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Asturian populations of maize

I. Morphological-vegetative description and variability

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ABSTRACT

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A description of sixty six maize populations recollected in Asturias, a Northern area of Spain, is reported. Plant, ear and grain traits were considered. Mean values of the populations were obtained.

Analyses of variance on eighteen traits indicated highly significant differences between populations; population x environment interaction was significant in seven traits. Heritability estimates for most of the 18 traits studied were high.

INTRODUCTION

Today, the great importance of phytogenetic resources in maize is the consequence of an historical process that has moved from a constant increase in genetical variability in the past to a loss and fast erosion of it in our days. Such degradation is mainly caused by a generalized utilization of a few commercial varieties (Sprague, 1971), that increases crop vulnerability and all its possible damages (Zuber y Darrah, 1980).

In Spain, since maize was introduced in the XVI century, the evolutive processes had natural selection as a control that exerted an influence over the variability that interchange and recombination migratory phenomena had created, giving advantage to those individuals with the best adapted genotypes. Humane selection provided the complement to this process of evolution, whose result was a constant increase in genetic diversity in maize.

Local varieties were the first sources of germplasm to obtain pure lines used in hybrids production (Darrah y Zuber, 1986). The possibilities of including local germplasm to enlarge variability in breeding programmes (Lonnquist,1974), are restricted by the necessity of identifying those varieties with good characteristics before its incorporation and also by the election of the most suitable breeding methods for them (Hallauer and Miranda, 1981; Crossa and Gardner, 1987).

The conservation of maize local varieties in those locations where recollection was still possible, was taken into account in Spain. Such was the case in the North of Spain, where a programme for recollection of local varieties was iniciated in 1975.

The purposes of this study are:

- Varietal characterization of maize populations from Asturias, through the study of morphological and vegetative traits.
- Identification of the most suitable traits for populations differentation, through the estimation of variance components, heritabilities and constancies.

MATERIAL AND METHODS

Sixty six maize populations from Asturias were studied. These populations could be considered as a good sample of the local germplasm of maize of the area at the moment of recollection, and they are today maintained at the Germplasm Bank in Estación Experimental de Aula Dei.

An experimental design of randomized blocks was used with 66 populations and three replications for two years, what might provide a good control of the environmental variation (Cochran and Cox, 1957; Ron, 1987). One row experimental plots, 6 m long, with plants at 0.25 m and 0.80 m between rows, were used. 15 plants at random were controlled in each plot, which is considered to be an appropriate sample to express the value of each replication and population (Sánchez-Monge, 1962; Camussi,1979).

The choice of the quantitative characters most suitable for the taxonomic classification is important (Arunachalam, 1981). There are many references concerning the characters used in the characterization of races or varieties (Sánchez-Monge, 1962; Brandolini, 1970), the taxonomic classification (Camussi, 1979; Broich and Palmer, 1980; Ron, 1987), and also the estimates of variance (Robinson et al.,1955; Moll et al.,1964).

For this work, the set of traits listed in Table 1 was chosen. Some of the traits are visually evaluated according to a subjective scale, which is an usual circumstance in varieties classification (Bartual et al., 1985).

Table 1.- Traits considered for the evaluation.

	Symbol	Trait
1	PH	plant height (cm)
2	EH	ear height (cm)
3	TNod	number of nodes per plant
4	ENod	node of ear
5	TF	tassel flowering time (days)
6	EL	ear length (mm)
7	ED	ear diameter (mm)
8	CD	cob diameter (mm)
9	CCo	cob colour (1=white, 3=red)
10	RN	number of row per ear
11	KN/R	number of kernel per row
12	TK/E	total number of kernel.per ear
13	KTy	kernel type (1=flint, 3=dent)
14	KCo	kernel colour (1=white, 3=purple)
15	KWe	200 kernel weight (g)
16	TWe	test weight (g/mL)
17	KL	kernel length (mm)
18	KWid	kernel width (mm)

The statistical analyses were carried out with the average results of 15 individuals per replication. Descriptive and variance analyses (Steel and Torrie, 1981) as well as the components of variance and its errors by the Comstock and Moll's method (1963), were calculated.

Broad-sense heritability was computed as the ratio of variances:

$$H=\frac{\sigma^2 v}{\sigma^2 p}=\frac{\sigma^2 v}{\sigma^2+\sigma^2 vy+\sigma^2 v}$$

v - populations
y - years
p - phenotypic

Errors were computed using the simplified method of Dickerson (1969), showed by Hallauer and Miranda (1981).

$$E(H)=\frac{E(\sigma^2)}{\sigma^2+\sigma^2 vy+\sigma^2 v}$$

Repetibility (Goodman and Paterniani, 1969) shows the stability of a character in a sequence of different environment (Eberhart and Russell, 1966), and was called constancy by Ron and Ordás (1987). It is calculated as:

$$C=\frac{\sigma^2 v}{\sigma^2 e}=\frac{\sigma^2 v}{\sigma^2+\sigma^2 vy+\sigma^2 y}$$

e - environmental

and its standard error was calculated following the simplified method of Dickerson, (1969) as:

$$E(C) = \frac{E(\sigma^2 v)}{\sigma^2 + \sigma^2 vy + \sigma^2 y}$$

RESULTS AND DISCUSSION

Tables 2 to 4 summarize the mean values of plant, ear, and kernel traits, respectively.

A high variability is present in serveral traits studied of the Asturian populations. Ranges are very wide, the highest value of the ear height (EH) is five times its lowest one. For the node of ear (ENod), and total number of kernel per ear (TK/E) their highest values are twice and a half the lowest ones. Moreover, plant height (PH), ear length (EL), cob diameter (CD), number of row per ear (RN), number of kernel per row (KN/R), and kernel weight (KWe) have as the highest values twice their lowest ones.

Analyses of variance on all the eighteen traits showed, high significant differences among populations (Table 5). There were no significant differences between years on five traits: number of nods per plant, cob colour, kernel type, kernel colour, and kernel width. Population x year interaction was only significant in seven traits: cob colour, number of kernel per row, total number of kernel per ear, kernel type, kernel weight, test weight, and kernel width.

Heritability estimates were generally very high on all the traits, specially tassel flowering time in plant traits; ear length, cob colour, and number of row per ear, in ear traits; and, related to kernel, type, colour and weight were relevant (Table 6).

The heritability estimates in our study were similar to those reported by Motto (1979) on plant and ear traits of a synthetic variety of opaque lines, and they were in agreement with those from Ron and Ordás (1987) on plant traits of populations from Northwestern area of Spain. However, they were higher than those summarized by Hallauer and Miranda (1981), or to those obtained by Goodman and Paterniani (1969) on South American maize races and subraces.

In other species, such as shorghum and soybean, heritabilities higher than 0.8 in production components, morphological traits, tassel flowering time, and plant height are reported (Lothrop et al.,1985; Ronis et al.,1985).

The constancy estimates (Table 6) showed, in general, values higher than 1.0. The comparison of these results with previous ones (Goodman and Paterniani, 1969; Ron and Ordás, 1987) showed that our constancy estimates were higher, in general, but keeping a similar arrangement, except in some ear traits, in which there were differences with South American populations (Goodman and Paterniani, 1969), that might be caused by a great geographical dispersion of such populations, from Argentina to Guyana.

Table 2.- Mean values of plant traits.

Pop.	Origin	PH	EH	TNod	ENod	TF
9	MOAL	139.25	48.10	9.11	4.37	48.99
10	TEVERGA	144.72	32.43	8.59	3.62	60.40
11	MIERES	188.89	93.13	11.66	6.54	60.48
24	LIMES	131.13	47.31	8.98	4.71	48.50
25	ALLANDE	106.61	33.34	8.03	3.60	45.93
26	NIEVES DE CASO	155.70	36.18	8.94	4.18	57.71
27	TELLADO	154.21	37.51	7.99	3.58	61.82
28	RICABO	150.11	46.88	9.88	4.72	65.63
40	VILLAVER DE PARADA	132.09	52.73	8.97	4.62	48.33
43	LA FIGUERINA	104.37	32.31	7.89	3.91	45.82
44	MURIAS	150.48	30.49	7.97	3.77	66.60
45	FELECHOSA	158.10	58.13	8.92	4.56	48.69
46	CALEAO	142.12	53.83	9.12	4.57	47.50
47	LA PEÑA	162.19	69.11	10.06	5.64	53.70
74	LUARCA	157.86	66.97	9.49	5.17	53.56
75	TAMALLANES	152.56	55.03	9.58	4.71	51.20
76	CANALES	147.74	67.02	9.49	5.38	50.04
82	ARRIONDAS	155.94	63.49	9.18	5.21	48.16
99	FRESNEDO	173.02	47.14	9.64	4.29	64.49
100	RIELLO	165.76	44.42	9.16	4.41	64.99
101	ONIS	138.07	53.46	8.40	4.29	46.23
102	SAN ESTEBAN	141.46	54.46	8.93	4.62	49.47
103	INFIESTO	150.36	67.38	9.08	5.09	51.07
109	QUEIROS	139.52	31.83	8.48	4.11	64.18
123	RODICAL	190.21	66.63	9.60	4.58	67.00
148	PELUGANO	176.33	39.56	7.37	3.09	64.53
149	MIER	155.11	71.89	9.39	5.53	51.54
150	TRESCARES	131.62	55.49	9.61	5.41	52.98
151	PANES	160.31	65.76	9.78	5.16	49.88
152	ALLES	175.54	80.29	10.27	5.47	51.43
153	CECOS	138.29	47.54	9.57	4.91	50.78
169	LA ESTRADA	146.68	60.70	8.96	5.19	48.90
170	SALAS	164.28	88.11	10.30	6.53	53.40
245	CARCEDIEL	119.41	35.01	8.63	4.21	51.19
246	CANGAS DE NARCEA	137.20	31.84	7.23	3.38	61.56
247	PARAJAS	121.20	34.47	8.07	3.81	61.97
249	CORIAS	148.12	32.93	7.20	3.36	64.43
251	TINEO	126.38	41.27	8.69	4.27	48.66
257	ARGANZUA	137.58	33.27	8.76	3.57	65.80
273	VILLAMEJIN	161.98	69.57	9.49	5.22	57.21
279	CANGAS DE ONIS	138.90	49.03	8.84	4.62	46.70
280	AMIEVA	170.18	69.40	10.15	5.35	54.11
288	CARDES	218.84	83.24	10.68	5.88	67.84
341	TRASCASTRO	140.49	44.11	9.12	4.28	47.37
342	VILLAR DE ROQUEDOS	127.30	43.54	9.13	4.51	48.18
343	GENESTOSO	117.57	39.54	8.90	4.37	49.05
344	VEGA DE REY	136.47	47.24	8.83	4.42	47.44
345	S.JULIAN DE ARBAS	144.49	56.87	9.03	4.88	49.07
346	VALLADO	129.17	45.47	8.49	4.23	48.78
347	BIMEDA	129.65	40.14	9.10	4.22	49.47
348	SONANDE	141.00	46.04	8.70	4.28	46.93
349	LLANERA	126.50	41.09	8.16	4.09	45.38
350	RIOMOLIN	142.63	54.89	8.94	4.52	48.16
360	TARNA	116.96	19.81	7.54	2.70	47.81
361	PARAMO	125.04	40.51	8.21	4.18	46.18
362	LA FONCELLA	108.18	33.26	8.38	3.98	45.01
363	CAUNEDO	113.23	17.93	7.42	2.81	57.87
364	POLA DE SOMIEDO	126.99	44.17	8.80	4.42	46.92
365	EL COTO	114.16	33.31	8.00	3.88	45.22
367	ALLER	156.10	65.59	9.50	5.32	50.88
368	EL PINO	145.31	54.47	8.99	4.87	48.00
369	VILLARES	140.83	52.23	9.27	4.79	46.83
375	PAJARES	129.54	45.48	8.31	4.37	47.61
376	ACEBOS	143.41	31.96	8.57	3.88	61.24
377	LA CRUZ	119.07	45.88	8.60	4.62	45.56
378	RIOSPASO	127.52	42.86	8.43	4.29	46.67
	mean	143.36	49.47	8.92	4.50	52.86

Table 3.- Mean values of ear traits.

Pop.	Origin	EL	ED	CD	CCo	RN	KN/R	TK/E
9	MOAL	122.66	36.22	26.00	1.00	11.53	22.50	244.53
10	TEVERGA	102.55	33.94	23.85	1.50	11.66	19.53	212.74
11	MIERES	142.77	35.05	24.93	1.00	10.13	24.17	230.64
24	LIMES	136.72	43.05	32.83	1.00	12.17	23.27	265.91
25	ALLANDE	123.27	36.22	25.91	1.00	12.42	21.75	353.23
26	NIEVES DE CASO	109.50	30.83	21.13	1.00	9.13	20.03	171.25
27	TELLADO	110.42	35.06	25.01	1.00	9.60	20.43	183.32
28	RICABO	130.00	32.44	22.62	1.00	8.68	23.83	191.69
40	VILLAVER DE PARADA	128.33	37.33	27.04	1.00	12.24	22.72	257.48
43	LA FIGUERINA	97.72	36.44	26.10	1.54	13.00	18.77	233.83
44	MURIAS	114.22	35.22	25.04	1.00	10.71	22.05	220.97
45	FELECHOSA	155.72	37.77	27.74	1.00	8.48	28.10	225.76
46	CALEAO	123.11	36.55	26.21	1.23	10.66	22.13	222.21
47	LA PEÑA	136.55	36.16	25.71	1.00	8.13	24.50	188.63
74	LUARCA	142.55	35.05	24.56	1.00	9.20	25.44	220.55
75	TAMALLANES	141.83	36.55	25.83	1.46	8.88	24.71	206.45
76	CANALES	128.38	35.16	24.41	1.00	7.82	24.72	182.27
82	ARRIONDAS	125.05	37.05	26.42	1.00	8.91	22.66	190.96
99	FRESNEDO	134.41	36.66	26.21	1.00	9.75	25.38	232.77
100	RIELLO	146.00	36.88	26.42	1.21	9.17	26.14	225.35
101	ONIS	124.61	37.50	26.74	1.00	9.06	23.97	204.68
102	SAN ESTEBAN	117.72	35.16	24.21	1.00	8.68	21.55	177.43
103	INFIESTO	121.22	35.05	24.12	1.00	8.97	22.11	188.73
109	QUEIROS	106.77	36.50	26.03	1.00	10.84	20.32	205.65
123	RODICAL	144.94	42.11	31.38	1.00	12.40	24.47	284.32
148	PELUGANO	126.38	36.16	25.47	1.00	10.24	25.06	240.12
149	MIER	134.05	41.00	29.65	1.00	8.66	24.87	204.65
150	TRESCARES	145.27	38.11	27.10	2.07	11.40	28.61	308.27
151	PANES	154.63	38.11	27.24	1.00	10.57	26.57	265.88
152	ALLES	146.83	37.55	26.67	1.00	10.37	26.57	255.16
153	CECOS	154.33	42.83	31.88	1.88	13.44	27.10	346.92
169	LA ESTRADA	123.83	36.22	25.30	1.00	8.68	22.42	186.08
170	SALAS	157.94	37.61	26.56	1.00	8.53	28.63	237.00
245	CARCEDIEL	127.88	34.55	23.74	1.00	8.48	24.37	196.62
246	CANGAS DE NARCEA	103.50	33.88	23.75	2.75	8.48	21.76	171.80
247	PARAJAS	113.88	36.11	25.67	1.00	9.53	22.37	198.66
249	CORIAS	108.38	36.50	26.08	2.37	9.15	21.86	185.26
251	TINEO	116.05	36.16	25.55	1.00	8.71	23.52	195.46
257	ARGANZUA	124.42	36.54	26.15	1.25	8.78	22.04	180.16
273	VILLAMEJIN	161.11	36.83	25.86	1.00	8.37	27.85	221.37
279	CANGAS DE ONIS	97.94	36.61	25.95	1.00	9.06	19.46	168.46
280	AMIEVA	127.22	34.66	24.11	1.00	9.08	22.60	194.93
288	CARDES	154.72	38.94	28.07	2.53	10.28	29.52	285.77
341	TRASCASTRO	137.55	40.50	29.75	1.00	12.00	22.25	253.06
342	VILLAR DE ROQUEDOS	135.77	41.33	30.70	1.00	11.80	22.15	247.62
343	GENESTOSO	116.27	40.61	29.74	1.00	12.60	20.61	246.17
344	VEGA DE REY	112.55	39.00	28.23	1.00	11.64	20.41	226.01
345	S.JULIAN DE ARBAS	126.27	39.88	29.34	1.66	12.37	22.84	269.36
346	VALLADO	119.33	41.27	30.52	1.00	14.33	20.11	276.18
347	BIMEDA	131.11	41.11	30.53	1.00	15.15	24.13	348.56
348	SONANDE	116.55	39.83	28.84	1.00	12.95	21.50	263.17
349	LLANERA	140.33	36.83	25.98	1.00	10.97	24.75	257.70
350	RIOMOLIN	121.38	39.27	28.34	1.00	12.77	21.05	253.88
360	TARNA	80.21	29.56	18.83	1.00	9.35	15.80	136.54
361	PARAMO	134.66	36.50	25.77	1.00	9.35	23.61	208.63
362	LA FONCELLA	104.77	36.50	25.82	1.00	10.68	19.56	197.83
363	CAUNEDO	100.11	34.36	23.35	1.00	11.64	17.86	194.34
364	POLA DE SOMIEDO	108.27	41.33	30.84	1.00	11.24	20.16	215.23
365	EL COTO	107.83	37.44	26.78	1.50	11.51	19.87	216.41
367	ALLER	120.22	37.05	26.18	1.00	9.17	22.24	192.76
368	EL PINO	130.83	33.61	22.81	1.44	8.33	23.37	184.66
369	VILLARES	127.11	37.38	26.67	1.00	9.26	23.12	201.88
375	PAJARES	110.94	36.44	25.48	1.00	9.35	20.87	183.84
376	ACEBOS	108.43	35.11	24.25	1.00	10.38	18.19	175.05
377	LA CRUZ	101.55	37.72	26.48	1.00	9.06	19.50	165.97
378	RIOSPASO	109.44	37.72	26.30	1.00	9.97	21.04	197.07
	mean	124.96	37.04	26.41	1.16	10.31	22.81	222.36

Table 4.- Mean values of kernel traits.

Pop.	Origin	KTy	KCo	KWe	TWe	KL	KWid
9	MOAL	1.00	4.00	62.48	75.16	8.83	10.13
10	TEVERGA	1.00	4.00	59.88	68.88	9.25	9.83
11	MIERES	1.00	5.55	72.58	70.35	8.98	10.71
24	LIMES	1.00	4.93	71.27	79.21	9.70	10.51
25	ALLANDE	1.00	4.75	49.73	73.43	8.58	9.15
26	NIEVES DE CASO	1.00	4.00	70.93	77.98	9.03	10.76
27	TELLADO	1.00	4.00	70.31	72.95	9.58	10.95
28	RICABO	1.00	3.66	63.10	73.76	8.86	10.31
40	VILLAVER DE PARADA	1.00	4.00	62.16	75.80	9.00	9.88
43	LA FIGUERINA	1.00	5.53	50.65	76.16	8.88	9.51
44	MURIAS	1.00	3.84	70.27	76.40	9.48	10.63
45	FELECHOSA	1.00	4.00	89.67	78.16	9.15	11.78
46	CALEAO	1.00	4.15	71.99	80.13	9.66	10.71
47	LA PEÑA	1.17	4.00	76.54	77.81	10.05	11.85
74	LUARCA	1.00	4.00	73.47	77.90	9.36	11.00
75	TAMALLANES	1.20	5.71	88.91	76.91	9.73	11.35
76	CANALES	1.00	4.00	67.91	78.80	10.23	10.33
82	ARRIONDAS	1.00	4.00	84.84	77.91	10.58	11.86
99	FRESNEDO	1.00	3.20	86.35	72.31	10.46	11.71
100	RIELLO	1.00	2.71	83.45	72.60	10.00	11.95
101	ONIS	1.00	4.27	77.59	78.60	9.41	10.38
102	SAN ESTEBAN	1.00	4.00	72.76	71.08	9.76	11.13
103	INFIESTO	1.00	4.00	68.27	75.85	9.01	10.38
109	QUEIROS	1.00	3.95	53.37	68.96	8.80	9.56
123	RODICAL	1.00	3.35	72.12	68.95	9.36	10.40
148	PELUGANO	1.00	4.00	66.42	72.66	9.41	10.46
149	MIER	1.00	1.00	73.92	68.35	9.36	11.05
150	TRESCARES	1.00	4.00	65.49	72.00	9.58	9.33
151	PANES	1.00	5.33	73.02	73.13	9.78	10.08
152	ALLES	1.00	8.00	87.39	74.68	10.11	11.90
153	CECOS	1.00	5.91	69.71	72.86	9.33	9.88
169	LA ESTRADA	1.00	1.00	61.00	73.36	9.36	10.76
170	SALAS	1.00	5.15	77.68	75.65	10.01	11.41
245	CARCEDIEL	1.00	4.80	72.51	76.28	9.26	11.96
246	CANGAS DE NARCEA	1.00	4.00	60.10	62.98	10.76	12.11
247	PARAJAS	1.00	4.00	68.19	73.33	10.36	11.56
249	CORIAS	1.00	5.08	67.99	71.68	9.61	11.05
251	TINEO	1.00	4.88	79.43	75.40	9.83	11.76
257	ARGANZUA	1.00	4.62	82.22	71.10	9.15	11.58
273	VILLAMEJIN	1.00	5.24	79.82	75.75	9.00	11.13
279	CANGAS DE ONIS	1.00	3.37	72.17	76.88	9.38	10.86
280	AMIEVA	2.00	1.00	82.63	74.41	10.36	11.71
288	CARDES	1.00	2.48	74.09	75.48	11.35	10.68
341	TRASCASTRO	1.00	4.00	71.12	78.95	9.33	10.36
342	VILLAR DE ROQUEDOS	1.00	4.37	62.68	72.85	8.65	9.63
343	GENESTOSO	1.00	4.00	55.86	74.53	9.33	9.65
344	VEGA DE REY	1.00	4.00	53.51	74.56	8.65	10.06
345	S.JULIAN DE ARBAS	1.00	4.30	68.58	77.10	10.25	9.80
346	VALLADO	1.00	4.00	57.09	69.43	10.63	11.01
347	BIMEDA	1.00	4.00	61.40	74.61	9.61	9.65
348	SONANDE	1.00	4.00	54.65	77.16	8.65	9.61
349	LLANERA	1.00	4.00	56.54	80.00	9.35	10.61
350	RIOMOLIN	1.00	4.31	54.77	75.16	8.76	9.91
360	TARNA	1.00	4.00	52.88	74.63	8.28	9.30
361	PARAMO	1.00	5.06	60.98	73.53	9.70	10.96
362	LA FONCELLA	1.00	5.37	64.05	67.18	9.21	10.60
363	CAUNEDO	1.00	4.80	57.42	65.68	8.70	10.13
364	POLA DE SOMIEDO	1.00	4.00	71.50	75.86	9.33	10.18
365	EL COTO	1.00	6.48	66.37	73.80	8.51	9.51
367	ALLER	1.00	3.35	72.29	73.23	9.68	10.88
368	EL PINO	1.00	4.00	77.17	76.15	9.76	10.96
369	VILLARES	1.00	4.00	76.73	75.63	9.58	10.10
375	PAJARES	1.00	4.00	56.11	75.78	9.38	10.60
376	ACEBOS	1.00	4.00	83.57	76.91	9.73	10.80
377	LA CRUZ	1.00	4.00	68.08	74.20	9.26	9.85
378	RIOSPASO	1.00	4.00	70.45	73.81	9.41	9.98
	mean	1.02	4.18	69.07	74.29	9.48	10.61

Table 5.- Significance of population (sv), year (sy) and interaction (svy) variances; and estimates of its components, interaction (σ^2vy), year (σ^2y), genetic (σ^2v), phenotypic (σ^2p) and environmental (σ^2e).

	F Sig.			Variance components					
Trait	sv	sy	svy	σ^2vy	σ^2y	σ^2v	E(σ^2v)	σ^2p	σ^2e
PH	.01	.01	NS	--	38.960	430.630	75.540	512.200	120.530
EH	.01	.01	NS	--	9.170	243.610	42.730	273.177	38.730
TNod	.01	NS	NS	--	.001	.660	.120	.760	.105
ENod	.01	.01	NS	--	.003	.574	.100	.630	.064
TF	.01	.01	NS	--	11.400	48.310	8.470	49.780	12.870
EL	.01	.01	NS	--	38.330	288.770	50.650	302.130	51.690
ED	.01	.01	NS	--	.950	6.492	1.140	8.570	3.034
CD	.01	.01	NS	--	2.180	6.010	1.050	8.020	4.191
CCo	.01	NS	.01	.001	--	.144	.025	.148	.004
RN	.01	.01	NS	--	.033	2.800	.490	2.870	.100
KN/R	.01	.01	.01	.360	.420	7.450	1.310	8.340	1.310
TK/E	.01	.01	.05	18.380	32.410	1682.120	295.060	1822.910	173.200
KTy	.01	NS	.01	--	--	.016	.003	.016	--
KCo	.01	NS	NS	--	--	1.189	.218	1.215	.026
KWe	.01	.01	.01	.850	.600	98.430	17.260	100.790	2.960
TWe	.01	.01	.01	1.240	1.980	10.780	1.890	13.590	4.790
KL	.01	.01	NS	--	.018	.334	.058	.442	.126
KWid	.01	NS	.01	.035	--	.570	.100	.700	.130

Table 6.- Heritabilities, constancies and its errors.

Trait	H	E (H)	C	E (C)
PH	0.841	0.147	3.573	0.627
EH	0.892	0.156	6.290	1.103
TNod	0.868	0.158	6.600	1.200
ENod	0.905	0.159	9.500	1.667
TF	0.970	0.170	3.754	0.658
EL	0.956	0.168	5.586	0.980
ED	0.757	0.133	2.142	0.376
CD	0.749	0.131	1.434	0.250
CCo	0.973	0.169	36.000	6.250
RN	0.976	0.171	28.000	4.900
KN/R	0.893	0.157	5.687	1.000
TK/E	0.923	0.162	9.712	1.703
KTy	1.000	0.187	∞	∞
KCo	0.979	0.171	45.209	7.909
KWe	0.976	0.171	33.253	5.831
TWe	0.793	0.139	2.250	0.394
KL	0.756	0.131	2.651	0.460
KWid	0.814	0.143	4.385	0.769

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