Pak. J. Bot., 22(1): 66-68, 1990.

A TECHNIQUE FOR THE DETECTION OF INTRASPECIFIC COMPETITION IN PURE PLANT POPULATIONS

D. KHAN AND S. SHAHID SHAUKAT

Department of Botany,
University of Karachi, Karachi-75270, Pakistan.

Competition between individuals of the same species is one of the most important density-dependent factor in nature that determines the distribution of individuals of a population in space (Odum, 1971). Linear correlation and regression analyses between the plant size and inter-plant distance have, therefore, been used to detect competition between plants in field (Laessle, 1965; Yeaton & Cody, 1976; Smith, 1979; Bell, 1981). To detect the intensity of intraspecific competition a relatively more sophisticated multivariate technique of canonical correlation analysis is employed in the present study.

To examine the variability in plant cover and spacing patterrn the method of multiple nearest neighbour was employed (Smith, 1979). Twenty five random pairs of co-ordinates were chosen in an old population of *Arthrocnemum indicum* (Willd.) Moq. (density/ha = 1944.44 ± 340.81; cv = 78.39% and cover/ha = 3055.93 ± 479.511 sq. m., cv = 70.17%) in a coastal dry salt marsh located at Hawk's Bay, Karachi and the plant nearest to the random point was selected as the reference plant. Distance from the reference plant to each of the four nearest neighbours (d_i, i = 1, 2, 3, 4) were measured from the centre of the reference plant. The cover of the reference plant and the nearest neighbours were measured as mean crown diameters along three different radii. A matrix (C) of combined crown diameter values of the reference plant and the i^{th} nearest neighbour (Δ_i, i = 1, 2, 3, 4) was generated. The corresponding distance matrix (D) was represented by four distances, d_1, d_2, d_3, d_4. Instead of simplistic approach of linear regression and correlation between the distance (d_i) and the corresponding combined crown diameter (Δ_i) separately for i^{th} nearest neighbour (Yeaton & Cody, 1976; Bell, 1981), a canonical correlation analysis (CANCOR) between the two sets of matrices viz. the matrix of combined crown diameters values of reference plant plus the i^{th} nearest neighbour (C) and the complementary distance matrix (D) was performed using the package of Orlóci & Kenkel (1985). The advantage of determining the canonical correlation is that the information inherent in the intraset and interest covariance structure is not lost. Such information is significant as it represents the competition between the i^{th} nearest neighbours as well as between the nearest neighbours and the reference plant. Thus the canonical correlation in this case more effectively represents the intensity of intraspecific competition.

The results of canonical correlation analysis are outlined in Table 1. The first canonical correlation (R_1) was found to be 0.8092. This canonical correlation explained 71.26% variability in the combined crown diameter values by the nearest neighbour distances. The degree of relationship between the two sets is expressed by Wilks lambda (λ =

Table 1. Results of canonical correlation analysis.

Canonical variates I *71.255% *(cumulative: 71.255%)	$R^2 = 0.654802$	R = 0.809198
Canonical variates II 24.506% (cumulative: 95.7611%)	$R^2 = 0.225196$	R = 0.474550
Canonical variate III 4.204% (cumulative: 99.761%)	$R^2 = 0.038636$	R = 0.196561
Canonical variate IV 0.0344% (cumulative: 100.000%	$R^2 = 0.000316$	R = 0.017790

Wilks lambda (λ) = 0.2570; p=4, q=4; $X^2 = 27.849$, df = 16, $P<0.05$.; *, magnitude of variation accounted for.

0.2570; $X^2 = 27.85$, $P<0.05$). The high order of first canonical correlation indicates strong competitive effect among individuals of *A. indicum*. Other canonical correlations (R_2, R_3, R_4) were found non-significant. The analysis indicated strong correlation between the first canonical variate (U_1) and combined crown diameter values for i^{th} nearest neighbours Δ_i (i = 1, 2, 3, 4) and also with the distance d_i (i = 1, 2, 3, 4) suggesting competition between the reference plant and its first four neighbours (Table 2).

Figure 1 diagramatically represents the situation of crown covers and distances of the first four nearest neighbours with respect to the reference plant. The close proximity of crown boundaries and the nearness of the lateral roots extending radially outwards clearly suggest above and below ground competition. *A. indicum* is known to exhibit phasic development with the individuals undergoing pioneer, building, mature, degenerate and eroded phases (Pemadasa, 1981). Thus competition is expected to be most severe in the mature and mature to degenerating phases of the cycle as the shoot and the lateral roots of neighbours come gradually closer.

Table 2. Intraset and interest correlations with the first canonical variate U_1.

Intraset		Interest	
variable	r	variable	r
Δ_1	0.8359	d_1	0.6874
Δ_2	0.7767	d_3	0.7456
Δ_3	0.9326	d_3	0.7513
Δ_4	0.7511	d_4	0.7638

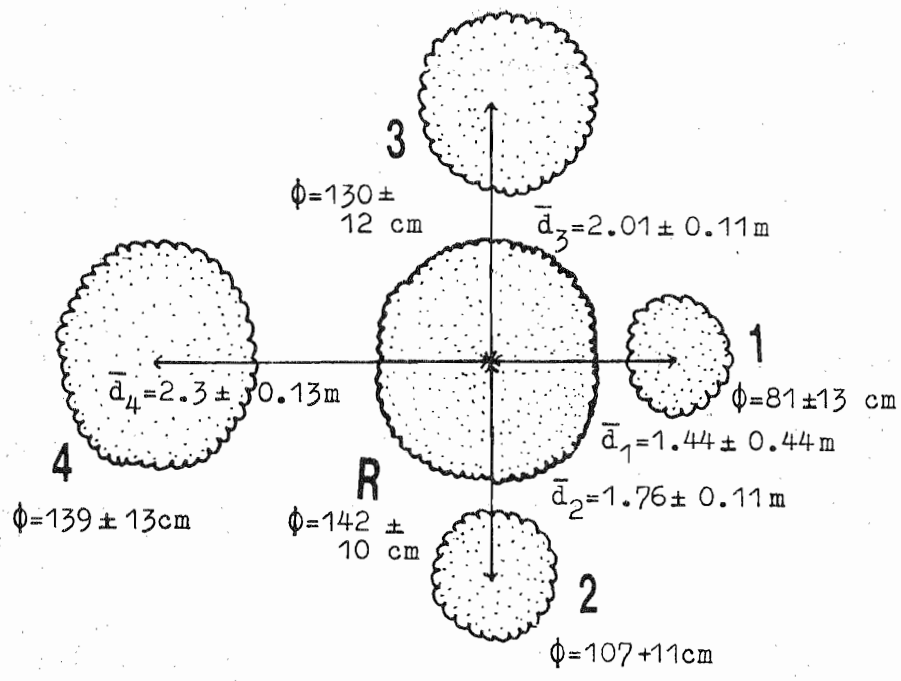

Fig. 1. The relationship of mean crown covers and distances of the first four nearest neighbours with respect to the reference plant in an old population of *Arthrocnemum indicum*. d, distance (m); ϕ, diameter of crown (cm). In each case N = 25.

In the light of experimental results on *A. indicum* population, it appears that canonical correlation analysis effectively summarizes the competitive influence between individuals in the pure population.

References

Bell, D.T. 1981. Spatial and size-class patterns in a central Australian spinifex grassland. *Aust. J. Bot.*, 29: 321-329.

Laessle, A.M. 1965. Spacing and competition in natural stands of sand pine. *Ecology*, 46: 65-72.

Odum, E.P. 1971. *Fundamentals of Ecology*. W.B. Saunders Co. xiv + 574 pp.

Orlóci, L. and N.C. Kenkel. 1985. *Introduction to data analysis with applications in population and community ecology*. ICPH, Maryland, USA.

Pemadasa, M.A. 1981. Cyclic change and pattern in an *Arthrocnemum* community in Sri Lanka. *J. Ecol.*, 69: 565-574.

Smith, A.P. 1979. Spacing patterns and crown size variability in an Ecuadorian desert shrub species. *Oecologia*, 40: 203-205.

Yeaton, R.I. and M.L. Cody. 1976. Competition and spacing in plant communities: the northern Mohave desert. *J. Ecol.*, 64: 689-696.

(Received for publication 27 January 1990)