Morphological characterisation of Spanish genetic resources of *Lathyrus sativus* L.

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Introduction

Grass pea (*Lathyrus sativus* L.) is known in Spain as "almorta", "muela", "tito", "guijo" or "chícharo", and was probably one of the first cultivated plants. At present, in Spain, this species remains a marginal crop in some areas around all of the country. In 1996 the area dedicated to grass pea was only 273 ha, with a production of 174 t of grain and 52 t of straw. In Spain there are no commercial varieties of *L. sativus* and for this reason the seed sown belong to traditional local types.

The Spanish Plant Genetic Resources Centre (CRF), belonging to the National Institute of Agriculture and Food Research Technology (INIA) and preserves a total of 445 accessions of genus *Lathyrus*, mainly *L. cicera* and *L. sativus*, and also some accessions of other wild species including *L. amphicarpos* and *L. annus* [(1)].

Material and Methods

The CRF *L. sativus* collections consist of 150 accessions, 132 corresponding to Spanish landraces. Sixty of them were characterised for the following agro/morphological traits from November 1994 to July 1995:

DFF:	Days to first flowering.
DF:	Days to 50% flowering.
DEF:	Days to end of flowering.
DM:	Days to maturity.
PLH:	Plant height (cm).
FPOH:	First pod height (cm).
STPL:	Number of primary stems per plant.
PEDL:	Peduncle length (cm).
POPL:	Number of pod per plant.
POL:	Pod length (mm).
POW:	Pod width (mm).
SEPO:	Number of seeds per pod.
SEL:	Seed length (mm).
SEW:	Seed width (mm).
SET:	Seed thickness (mm).
100SEW:	100-seed weight (g).
FC:	Flower colour.
SEC:	Seed colour.

The characterisation site was located in Alcalá de Henares (Madrid) in 40º31'N, 3º17'W and 610 masl. Each accession was sown in an experimental plot of 5 rows 3 m length, 35-40 cm between rows, with 150 seeds/accession. Observations were recorded about the whole plot for the phenological characters and flower and seed colour. The mean of ten plants, pods or seeds was calculated for the metric traits.

Pearson correlation was performed to determine the interrelationships between traits. Principal Component Analysis (PCA) was utilised to show the patterns of covariation of quantitative variables among accessions. Statistical calculations were made using the SPSS package.

Results and Discussion

Table 1 summarises the results of field characterisation for quantitative characters. For each trait, mean, standard deviation, maximum and minimum value about the total accessions is recorded. These results show the existence of high variability in plant, pod and seed traits, in a similar range of variation to that in a collection that included the known geographical distribution of *L. sativus* [(7)]. The populations evaluated in this study were later and their range of variability for phenological data was lower that those evaluated in a collection of Mediterranean *L. sativus* lines [(6)]. The lesser variation for these traits can be as a consequence of the more restricted geographical origin of the CRF collection. Furthermore, Spanish grass pea exhibited bigger seeds that Mediterranean lines mentioned above; the larger seed size is probably derived from their preferential use as grain.

Table 2 shows the percentage of each class for flower and seed colour. The coloured flower category includes completely blue flowers and white ones that have some blue or pink pigmentation on the standard petal, lateral petal or both. Although grass pea is reported as an autogamous species, the great percentage of accessions with a mixture for seed and flower colour could be due to outcrossing. Data of hereditability of flower colour [(3)] and isozymes heterozygosity [(4)] indicated a variable level of outcrossing depending of environmental conditions. Field observation in our experimental plot confirm this aspect, for this reason we use spatial isolation for seed increase of landraces of grass pea in order to maintain the genetic integrity of individual accessions.

Table 1. Mean, standard deviation, maximum and minimum for the quantitative evaluated traits (see text for the explanation of descriptor codes).

Descriptor	Mean	Std Dev	Max	Min
DFF	139.95	2.63	147.00	136.00
DF	147.18	2.57	154.00	143.00
DEF	191.81	2.44	197.00	187.00
DM	209.57	5.82	222.00	200.00
PLH	53.35	8.15	77.10	39.30
POH	15.18	3.69	27.70	9.30
STPL	2.46	0.42	4.50	1.90
PEDL	3.69	0.52	4.93	2.67
POPL	29.37	6.52	46.80	17.40
POW	15.03	0.94	17.00	11.90
POL	42.08	3.07	52.45	34.50
SEPO	2.94	0.33	4.00	2.20
SEL	8.95	0.97	11.04	6.47
SEW	9.00	0.70	10.57	7.15
SET	4.79	0.29	5.71	4.21
100SEW	25.77	3.92	36.80	13.80

Table 2. Class frequency of grass pea non metric characters.

Descriptor	Class	Frequency (%)
Flower colour (FC)	White	16.6
	Coloured	43.3
	Mixture	40.3
Seed colour (SC)	Light	23.3
	Light with blue or black line	36.6
	Light with wide black ornamentation	1.6
	Mixture	38.3

Correlations between metric characters were calculated (Table 3), many of them were as expected. The strongest positive correlations were between days to first flower with days to 50% flowering, days to end flowering with days to maturity, plant height with first pod height, peduncle length with plant height and first pod height, number of primary stems per plant with number of pod per plant, pod width with pod length, seed length with seed width and 100 seed weight with seed length and width. Significant negative correlations ($P< 0.05$) were found between days to first flowering with days of end flowering and days to maturity, days of end flowering with first pod height, number of pod per plant with seed length and width and 100 seed weight with number of seed per pod. Similar correlations were found in a collection of Spanish faba bean germplasm [8]. Seed and flower colour data were not included in correlation analysis but, as reported elsewhere [7], in this species there is an association between less coloured seed and flowers. The Spanish landraces, probably more domesticated forms, contain a low ODAP content [5].

Table 3. Correlation coefficient between quantitative traits (see text for the explanation of codes). Coefficients not shown were not significant at P<0.05.

	DFF	**DF**	**DEF**	**DM**	**PLH**	**FPOH**	**STPL**	**PEDL**	**POPL**	**POL**	**POW**	**SEPO**	**SEL**	**SEW**	**SET**	**100 SEW**
DFF	1.00															
DF	**0.73**	1.00														
DEF	-0.32	-	1.00													
DM	-0.30	-	**0.51**	1.00												
PLH	-	-	-	-	1.00											
FPOH	-	-	-0.39	-	**0.62**	1.00										
STPL	-0.26	-	-	-	0.37	0.42	1.00									
PEDL	-	-	-0.32	-	**0.56**	**0.55**	-	1.00								
POPL	-	-	-	-	0.44	0.36	**0.59**	0.34	1.00							
POL	-	-	-	-	-	-	-	-	-	1.00						
POW	-	-	-	-	-	0.27	-	-	-	**0.61**	1.00					
SEPO	-	-	-	-	-	-	-0.26	-	-0.28	-	-	1.00				
SEL	-	-	-	-	-	-	-0.25	-	-0.38	-	-	-	1.00			
SEW	-	-	-	0.30	-	-	-	-	-0.36	-	-	-	**0.82**	1.00		
SET	-	-	-	-	-	-	-	-0.27	-	-	-	-	-	0.33	1.00	
100 SEW	-	-	-	0.25	-	-	-	-	-0.35	-	-	-0.32	**0.86**	**0.82**	-	1.00

Table 4. Correlation of the analysed traits with the three first principal axes F1, F2 and F3 (see text for the explanation of codes).

	F1	**F2**	**F3**
DFF	0.106	-0.494	**0.676**
DF	0.111	-0.453	**0.629**
DEF	0.393	0.135	**-0.627**
DM	0.177	0.562	-0.362
PLH	**-0.608**	0.480	0.025
FPOH	**-0.645**	0.394	0.274
STPL	-0.560	0.391	-0.022
PEDL	-0.551	0.422	0.247
POPL	**-0.703**	0.053	0.160
POL	-0.103	0.501	0.172
POW	-0.011	**0.616**	0.130
SEPO	0.009	-0.140	-0.410
SEL	**0.736**	0.427	0.344
SEW	**0.696**	0.533	0.264
SET	0.375	0.090	-0.269
100SEW	**0.687**	0.474	0.414
Eigen value	3.75	2.85	2.18
% Variation explained	23.47	17.82	13.65
% Variation accumulated	23.47	41.30	54.96

Results of PCA were summarised in Table 4, which shows the correlation of each character with the three principal components, the percentage of variation explained by this components, the eigen values and the variability explained and accumulated by the 3 PC. F1 explained 23.47% of variability. In this axis, the traits with the most important contribution were related to plant architecture (plant height, first pod height and pod per plant) and to seed characters (100 seeds weight and seed length and width), these two groups of variables showing an inverse relation. F2 (17.82% of variation) was mainly loaded by traits related to pod size. F3 (13.65% of variability) was positively correlated with the phenological characters days to first flowering and days to 50% of flowering and correlated negatively with days to end of flowering. Similar results of variability distribution have been found for a Spanish collection of *Vicia articulata* [(2)].

The total amount of variability accounted for the three principal components was 54.96%; this low percentage indicates that traits did not show a strong association, due probably, to the scarce breeding work made in Spanish populations of grass pea. In a similar study [(9)] of grass pea accessions, collected in the Marche region of Italy, the accumulated variation in the first 3 principal components was 91.74%. This high difference in percentages of variation could be explained by the different provenance of accessions; Italian material was collected in a small area whereas our landraces were gathered in a wider range of places.

In spite of the problem of lathyrism, which has restricted the exploitation of *L. sativus*, the variability found in our collection for plant architecture and seed traits should be taken into account for future breeding programs in this species. In a moment when Europe is looking for diversification of cropping systems and for more environmental friendly agriculture, the grain legumes are a very interesting option and grass pea could play an important role in some regions of Southern Europe.

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