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Morphological and bio-agronomic evaluation of populations of *Scorpiurus subvillosus* L.

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SUMMARY – With the aim of improving the quantitative traits of native pastures of the Hyblean plateau, 4 Sicilian populations and 7 selected lines (for flowering earliness and seed production) of *Scorpiurus subvillosus* L. were evaluated on plant spaced plots. Morphological (plant height, diameter of plant and length of the longest ramification, in three different periods), phenological (flowering time, duration of the flowering period and pod ripening), and productive (seeds per plant, weight of 1000 seed) parameters were measured. Positive correlations emerged among morphological traits and the length of flowering. Namely, early flowering ecotypes showed greater seed production. The PC analysis concludes that selected lines maintained the characteristics for which they had been selected. Moreover, two populations showed high seed production as well, but with a later flowering and pod ripening. Anyway, the observed variability could contribute to enhancing the genetic improvement of the species for other traits.

Key words: *Scorpiurus subvillosus*, variability, correlation, PC analysis.

RESUME – "Evaluation morphologique et bio-agronomique de populations de *Scorpiurus subvillosus* L.". Dans le but d'améliorer les caractères quantitatifs des pâturages natifs du Haut Plateau des Iblés, 4 populations siciliennes et 7 lignées sélectionnées (précocité de floraison et production de semences) de *Scorpiurus subvillosus* L. ont été évaluées en plantes espacées sur une parcelle de terrain. Des paramètres morphologiques (hauteur et diamètre de la plante et longueur de la plus longue ramification, sur trois périodes différentes), phénologiques (temps de floraison, durée de la floraison et temps de maturation des gousses), et productifs (quantité de semences par plante, poids de 1000 graines) ont été mesurés. Des corrélations positives émergent parmi certains caractères observés. Par exemple, les écotypes à floraison précoce montrent une plus grande production de graines. L'analyse en composantes principales permet de synthétiser que les lignées sélectionnées ont maintenu les caractéristiques pour lesquelles elles ont été sélectionnées. De plus, deux populations ont montré une production très élevée de graines, mais avec une floraison et une maturation plus tardives. En tout cas, la variabilité observée a pu contribuer à augmenter l'amélioration génétique de cette espèce pour d'autres caractères.

Mots-clés : *Scorpiurus subvillosus*, variabilité, corrélation, analyse en composantes principales.

Introduction

In Mediterranean environments, characterized by irregular climatic conditions, native species and ecotypes of pasture plants are considered to have better adaptation and productivity when compared to introduced species or cultivars. The wide range of genetic variability in local ecotypes, offers many opportunities for the genetic improvement of those plant materials.

Annual self-reseeding legume species play an extremely important role in Mediterranean environments, contributing to form a considerable native resource (Caporali and Campiglia, 2001) susceptible of different uses (forages, pastures, cover crops, ley farming) (Osman *et al.*, 1990).

Ecotypes of these species, not only have a great capacity of adaptation to difficult climate conditions, particularly due to their ability to persist through hard and dormant seeds, but also are able to increase pasture productivity and improve soil fertility at low cost, due to their capacity to fix considerable amounts of symbiotic nitrogen, thus dispensing any application of fertilizer nitrogen. Legumes are also fundamental components of high quality pastures or forage crops, because of their higher protein content, and a superior intake when compared with other plants.

Among spontaneous pasture species, prickly scorpion's tail (*Scorpiurus subvillosus* L.) is an interesting annual legume, which is quite common in the Mediterranean basin (Bensalem *et al.*, 1990; Beale *et al.*, 1991). It is a hard seed (Gresta *et al.*, 2007) and high palatable species to livestock.

The present research work was carried out to evaluate variability in spontaneous and selected populations of *Scorpiurus subvillosus*.

Materials and methods

A trial was carried out in 1999-2000 in Pozzallo (lat. 36° 44' N; long. 14° 51' E; alt. 10 m a.s.l.) South Eastern Sicily, Italy) on 11 *Scorpiurus*, four ecotypes (1-4) from spontaneous population of different sites in Sicily and 7 genotypes (5-11) coming from the Hyblean plateau populations and submitted to two cycle of genealogical selection addressed to seed productivity and early flowering (Table 1). Sowing was executed in the middle of November, with scarified seeds, on plot of 16 m² (4 x 4 m) with 16 plants spaced 1 meter apart, in a randomized block design with three replicates.

Table 1. Sites of origin of studied ecotypes

N	Provenience	Area code	Selection
1	Caltanissetta	CL	
2	Carlentini	SR	
3	Mauto	RG	
4	Messina	ME	
5	Parabuto	RG	8-17
6	Parabuto	RG	8-35
7	Pozzo Cassero	RG	5-1
8	Pozzo Cassero	RG	5-20
9	Pozzo Cassero	RG	20-29
10	Pozzo Cassero	RG	28-26
11	Torre Cannata	RG	21-12

The following traits were measured: maximum plant diameter (MPD - cm), maximum branch length (MBL - cm), plant height (PH - cm), time to flowering (FT - days from sowing, 30% plant with inflorescences), flowering length (FL - days between the first and last dates of flowering), pods ripening (PR - days from sowing, 30% plant with brown pods), seed plant production (PP - g) and weight of 1000 seeds (SW - g).

The relationships between the different traits were quantified using Pearson correlation and Principal Component Analysis (PCA). PCA on standardised data was performed with Systat 12 (SYSTAT Software Inc.). Principal components with eigenvalues >1.0 were selected and correlation values >0.6 were considered as relevant for the PCA.

Results and discussion

The average performance of *Scorpiurus* ecotypes are reported in Table 2. Among morphological traits, PH showed the lowest variability ranging between 5.3 and 8.6 cm, whilst MBL the highest CV value (25.3%). Number of days to 30% flowering varied between 119 and 139, showing a very low CV (4.4%) as well as PR (2.7%). Productive parameters showed the absolute greatest variability 53.8 for SW and 78.9 for PP. Knowledge of the existing phenotypic variability of seed production is essential for the development of high yield genotypes. Results of Pearson correlation analysis shows significant relation for some of the evaluated characters (Table 3). Positive relations emerge among morphological traits and flowering length. Moreover seed plant production resulted positively correlated with all the morphological studied traits and with the flowering length and negatively with flowering time. This means that early flowering ecotypes show a greater seed production.

Table 2. Descriptive statistics of the evaluated traits

Variable	mean	max	min	CV
MPD (cm)	26.1	32.6	14.1	19.7
MBL (cm)	60.6	76.8	35.6	25.3
PH (cm)	6.9	8.6	5.3	12.1
FT (dd)	129.5	138.6	118.6	4.4
FL (dd)	53.5	64.8	40.7	13.9
PR (dd)	195.8	203.7	187.9	2.7
PP (g)	64.7	106.6	13	78.9
SW (g)	14	17.4	11.3	53.8

Table 3. Pearson correlation of the studied parameters

Variable	MBL	PH	FT	FL	PR	PP	SW
MPD	0.670*	0.511	-0.326	0.761**	0.236	0.761**	0.166
MBL		0.676*	-0.674*	0.646*	-0.164	0.810**	0.123
PH			-0.513	0.651*	0.119	0.799**	0.072
FT				-0.538	0.305	-0.676*	-0.386
FL					0.492	0.897***	0.036
PR						0.265	-0.185
PP							0.097

From the Principal Component Analysis, two principal components obtained explain 75.2% of the variability (Table 4). For component one, which explained 55.0% of the variation, almost all the traits were associated except pod ripening and seed weight. The second component is responsible for the 20.2% of the variability and is exclusively associated to ripening time.

Table 4. Results of the principal component analysis (PCA)

	PC 1	PC 2
Eigenvalue	4.4	1.6
% of variability	55	20.2
Cumulative %	55	75.2
MPD	0.804	0.183
MBL	0.865	-0.244
PH	0.813	0.017
FT	-0.715	0.546
FL	0.899	0.333
PR	0.174	0.885
PP	0.977	0.102
SW	0.197	-0.568

In Fig. 1, the rays connecting the traits to the biplot origin, are referred to as trait vectors. The vector length of a trait measures the magnitude of its effect (positive or negative). All the morphological traits (MPD, MBL and PH) had relatively long vectors, suggesting that they could have relatively large weight on the selection of representative traits.

The graphical representation of the relationships among ecotypes shows a high amount of variability among all the ecotypes, but selected lines come from the same plant generally kept homogeneous traits. In fact, a first group, composed by the ecotypes 5 and 6 (same mother plant - Parabuto "8"), showed late flowering time (138 days versus 129 days of the total average); a second

group which includes ecotypes 7 and 8 (same mother plant Pozzo Cassero "5"), shows the high values of morphological traits and a early flowering (122 days versus 129 days of the total average); a third group (10, 9 and 1) with negative PC1 and PC2 values, presents a short flowering length (45 days versus 54 days of the total average) that is strict related with a lower seed plant production (39.3 g versus 64.7 g of the total average). On the contrary these ecotypes show the highest 1000 seed weight (15 g versus 14 g of the total). Finally, the ecotype 2 was the unique to be characterized by a late pod ripening (201 days versus 196 days of the total average) and a large flowering length (64 days versus 54 days of the total average).

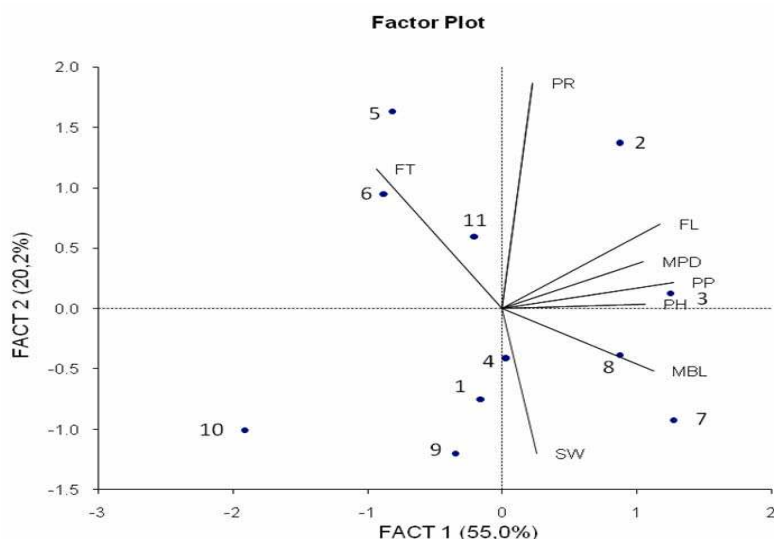


Fig. 1. Scatter plot grouping of *Scorpiurus* spp. based on PC1 and PC2 of the principal component analysis.

Conclusions

Ecotypes and selected lines show a considerable variability for studied traits. Namely, selected lines 7 and 8, coming from the same mother plant in Pozzo Cassero, maintained the characteristics for which they have been selected (early flowering and seed production) with a strict similarity between them. Differently, lines 5 and 6, coming from same mother plant, but from another collection environment (Parabuto), shows similar traits, and, although they were selected for early flowering, are both with a later flowering compared to ecotype 3 (coming from the same area) and to all the other selected lines. In ecotypes 2 and 3 a high seed production was observed, even if with a late flowering and pod ripening. Anyway, the observed variability could contribute to enhance the genetic improvement of the crop for other traits.

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