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Short communication

Comparison between a wild population and cultivar of common vetch (*Vicia sativa* L., Fabaceae) on cytological and agronomic characteristics

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Abstract The aim of this study was to compare a wild population of common vetch (*Vicia sativa* L.) collected from the Serinyol district of Antakya in the east Mediterranean coastal region of Turkey with a cultivar of common vetch (*V. sativa* 'Anadolu'), on somatic chromosome number and important agronomic attributes. Somatic chromosome counts from material collected from the wild population of *Vicia sativa* L. were consistently $2n = 10$, while the cultivar had $2n = 12$. There were no significant differences between wild and cultivated cytotypes in plant height, seed number or pod number, although the wild cytotype had significantly more branches, smaller seeds, higher hardseededness and lower germination rates.

Keywords *Vicia sativa*; chromosome number; agronomic attributes

INTRODUCTION

The genus *Vicia* has long been a subject of active research because it contains several species of economic importance, e.g., *V. faba*, *V. sativa*, *V. narbonensis*, *V. ervilla*, and *V. villosa*, many of which have been domesticated since the origin of agriculture (Gil & Cubero 1993). The common vetch, an economically important fodder crop, is a member of the *Vicia sativa* L. aggregate, a closely related group of autogamous annual taxa (Potokina et al. 2002). Common vetch seems most likely to have originated from southern Europe or south-west Asia (Maxted 1995). In some of the Mediterranean countries, it is one of the most prominent types within the agricultural system. The common vetch is a highly variable and polymorphic species containing both indigenous weeds and cultivated forms. It represents a wide range of morphological variation, which has caused considerable taxonomic uncertainty. While some authors recognise eight taxa in this aggregate, some other taxonomists regard it as only a single species *V. sativa* L. sensu lato with certain subspecies and varieties (Potokina 1997). Selection under domestication and the secondary establishment of wild populations that have escaped from cultivation have further contributed to extraordinary morphological variation of *V. sativa*.

This species also varies cytologically. Three different chromosome numbers have been reported for *V. sativa*. The majority of counts are $2n = 12$, with $2n = 10$ and $2n = 14$ occasionally reported, e.g., Ladizinsky 1978; Ladizinsky & Temkin 1978.

The objective of this study was to compare wild and cultivated material of *V. sativa* in cytologic and agronomic characters.

MATERIALS AND METHODS

A cultivar of common vetch officially registered as *V. sativa* 'Anadolu' and commonly grown in Mediterranean region of Turkey, and a wild population of common vetch collected from the Serinyol district of Antakya in the east Mediterranean coastal region

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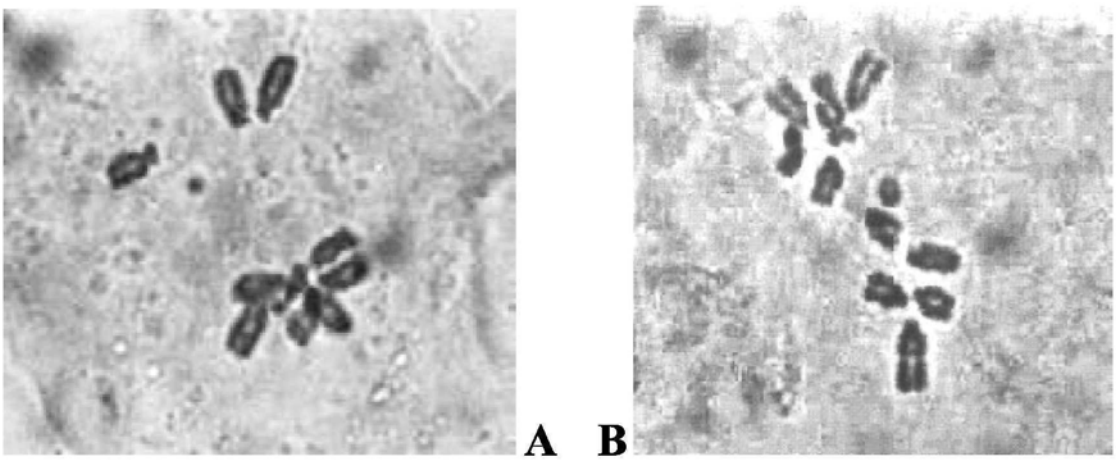


Fig. 1 Somatic chromosomes of two *Vicia sativa* L. cytotypes (1000×). **A**, Material of wild origin $2n = 10$; **B**, cultivar *Vicia* 'Anadolu' $2n = 12$.

of Turkey were compared for cytological and eight plant characteristics.

The experiment was conducted in a completely randomised design with 10 replications under glasshouse conditions. The seeds of the cultivar were obtained from the seed bank of Agricultural Faculty of Çukurova University, while the wild material was collected from the natural flora 1 year before. Pots (220 × 180 × 250 mm) were filled with a soil + sand + manure mixture for both the wild cytotype and the cultivar, and four seeds were sown in each on 15 December 2003 for subsequent morphological examination. Five pots (70 × 70 × 70 mm) for the wild cytotype and five for the cultivar were prepared on the same date for the cytological investigation. Seeds were germinated in an incubator at 25°C in petri dishes with Whatman paper dampened with sterile distilled water, and when 4 days old were planted in each pot. All the pots were irrigated regularly to field capacity and the weeds were removed manually.

Cytological investigation was done with root tips when the seedlings were about 150 mm high. The root-tips were pre-treated with a saturated aqueous solution of α-mono bromo-naphthalene for 4 h at room temperature. They were then fixed in glacial acetic acid for 30 min, hydrolysed in a water bath at 60°C with 1 *N* HCl for 12 min, stained by the Feulgen method described by Hatipoğlu (1991), and finally squashed. Well dispersed metaphase chromosomes were photographed at 1000× magnification. The chromosome lengths were measured using five photographs with 0.1 mm sensitivity and then converted to μm to take account of the magnification rate. Non-stained parts of chromosomes such as centromeres and the distance between the satellite and carrier arm were not added to the measurements. The length was calculated by the equation short arm + long arm for each chromosome as described by Krikorian et al. (1983).

Morphological and physiological investigations were done at 50% flowering (days to 50% flowering, plant height, and number of main branches) and after physiological maturity (pod number, seed number, seed yield, and 100-seed weight). After the chromosomal differences were identified, the germination rates were determined from the initial seeds (not cultured). Determination of this rate was done with the counting of 7-day-old seedlings obtained from the seeds germinated in an incubator at 25°C in petri dishes with Whatman paper wetted with sterile distilled water. The plant height was measured from the soil surface to the base of top tendril of the main branch. All pods from each pot were picked manually after physiological maturity and the numbers of pods and seeds per plant were determined. Harvested seeds were weighed and the value obtained divided by 4 to get the seed yield per plant. Data were analysed with a *t*-test.

RESULTS AND DISCUSSION

Cytological findings

The microscopic investigations for the chromosome counts were done in 10 cells per plantlet from each of the five pots of both cytotypes. Two different chromosome numbers were determined.

While the chromosome number was uniformly $2n = 10$ (Fig. 1A) for all samples of the wild derived *V. sativa* L. population, it was $2n = 12$ for material of the cultivar (Fig. 1B).

In the genus *Vicia*, $2n = 14$ is the most widespread chromosome number, but species with $2n = 12$ are found in several sections. Tetraploids with $2n = 24$ and $2n = 28$ and a hexaploid with $2n = 36$ are also found in several species closely related to the *V. sativa* aggregate (Hollings & Stace 1974). Three different chromosome numbers ($2n = 10, 2n = 12, 2n = 14$) have previously been reported for the *V. sativa* aggregate (e.g., Hollings & Stace 1974; Ladizinsky & Temkin 1978; Gil & Cubero 1993). Ladizinsky (1978) mentioned the complexity and plasticity of *V. sativa*. The existence of several cytotypes within the same taxon, or different taxa with the same karyotype, might suggest a conspicuous genetic connection between the cytotypes having different chromosome numbers. These cytogenetic affinities, that sometimes cause confusion between the various individuals of *V. sativa*, suggest chromosomal evolution in this aggregate. Hollings & Stace (1974) proposed a reduction in chromosome numbers *per se* $2n = 14 \rightarrow 2n = 12 \rightarrow 2n = 10$ for this aggregate. On the other hand, Ladizinsky & Temkin (1978) pointed out that cytogenetic information is compatible with the $2n = 12 \rightarrow 2n = 10$ evolution, but not the declined aneuploidy such as $2n = 14 \rightarrow 2n = 12$.

The relative somatic chromosome lengths of the wild cytotype were determined between 3.71 and 5.64 µm and were between 2.69 and 5.38 µm for the cultivar 'Anadolu' (Table 1). These findings were very close to the statement of Ladizinsky (1978) on both cytotypes. The plants belonging to the $2n = 10$ cytotypes were also identified as var. *angustifolia* or var. *cordata* by the same author.

Agronomic attributes

Plant height, pod number, and the seed number of the two cytotypes were not statistically different (Table 2). Samples from the wild population of *V. sativa* L. had more branches than the cultivar. Branching differences resulted from genotypic differences between two vetch cytotypes, since branching is controlled by gene(s) and environmental factors in crops (Nelson 1997).

Material from the wild population produced more seeds, but considering the 100-seed weight

Table 1 Relative somatic chromosome length (µm) of two cytotypes in *Vicia sativa*.

	$2n = 10$			$2n = 12$		
Chromosome	Min.	Max.	Av.	Min.	Max.	Av.
I	5.27	6.02	5.64	4.83	6.13	5.38
II	4.54	5.20	5.05	4.64	5.46	4.96
III	4.10	4.90	4.58	4.45	5.03	4.68
IV	4.04	4.67	4.31	4.06	4.42	4.32
V	3.25	4.40	3.71	2.78	4.18	3.74
VI				2.20	3.41	2.69

Table 2 Comparison on morphological traits between a wild population and a common cultivar of *Vicia sativa* L. *, Means in the same column are significantly different by *t*-test at the $P \leq 0.05$ level; **, means in the same column are significantly different by *t*-test at the $P \leq 0.01$ level.

	Plant characteristics							
Population	Plant height (mm)	No. of main branches	Pod number/ plant	Seed number/ plant	Seed yield (g/plant)	100-seed weight (g)	Germination rate (%)	Days to 50% flowering
Material of wild origin	553	8.8**	5.9	24.6	0.64*	2.72**	63**	114
Cultivar *V.* 'Anadolu'	581	5.2	6.2	21.6	1.24	5.98	90	104

parameter, the seeds were lighter than those of the cultivar. Germination rate was also significantly different between the two populations. The wild population showed a very low germination rate. Hancock (1992) discussed more even and rapid germination via the domestication process, associated with greater seed size and loss of germination inhibitors. Seeds of some pasture and forage plants show hardseededness because their seed coats often represent temporarily impermeable barriers, causing a low germination rate (De Sousa & Filho 2001). Dormancy is important for wild species. Some dormancy is required to build up a seed bank in the soil (Harlan 1995). This is useful in the ley farming system, which also needs high hardseededness (Moneim 1992). Weather-resistant pods and hardseededness allow natural re-establishment in succeeding years, even if winter rains are insufficient in a season to permit seed production (Crawford et al. 1989). This trait, along with hardseededness mechanisms, allows a proportion of a seed population to survive extended drought and promotes germination only when soil moisture is high enough to support seedling growth. Once germinated, annual legumes exhibit rapid vegetative growth and maturity, and extreme developmental plasticity. This increases the chances for seed production under conditions of erratic and low precipitation (Kemp 1989).

The material from the cultivar flowered 10 days earlier than the wild population. Similarly, Weber & Schifino-Wittmann (1999) reported that flowering and fruiting periods were shorter for *V. sativa* ($2n = 12$).

Such mixed populations were detected in nature and in two populations even $2n = 12$, $2n = 10$ and $2n = 14$ types can be found side by side. While the $2n = 12$ types of the *V. sativa* L. aggregate are confined to the primary vegetation, the $2n = 10$ types have strong weedy tendencies in agricultural habitats. The reduced genetic flexibility in the $2n = 10$ resulting from the reduced chromosome number, could play some role in weediness of these types (Ladizinsky & Temkin 1978). The confused taxonomic status of the *V. sativa* L. aggregate is apparently due to hybridisation between these individuals of the different cytotypes. Moreover, Rowlands (1959) reported contaminant plants in commercial crops of lentils (*Lens esculenta* L. ($2n = 14$)) due to the spontaneous hybridisation with *V. sativa* ($2n = 12$). Consequently, a genetic contamination is also possible in the *Vicia* aggregate. Wild populations can be considered as a gene pool for the several breeding purposes, such as resistance to various stress factors, insect and plant diseases, forage quality, earliness, etc. So, it is economically important to investigate for valuable characteristics in the wild forms of *V. sativa* L. and to transfer them to the cultivated lines.

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