

Determination of Morphological, Agricultural and Cytological Characters of Some *Lathyrus* species

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In this study, some morphological, agricultural and cytological characters of naturally grown *Lathyrus* species (*Lathyrus hirsutus* L., *L. ochrus* L. (DC), *L. aphaca* L. var *affinis*, *L. laxiflorus* ssp *laxiflorus*, *L. annuus* L., *L. sphaericus* Retz.) were investigated in 2003 and 2004. Average plant height varied between 32.50 and 131.00 cm, dry yield/plant between 0.32 and 22.16 g/plant, crude protein of hay between 15.00 and 21.00 % and, 20.51 and 28.36 % in seed and ash content between 7.06 and 10.82 %. K, Ca, Mg, Fe, Zn and Mn contents were determined in both whole plants and seeds. Chromosomal and cytogenetic studies have shown that investigated *Lathyrus* species has diploid with $2n = 14$ somatic chromosome number.

Key Words: *Lathyrus*, Agricultural characters, Cytogenetic.

INTRODUCTION

The genus *Lathyrus* has 187 species and subspecies¹. Centers of diversity for ancient periods are Asia Minor and the Mediterranean region². Only one species (*Lathyrus sativus*) is widely cultivated as a food crop³. Other economically important species are *Lathyrus cicera* and *L. tingitanus* for grain and *L. ochrus*, *L. latifolius* and *L. sylvestris* for forage. A newly described species, *Lathyrus amphicarpus*, is presently found in the Middle East and has a potential of becoming important as a self-seeding forage species. While other species are cultivated to a lesser extent for both food and forage, some species are valued as ornamental plants, especially the sweet pea (*L. odoratus*).

Cytogenetic and biosystematic studies that have been conducted on some of the main pulse crops have focused on assuming wild species and their more efficient use in crop improvement. Chromosomal and cytogenetic studies have shown the genus *Lathyrus* to be predominantly diploid with $2n = 14$ chromosome numbers. More than 60 species have been reported with only three species having been shown to have more than 14 somatic chromosomes⁴. Two species (*L. pratensis* and *L. venosus*) are

tetraploid with $2n = 28$ chromosomes and, one species (*L. palustris*) is hexaploid with $2n = 42$ chromosomes. These species have been studied cytologically and shown to be autopolyploids.

Lathyrus genus includes about 61 species in Turkey, although some of them being endemic such as, *L. cilicicus*, *L. elongatus* and *L. undulatus*⁵. Only *L. sativus* and *L. cicera* are cultivated widely for forage and lesser for food crop in country⁶. Tosun⁷ also mentioned that *L. hirsutus* had been cultivated especially in Inner and Central Anatolia, during 1960s and *Lathyrus odoratus* was cultivated as an ornamental¹⁵.

In this study, similar morphological, agricultural and cytological characters of six *Lathyrus* species was determined; namely a list six *Lathyrus* species (*Lathyrus hirsutus* L., *L. ochrus* L. (DC), *L. aphaca* L. var *affinis*, *L. laxiflorus* ssp *laxiflorus*, *L. annuus* L., *L. sphaericus* Retz.), grow naturally in Kurupelit Campus of Ondokuz Mayıs University^{8,9}.

EXPERIMENTAL

Six *Lathyrus* species (*Lathyrus hirsutus* L., *L. ochrus* L.(DC), *L. aphaca* L. var *affinis*, *L. laxiflorus* ssp *laxiflorus*, *L. annuus* L., *L. sphaericus* Retz.) which are growing naturally were collected in Kurupelit Campus of Ondokuz Mayıs University (Samsun-Turkey). *Lathyrus hirsutus* L., *L. ochrus* L.(DC), *L. aphaca* L. var *affinis* and *L. laxiflorus* ssp *laxiflorus* were common, but *L. sphaericus* Retz. and *L. annuus* L. were uncommon in campus area and in the year 2003, *L. sphaericus* Retz. and *L. annuus* were not found.

In campus area, altitude ranges from 24 to 197 m and soil depth from 10 to 120 cm. As soil characters determined from six samples taken in 2002 (October), for 0-20 cm soil depths; pH: 6.35-7.30, P_2O_5 : 3.893-13.00 kg/da, K_2O : 30.00-234.60 kg/da, organic mater: 1.17-4.95 %, Ca: 0.52-0.75 %, Mg: 0.03-0.10 %, Fe: 8.20-42.77 ppm, Zn: 1.08-4.08 ppm, Cu: 1.44-3.70 ppm and Mn: 16.65-56.00 ppm (Table-1).

In Samsun, annual mean precipitation is 669.6 mm. Growing season (from January to August) total precipitation was 322.6 mm in 2003 and 578 mm in 2004. Precipitation was lower in 2003 than 2004 in growing season (Fig. 1). Monthly mean temperature was lower in 2003 than in 2004, especially in the February, March and April which are most important months for plant growing (Fig. 2).

Observations were recorded in 10 randomly selected plants (from nature lands) of each species for plant height, number of primary branch, leaf number/plant, dry yield/plant, pod number/plant, pod length, seed number/pod, seed yield/plant. Crude protein (CP), crude ash and mineral matter contents (K, Ca, Mg, Fe, Zn and Mn) were measured for dried milled whole plants (harvested in 50 % flowering and dried at 70°C for 24 h) and

seeds. Crude protein content was assessed by Kjeldhal method¹⁰, crude ash content¹¹ and mineral contents by using atomic absorption spectrophotometer¹⁰. In addition, 1000 seed weights were determined for all species.

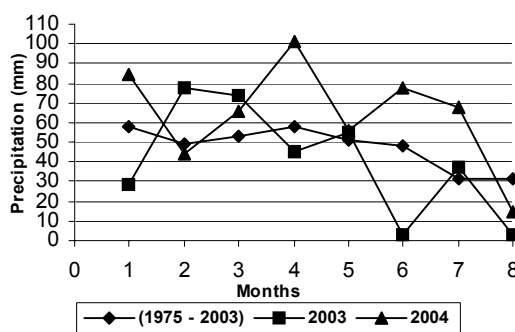


Fig. 1. Monthly precipitation in growing season (January-August) in Samsun

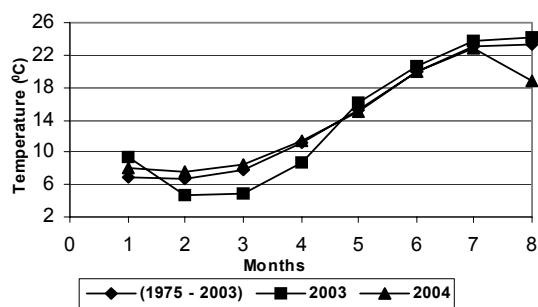


Fig. 2. Monthly average temperature in growing season (January - August) in Samsun

The germination test, 50 seeds as replicated four times placed in Petri-dishes on filter paper and moistened with distilled water and then incubated at room temperature ($20 \pm 2^\circ\text{C}$) and seeds were counted at 7th and 14th days¹². Scarification was carried out with using sandpaper.

The somatic chromosome number of the *Lathyrus* species was determined by germinating seeds on moist filter paper in the laboratory at 25°C . The growing root tips, 1.0 to 1.5 mm long, were excised and pretreated in a saturated solution of α -bromonaphthalene for 3 h. After the pretreatment, the root tips were fixed in glacial acetic acid for 0.5 h. The chromosomes were stained according to Feulgen method after hydrolysis in HCl (1 N) for 12 min, at 60°C . Root tips were then squashed in 45 % acetic acid^{13,14}.

TABLE-1.
SOME PHYSICAL AND CHEMICAL PROPERTIES OF CAMPUS SOILS

Altitude (m)	Soil depth (cm)	pH	Soil properties								
			P ₂ O ₅ (kg/da)	K ₂ O (kg/da)	Organic matter (%)	Ca (%)	Mg (%)	Fe (ppm)	Zn (ppm)	Cu (ppm)	Mn (ppm)
Min.	24	10	3.89	30.00	1.17	0.47	0.03	8.20	1.08	1.13	16.65
Max.	197	120	13.00	234.60	4.95	0.75	0.10	47.77	4.08	3.70	56.00

TABLE-2
PLANT HEIGHT, NUMBER OF PRIMARY BRANCHES, LEAF/PLANT AND DRY YIELD/PLANT VALUES OF *Lathyrus* SPECIES

Species	Year	Plant high (cm)		Num. of pir. branch		Leaf/plant		Dry yield/plant (g)	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
<i>L. hirsutus</i> L.	2003	101.41	± 9.41	9.70	± 1.40	102.00	± 15.07	11.14	± 3.17
	2004	131.00	± 8.98	7.10	± 2.40	90.10	± 26.51	18.80	± 8.66
<i>L. ochrus</i> L.(DC)	2003	83.80	± 21.35	6.70	± 1.22	132.00	± 37.60	22.16	± 8.10
	2004	89.10	± 8.37	6.80	± 1.71	106.00	± 23.46	12.66	± 3.31
<i>L. aphaca</i> L. var affinis	2003	48.25	± 3.22	1.75	± 0.37	30.50	± 5.42	0.32	± 2.02
	2004	58.05	± 5.75	12.20	± 2.60	144.30	± 42.00	3.50	± 1.05
<i>L. laxiflorus</i> ssp laxiflorus	2003	32.50	± 3.54	5.70	± 1.91	26.50	± 8.68	1.31	± 0.53
	2004	36.83	± 3.07	14.11	± 1.94	108.00	± 37.15	2.05	± 0.55
<i>L. annuus</i> L.	2003	—	—	—	—	—	—	—	—
	2004	100.4	± 15.68	7.50	± 1.95	72.60	± 30.60	7.98	± 2.58
<i>L. sphaericus</i> Retz.	2003	—	—	—	—	—	—	—	—
	2004	34.22	± 3.63	18.60	± 5.00	89.20	± 26.84	2.55	± 1.03

n = 10

RESULTS AND DISCUSSION

Among *Lathyrus* species and years, it was determined that average plant height ranged from low in 32.50 cm *L. laxiflorus* ssp *laxiflorus* to high 131.00 cm in *L. hirsutus* L., number of primary branches from 1.75 (*L. aphaca* L. var *affinis*) to 8.60 (*L. sphaericus* Retz.), leaf/plant from 26.50 in *L. laxiflorus* ssp *laxiflorus* to 144.30 in *L. aphaca* L. var *affinis* and dry yield/plant from 0.32 g/plant in *L. aphaca* L. var *affinis* to 22.16 g/plant in *L. ochrus* L.(DC) (Table-2). Acar *et al.*⁸ reported that plant height and number of primary branch were 75-110 cm and 5-11 in *L. hirsutus*, 90-120 cm and 1-4 in *L. ochrus*, 80-110 cm and 3-5 in *L. aphaca* L. var *affinis*, 25-50 cm and 3-8 in *L. laxiflorus* sp *laxiflorus*, 100-160 cm and 1-6 in *L. annuus*, 20-35 cm and 5-9 in *L. nissolia*, respectively. Except *L. aphaca*, these results similar to present study results. Plant height of *L. aphaca* was higher than present finding. Inter-intra species plant height, number of primary branches, leaf/plant and dry yield/plant values generally was higher in 2004 than in 2003. Climatic conditions effected these features since the precipitation and temperature were not same, especially precipitation was higher in 2004 than in 2003 in growing season (Fig. 1 and 2).

Average crude protein, crude ash and some minerals (K, Ca, Mg, Fe, Zn, Mn) were determined in both hay (50 % flowering) and seed in *Lathyrus* species are given in Tables 3 and 4.

While crude protein contents of hay varied between 15.00 and 21.00 %, ash contents varied 7.06 to 10.82 %. The highest crude protein was determined in *L. sphaericus* Retz) (21 %) and the highest crude ash (10.82 %) was determined in *L. aphaca* L. var *affinis* (Table-4). Acar *et al.*⁸ reported for some *Lathyrus* species, that CP contents varied from 15.03 to 20.66 % and ash content varied from 8.79 to 9.50 %. These results are approximately near to present findings.

In hay, among to species and years, K content ranged from 1.20 % in *L. hirsutus* to 3.15 % in *L. aphaca*, Ca content ranged from 1.08 % in *L. hirsutus* to 3.10 % in *L. ochrus*, Mg content ranged from 0.11 % in *L. ochrus* to 0.50 % in *L. hirsutus*, Fe content ranged from 38.40 ppm in *L. hirsutus* to 72.76 ppm in *L. annuus*, Zn content ranged from 14.36 ppm to 56.61 ppm in *L. ochrus* and Mn content ranged from 38.20 ppm in *L. hirsutus* to 75.84 ppm in *L. annuus* (Table-3).

It has been suggested that K ratio of hay is to be 0.8 % as a minimum^{15,16}. Ca ratio is to be 0.3 % and Mg ratio is to be 0.1 - 0.2 % as a minimum for the ruminants^{16,17}. Fe, Zn, Mn levels are also to be 50 ppm¹⁸. Generally K, Ca and Mg ratios are enough but, Fe (in *L. hirsutus* L.), Zn (in *L. hirsutus* L., *L. aphaca* L. var *affinis*, *L. laxiflorus* ssp *laxiflorus*, *L. annuus* L. and *L. sphaericus* Retz), Mn ratio (in *L. aphaca* L. var *affinis* and *L. sphaericus* Retz.) are lower than suggested levels (Table-4).

TABLE-3
AVERAGE CRUDE PROTEIN, ASH AND MINERAL MATTER (K, Ca, Mg, Fe, Zn, Mn) CONTENTS OF *Lathyrus* SPECIES AT TIME OF 50% FLOWERING.

Species	Year	CP (%)	ASH (%)	K (%)	Ca (%)	Mg (%)	Fe (ppm)	Zn (ppm)	Mn (ppm)
<i>L. hirsutus</i> L.	2003	17.78	7.06	1.20	1.08	0.50	46.75	24.07	38.20
	2004	16.28	7.32	1.65	1.18	0.32	38.40	36.45	60.00
<i>L. ochrus</i> L.(DC)	2003	15.18	8.32	1.52	3.10	0.11	60.45	14.36	47.86
	2004	16.90	9.96	1.48	2.75	0.43	43.40	56.61	66.28
<i>L. aphaca</i> L. var affinis	2003	16.23	10.82	2.20	2.68	0.16	58.32	30.00	48.65
	2004	18.21	8.70	3.15	2.70	0.16	42.84	40.36	40.03
<i>L. laxiflorus</i> ssp laxiflorus	2003	15.00	7.80	1.89	1.92	0.15	46.43	19.04	61.40
	2004	17.28	7.81	1.50	1.77	0.28	50.00	28.01	65.78
<i>L. annuus</i> L.	2003	-	-	-	-	-	-	-	-
	2004	20.60	9.40	2.72	1.59.	0.30	72.76	39.60	75.84
<i>L. sphaericus</i> Retz.	2003	-	-	-	-	-	-	-	-
	2004	21.00	8.70	3.09.	1.72	0.14	52.00	32.82.	45.28

TABLE-4
AVERAGE CRUDE PROTEIN, ASH AND MINERAL MATTER (K, Ca, Mg, Fe, Zn, Mn) CONTENTS OF *Lathyrus* SEEDS

Species	Year	CP (%)	ASH (%)	K (%)	Ca (%)	Mg (%)	Fe (ppm)	Zn (ppm)	Mn (ppm)
<i>L. hirsutus</i> L.	2003	25.68	2.96	0.77	0.08	0.09	34.80	34.94	32.15
	2004	25.09	2.97	1.53	0.08	0.09	35.82	32.56	23.15
<i>L. ochrus</i> L.(DC)	2003	20.51	3.52	1.04	0.06	0.12	34.67	46.11	36.28
	2004	21.55	3.90	1.84	0.07	0.13	36.42	50.37	30.84
<i>L. aphaca</i> L. var affinis	2003	28.33	3.30	0.98	0.06	0.10	34.67	44.26	29.71
	2004	28.36	3.50	1.53	0.07	0.09	34.88	44.91	20.53
<i>L. laxiflorus</i> ssp laxiflorus	2003	23.66	3.00	1.18	0.06	0.15	32.53	38.28	43.96
	2004	23.96	3.30	1.60	0.06	0.13	34.28	41.14	36.84
<i>L. annuus</i> L.	2003	-	-	-	-	-	-	-	-
	2004	23.25	3.20	2.72	1.58	0.30	72.45	39.58	75.59
<i>L. sphaericus</i> Retz.	2003	-	-	-	-	-	-	-	-
	2004	25.18	2.60	1.31	0.15	0.15	33.98	37.50	24.09

Average crude protein ratio of seeds was determined between 20.51 % (*L. ochrus* L.(DC)) - 28.36 % (*L. aphaca* L. var *affinis*). The average ash ratio also varied from 2.60% (*L. sphaericus* Retz)- to 3.90 % (*L. ochrus* L.(DC) (Table-4). Granati *et al.*¹⁹ reported that in seeds of 133 *Lathyrus* lines, belong to different species, crude protein ratio was between 23-31 % and their ash ratio was between 2.1-4.0 %.

As a mineral matter in seeds the K ratio varied between 0.77-2.73 %, Ca between 0.06-1.58 %, Mg between 0.09-0.30 %, Fe between 32.53-72.45 ppm, Zn between 32.56-50.37 ppm and Mn between 23.15-75.59 ppm. While the highest K, Ca, Mg, Fe, Mn contents were in *L. annuus*, the highest Zn content was in *L. ochrus* L.(DC) (Table-4).

According to years and species, pod number/plant and pod length were between 8.70-78.90 and 2.58-6.06 cm, respectively. Other features, seed number/pod was between 3.80-9.30, seed yield/plant was between 2.73-10.90 g and also 1000 seeds weight was between 12.39-120.00 g (Table-5). The highest pod number/plant was determined in *L. hirsutus* L., with 78.90 in, the highest pod length (6.06 cm) was determined in *L. annuus* L. in and the highest seed number/pod (9.30) in *L. sphaericus* Retz. The highest seed yield (10.90 g/plant) and 1000 seeds weight (129 g) was in *L. ochrus* L (DC) (Table-5). Except 1000 seed weight all the highest values given Table-5 were determined in 2004.

Germination ratios of species shown in Table-6 were generally low and also differ among species and years. These results indicated that investigated *Lathyrus* species apart from *L. sphaericus* Retz. has hard seed coat and this character is highly effected by climatic conditions. Many legume plants especially wild species have also hard seed coat. This feature is changed by climatic factors and it increases at high temperature and drought condition¹². In 2004, precipitation and temperature values more suitable for plant growing (Figs. 1 and 2) and as a result, germination ratios of species (except *L. ochrus*) were higher in 2004 than 2003. There are inter-species variation in terms of germination ratio by reason of different vegetation periods and also genetics of species. However both germination speed and vigor increased with mechanic disruption. The effect of mechanic disruption was generally positive (especially for *L. ochrus*, *L. aphaca* and *L. laxiflorus*) but it was negative for *L. annuus*.

Chromosomal and cytogenetic studies have shown that *Lathyrus* species are diploid with $2n = 14$ somatic chromosome number.

Conclusion

There are excessive inter/intra species variation in terms of investigated morphological and agricultural features for 6 naturally grown *Lathyrus* species in Kurupelit Campus of Ondokuz Mayıs University. Inter species

TABLE-5
SOME POD AND SEED FEATURES OF *Lathyrus* SPECIES NATURALLY GROWING IN KURUPELIT CAMPUS AREA

Species	Year	Pod number/plant		Pod length (cm)		Seed number/pod		Seed yield/plant (g)		1000 seed weight (g)	
		Mean \pm SD	Mean \pm SD	Mean \pm SD	Mean \pm SD	Mean \pm SD	Mean \pm SD	Mean \pm SD	Mean \pm SD	Mean \pm SD	Mean \pm SD
<i>L. hirsutus</i> L.	2003	36.30 \pm 9.75	3.46 \pm 0.11	5.06 \pm 0.55	6.06 \pm 3.30	26.05					
	2004	78.90 \pm 7.83	3.08 \pm 0.04	6.02 \pm 0.56	8.94 \pm 3.81	26.59					
<i>L. ochrus</i> L.(DC)	2003	8.70 \pm 1.90	5.21 \pm 0.31	5.46 \pm 0.67	5.46 \pm 0.67	129.00					
	2004	25.40 \pm 7.18	5.46 \pm .25	5.87 \pm 0.20	10.90 \pm 3.48	121.72					
<i>L. aphaca</i> L. var affinis	2003	-	-	-	-	14.23					
	2004	40.90 \pm 15.73	2.58 \pm 0.30	5.76 \pm 0.76	2.73 \pm 0.96	13.77					
<i>L. laxiflorus</i> ssp laxiflorus	2003	-	-	-	-	12.39					
	2004	-	3.55 \pm 0.14	3.80 \pm 0.90	-	13.77					
<i>L. annuus</i> L.	2003	-	-	-	-	-					
	2004	-	6.06 \pm 0.15	7.10 \pm 1.02	-	71.14					
<i>L. sphaericus</i> Retz.	2003	-	-	-	-	-					
	2004	-	5.65 \pm 0.63	9.30 \pm 0.65	-	18.96					

n = 10

TABLE-6
GERMINATION RATIOS OF *Lathyrus* SPECIES NATURALLY GROWING IN KURUPEIT CAMPUS AREA

Species	2003						2004					
	Control			Scarification			Control			Scarification		
	7th day	14th day	14th day	7th day	14th day	14th day	7th day	14th day	14th day	7th day	14th day	
<i>L. hirsutus</i>	8.20	17.12	17.12	15.15	22.32	22.32	50.00	57.50	57.50	57.50	65.00	
<i>L. ochrus</i> L.(DC)	2.00	2.00	2.00	40.62	40.62	40.62	0.00	0.00	0.00	10.00	15.00	
<i>L. aphaca</i> L. var affinis	0.00	0.00	0.00	1.00	2.00	2.00	8.00	12.00	12.00	87.50	90.00	
<i>L. laxiflorus</i> ssp laxiflorus	1.00	5.00	5.00	1.00	14.00	14.00	2.50	2.50	2.50	17.50	70.00	
<i>L. annuus</i> L.	-	-	-	-	-	-	25.00	30.00	30.00	22.50	25.00	
<i>L. sphaericus</i> Retz.	-	-	-	-	-	-	76.00	82.00	82.00	96.00	96.00	

variation have been expected case because of genetic differences. Intra species variation may be due to different soil and climatic condition. In addition to intra species, genetic variation was high probability. Because all the investigated *Lathyrus* species were not cultivar and they were wild grown. In addition our study region (Middle Black Sea) is a micro gen center for legume forages⁵. As a result of this study, especially *L. ochrus* L. (DC), *L. hirsutus* L and *L. annuus* are thought as a promising materials for breeding study will be carried out in the near future.

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