The average rainfall in the region ranged between 270 mm and 700 mm with about thirty rainy days. The minimum and maximum air temperature ranges 12.5°C to 25.6°C and 32.1°C to 42.2°C respectively, the relative humidity ranges from 35 to 75 per cent and the mean wind speed ranges from 10.5 to 18.3 Km/h.

40 most common weed species were considered for the present study. The list of the species was prepared after identification with the help of literature (Cooke 1958; Bor 1960; Shah 1978; Bole & Pathak, 1988). The survey was conducted during 40 to 60 days after crop sowing since the density of the weeds were found to be maximum during the said period (Bhattacharyya & Pandya 1994). During the weed survey from 1987-1990 38 locations of Saurashtra (India) were studied. In each location

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around 10 to 12 crop fields were surveyed for the occurrence and abundance of 40 common taxa of weeds.

For the collection of vegetaion data one meter square quadrats were used. Twenty quadrats were laid randomly in each field. Presence of species were recorded in each quadrat and the data arranged in the form of a contingency table.

		Species A			
		+	-		
Species	+	a	b	a+b	=p
B	-	c	d	c+d	=q
		a+c=m	b+d=n	a+b+c+d	=N

A and B are the two species, a is the total number of quadrats containing both species, b & c the number with only one and d with neither, and N is the total number of quadrats. Species A and B are positively associated when they have higher values for a and d, but low for b and c. Species A and B are negatively associated when they are found together less often than would be expected (Dale & Thomas 1987).

The X^2 values were calculated using the formula given by Sokal and Rolf (1981).

(1) $X^2 = (ad - bc)^2 \times N/E$

Where $E = m \times n \times p \times q$

The results were examined for significance (Sokal & Rolf 1981) to x^2 table. Plus (+) sign indicates positive association and (-) sign indicates negative association.

For detecting natural groupings cluster analysis was performed. The similarity coefficients for each pair of species were calculated using Jaccards index (S) (Dale & Thomas 1987).

(2) $S = a / (a+b+c)$

Thus a 40 by 40 half matrix of similarities was obtained for each subdivision of the data set. These matrices were used as a basis for cluster analysis (Dale & Thomas 1987). Cluster analysis divides the set of 40 species into a hierarchy of subgroups of increasing size, the larger subgroups show lower similarities among their members (Legendre & Legendre 1983; Pielou 1984). The clustering has been depicted by dendrogram (Fig. 1). Each joint of the clustering depicts the level of similarity of the weed-species pair.

RESULTS AND DISCUSSION

The 40 commonly occurring weed species that were considered in the present sudy are listed in order of increasing Coefficient of variation (CV) and decreasing mean density values (c.f. Table-1),

Table 1: List of 40 commonly occurring weed species (Sp. are listed in order of increasing C.V. of density and decreasing mean density values).

Species Nos.	Name of species	CV of density	Mean desnsity
1.	*Echinochloa colonum* (l.) Link	0.60	19.6
2.	*E. crusgalli* (L.) P. Beauv.	0.80	19.4
3.	*Chenopodium album* L.	0.80	13.2
4.	*C. murale* L.	1.00	11.6
5.	*Commelina benghalensis* L.	1.01	8.9
6.	*Convolvulus arvensis* L.	1.01	8.7
7.	*Melilotus indica* All.	1.01	8.6
8.	*Triumfetta rotundifolia* Lam.	1.02	7.7
9.	*Portulaca oleracea* L.	1.02	7.6
10.	*Anagallis arvensis* L.	1.03	11.7
11.	*Euphorbia orbiculata* H.b. & K.	1.03	8.9
12.	*E. hirta* L.	1.03	8.3
13.	*Amaranthus viridis* L.	1.03	8.1
14.	*Chloris virgata* Sw.	1.04	16.4
15.	*Asphodelus tenuifolius* Cav.	1.04	8.6
16.	*Amaranthus tricolor* L.	1.04	7.9
17.	*A. spinosus* L.	1.04	7.8
18.	*Digera muricata* (L) Mart.	1.04	7.5
19.	*Physalis minima L.*	1.04	6.5
20.	*Cynodon dactylon* (L.) Pers.	1.10	18.1
22.	*Brassica nigra* Koch.	1.10	8.6
23.	*Acalypha ciliata* Forsk	1.11	8.2
24.	*Abutilon glaucum* (Csav.) Sw.	1.11	7.4
25.	*Cocculus hirsutus* (L.) Diels.	1.11	7.3
26.	*Corchorus aestuans* L.	1.11	7.2
27.	*Cressa cretica* L.	1.11	7.1
28.	*Portulaca quadrifida* L.	1.12	8.5
29.	*Rumex dentatus* L.	1.12	7.3
30.	*Andrographis echioides* (L.) Nes	1.12	7.1
31.	*Ipomoea eriocarpa* R. Br.	1.12	8.3
32.	*Launaea procumbens* (Roxb.) Ram& Raj	1.13	7.1
33.	*Argemone mexicana* L.	1.14	6.4
34.	*Eclipta alba* (L.) Hassk.	1.14	6.1
35.	*Dactyloctenium aegyptium* (L.) P. Beauv.	1.20	17.6
36.	*Cyperus rotundus* L.	1.20	17.3
37.	*Digitaria adscendens* (H.B. & K) Hens.	1.20	14.1
38.	*Eragrostis tenella* (L.) P. Beauv.	1.20	13.0
39.	*Setaria glauca* (L.) P. Beauv.	1.20	12.9
40.	*Phyllanthus maderaspatensis* L.	1.20	6.3

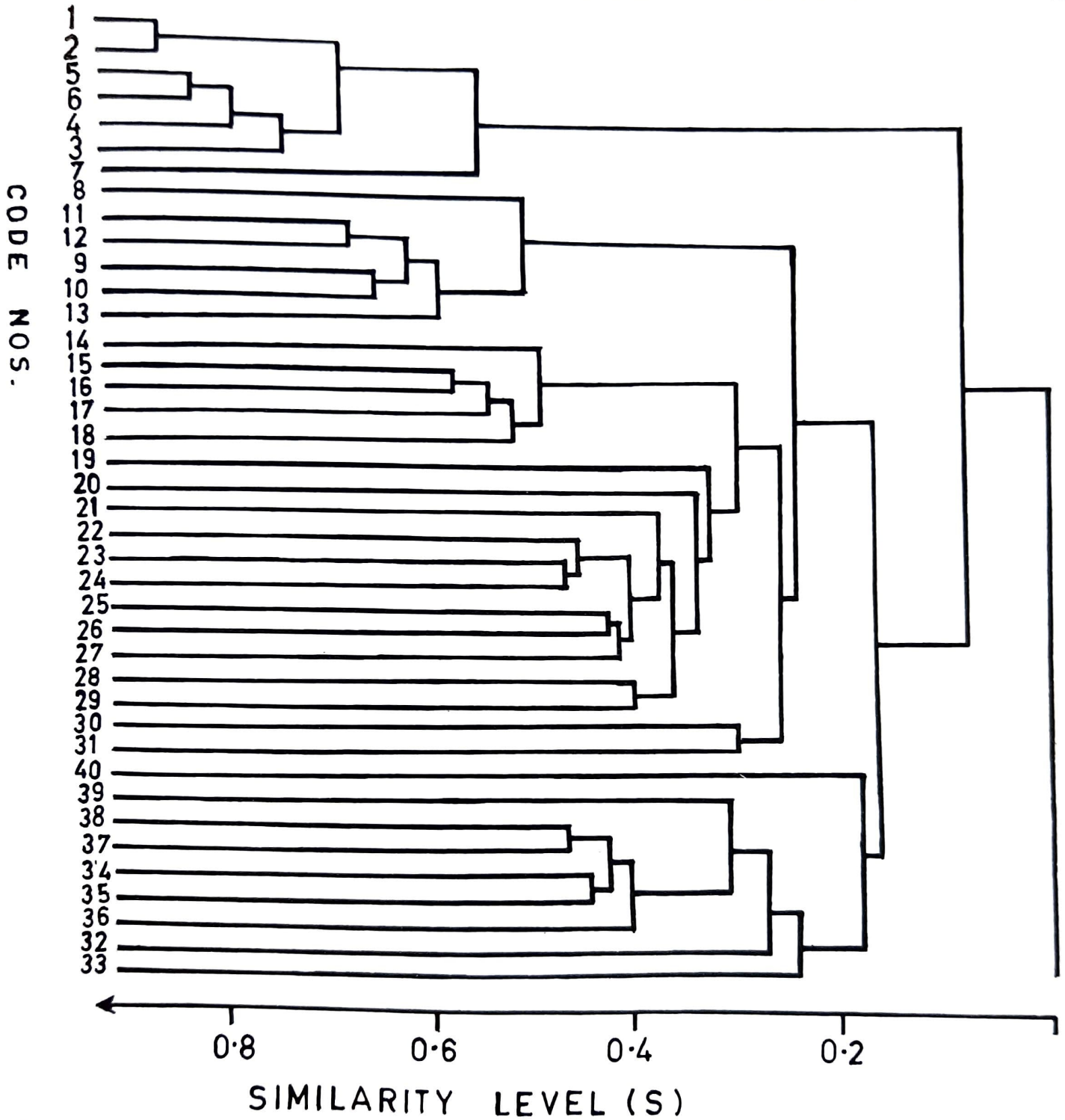

Fig: 1 Dendrograms of cluster analysis showing similarity levels of all joints (1 to 40 are species nos. as appeared in Table 1).

CV of density as adopted by Kershaw (1964) indicates dispersion of a species at a given time. The cluster analysis of the data set divided all the 40 species into five groups. Group I containing the species numbered as 1, 2, 3, 4, 5 and 6 which were quite common throughout Saurashtra. Two species *Melilotus indica* and *Triumfetta rotundifolia* occured between the clumps of group - I and group - II. *Andrographis echioides, Ipomoea eriocarpa, Launaea procumbens, Argemone mexicana* and *Phyllanthus maderaspatensis* also do not merge with the cluster groups and were found restricted in some locations (Table-2). Among these *Melilotus indica* All. was found dominant. The other groups were; group-II, containing the species numbered as 9, 10, 11, 12 & 13; group-III contains 14, 15, 16, 17 and 18; Group IV contains 19, 20, 21, 22, 23, 24, 25, 26, 27, 28 and 29; and the group-V contains the species numbered

Table 2. Chi-square matrix for 38 stands showing + ve and - ve sp. relationships present (1 to 40 are sp. nos.)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
1.																																								
2.	+																																							
3.	+																																							
4.		+	+																																					
5.	+	-																																						
6.		-		+	+																																			
7.				-																																				
8.	+	+	-			+	-																																	
9.		-	+	-	+	+																																		
10.			+	-	+	+			+																															
11.	+	-		+	-	+	+		-	-																														
12.	-	-	-		+	+		+			-																													
13.		-	+	-	+	+			+	+	+																													
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25.	+		+		-					+					-			-		+	+		+	+																	
26.								-	+				+	-		-			+	+		+		+	+																
27.		-	+	+		-	-		-		-	-			+		-	-	+	+	+	-	-	-	-	-														
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29.	-							-						-		+			+	+				+	+	-	+	+	+												
30.			+												+				-			+						+													
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32.	-			+	+	+		-				+	+		-			+	+	+		+			+		+				-									
33.		-							+		+							+								+	-		-											
34.	+		+	+			+		-	-		-					+		-	+		-		-			+	+			+		+			+				
35.					-			-		+		-			-					-	-	+		-	-					-				-	-					
36.		-				+	-							-		-				-			-		-	-		+						+	+					
37.	-			+		+					-		-		+	+			-		-	+		+			-		+				-		-				
38.				+				+						+	-			-		-			-		-		+	-		+	+	-	-			+			
39.		+			+		+							-		-					+			-				+						+	+	-	+		+	
40.			+								+						+							+			+			+	+	-				-				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40

Table- 3: The phytosociological associations within and between groups of species formed by the cluster analysis.

Species No.	Within group		Between groups	
	Positive	Negative	Positive	Negative
1.	2	3	4	5
Associations within group I & between I and II to V				
1	3	0	4	6
2	2	2	3	7
3	2	0	12	1
4	3	1	5	6
5	2	2	6	4
6	2	1	10	3
Total	14	6	40	27
Associations within group II and between groups II and III, IV, V				
9	2	1	7	4
10	2	1	3	5
11	1	3	0	6
12	0	1	1	7
13	3	0	4	4
Total	8	6	15	26
Association within group - III and between groups III and IV, V				
14	1	1	3	5
15	1	2	4	5
16	1	0	4	7
17	2	1	2	5
18	3	0	1	5
Total	8	4	14	27
Associations within group - IV and between groups IV and V				
19	6	0	0	2
20	7	0	2	3
21	5	0	0	2
22	5	1	2	1
23	5	1	0	2
24	8	1	1	3
25	5	3	0	3
26	6	1	1	1
27	3	5	2	1
28	5	1	2	1
29	7	1	0	3
Total	62	14	10	22
Associations within group - V and between groups V and IV				
34	2	0	3	4
35	1	1	1	5
36	3	0	1	4
37	1	0	2	4
38	2	0	1	4
39	3	1	2	1
Total	12	2	10	22

*Species Nos. as appear in Table-1

Table-4: Percentage frequency of the weed species in different soil regions

Species Code No.	Deltaic alluvial	Medium black	Deep black	Shallow black	Coastal alluvial	Grey brown
1.	15.0	25.0	10.0	15.0	20.0	15.0
2.	15.0	15.5	12.0	12.0	30.5	15.0
3.	19.5	24.0	17.2	17.2	11.4	10.7
4.	17.3	17.3	13.5	10.5	21.0	10.4
5.	18.0	18.2	19.0	18.2	12.1	14.5
6.	16.3	19.3	18.3	18.8	12.3	15.0
7.	12.4	22.6	15.8	7.4	15.8	26.0
8.	2.5	28.3	12.5	20	15.0	21.2
9.	14.9	21.2	17.3	14.9	14.4	17.3
10.	14.8	19.7	14.8	18.2	16.4	10.1
11.	18.5	19.0	20.0	20.0	12.5	10.0
12.	18.3	20.0	16.7	18.0	10.3	16.7
13.	14.4	27.4	14.4	12.9	17.4	13.5
14.	10.0	19.0	15.0	14.0	17.0	15.0
15.	16.5	30.0	15.0	10.0	10.2	18.3
16.	15.6	40.7	11.1	16.0	11.1	5.5
17.	17.7	36.2	7.7	10.0	13.4	15.0
18.	14.8	30.9	3.0	14.8	17.0	19.5
19.	14.7	23.8	3.0	27.7	15.4	15.4
20.	12.8	34.3	4.3	22.9	21.4	4.3
21.	23.3	20.5	6.3	27.3	21.6	0.0
22.	10.0	17.0	17.1	34.3	14.4	7.1
23.	14.3	37.1	4.0	40.0	10.6	4.0
24.	17.7	23.8	0.0	45.4	13.1	0.0
25.	12.1	9.6	7.5	32.3	25.0	12.5
26.	13.6	19.1	19.4	28.8	19.1	0.0
27.	31.3	14.2	3.0	5.0	46.5	0.0
28.	14.1	24.6	11.1	25.7	22.2	2.3
29.	15.4	26.2	15.4	12.1	27.7	3.2
30.	7.0	31.4	7.4	24.3	24.3	5.6
31.	5.0	30.0	5.0	22.5	31.5	6.0
32.	14.0	26.4	4.0	21.6	30.0	4.0
33.	10.0	35.4	20.0	6.4	20.0	8.0
34.	14.8	34.2	7.0	5.6	31.0	7.4
35.	22.5	22.7	3.2	12.5	35.0	4.1
36.	15.6	14.4	0.0	21.1	32.2	16.7
37.	20.0	20.8	10.0	11.1	31.1	7.0
38.	25.5	15.9	7.7	17.7	25.5	7.7
39.	28.3	16.7	0.0	4.0	36.7	14.3
40.	7.0	25.0	7.0	26.3	28.7	6.0

as 34, 35, 36, 37, 38 and 39. Table-2 presents the positive and negative associations of the 40 commonly occurring species reported in this study. It shows that certain species of weeds are relatively, indifferent to other species e.g. *Ipomoea eriocarpa* R. Br. and *Andrographis echioides* (L) Nees while several other species show attraction or repulsion with other species (e.g. *Asphodelus tenuifolius* and *Amaranthus tricolor* L.).

Group-I and group-II weed communities are distributed over all the six soil type of Saurashtra, group-III mainly on the medium black soil, while most of group-IV members are on the shallow black and some are on the alluvial soils. Group-V community is common on the alluvial soils (Table-4).

The phytosociological associations of the groups (Table-3) showed more positive associations within the groups and more negative associations between two groups confirms their separation and proves a good agreement of the two methods of analysis.

The analysis indicated that the weed communities could be divided into five groups based on soil types of Saurashtra. Some widely distributed weed species made negative associations with several weeds within the group as well as between the groups, such as *Echinochloa crusgalli*, *C. murale* and *Commelina benghalensis* of Group-II, *Cressa cretica* of group-III and *Dactyloctenium aegyptium* of group-IV (Table-3). *Echinocloa crusgalli* was negatively associated with *Commelina benghalensis*, *Convolvulus arvensis*, *Euphorbia orbiculata* and *E. hirta*. All of these are rare in the coastal alluvial soils where *E. crusgalli* is quite frequent (Table-4). Similarly *Cressa cretica* was negatively associated with *Trianthema portulacastrum*, *Acalypha ciliata*, *Abutilon glaucum* and *Corchorus aestuans*, All of these are quite rare in the delteic alluvial soil regions as well as in coastal alluvial soils, where *Cressa cretica* L. is the most frequently growing species (Table-4). Thus, the above mentioned fact suggests that the soil characteristics and/or associated climatic conditions may have a stronger influence on the weed communities than the associated cultural practices.

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