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Cooking quality of chickpea

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SUMMARY - Different indexes have been tested in the last four years (1984-1987) to determine the cooking quality of chickpea. The influence of the cultivars, environment and cropping techniques in Andalusia (Spain) with respect to quality were studied. Climate and cultivars greatly influenced all quality indexes. The number of grains/ounce depends more on the chickpea cultivar or type than on the environment. Protein and ash content, and cooking quality are highly influenced by the environment. Better cooking quality chickpeas with a higher protein and ash content are obtained on clayey vertisol Andalusian soils. The higher the protein and ash content of chickpea, the better its cooking quality (as measured by tenderometer). The amount of water absorbed by the seed increases as the seed coat percentage increases. Seed coat percentage depends mainly on the cultivar and is related to the size and rugosity of the seed.

RESUME - "Qualité culinaire du pois chiche". Différents paramètres ont été testés durant quatre années (1984-1987) pour déterminer l'aptitude à la cuisson du pois chiche. Nous avons étudié l'influence du cultivar, de l'environnement et des techniques de culture en Andalousie (Espagne), sur cette qualité. Le climat et le cultivar modifient fortement tous les paramètres de qualité. Le nombre de graines par kilogramme dépend plus du cultivar que de l'environnement. La teneur en protéines et en cendres et l'aptitude à la cuisson sont fortement influencées par l'environnement, les meilleurs résultats étant obtenus dans les vertissols argileux de l'Andalousie. Les meilleures aptitudes à la cuisson, mesurées au pénétromètre, sont obtenues avec les graines de pois chiche ayant la plus forte teneur en protéines et en cendres. La quantité d'eau absorbée par les graines augmente avec le pourcentage de téguments. Ce dernier dépend principalement du cultivar et est lié à la taille et à la rugosité de la graine.

Introduction

Chickpea plays an important role in the diets of most Mediterranean countries. The way it is eaten is quite varied. It may be eaten green, soaked and cooked then eaten whole or mashed, or roasted and eaten as a snack. The grain decorticated or whole grain may also be made into flour. Thus the way in which cooking quality is commonly determined is quite varied, depending on the way it is going to be eaten, often using non-standardized cooking parameters. In recent years studies on chickpea, especially on its cooking quality, have begun to be carried out. Most of these few studies have been conducted by ICARDA and have dealt with the influence of the genotypes on grain size or have tried to determine the influence that processing, especially for cooking, has on protein and other nutrients (Haytowitz and Thompson, 1983; Williams and Nakkoul, 1983; Smithson and Thompson, 1985; ICARDA, 1988). However, as Smithson and Thompson (1985) have pointed out, there are very few studies which analyse the effects of the environment on the cooking quality of chickpea. A study on the influence of irrigation carried out by ICARDA (1988) and one on the influence of soil and locality by Fuentes *et al.* (1987) should be mentionend.

Considering that the chickpea in Spain is traditionally eaten as a whole grain cooked after soaking, size is of utmost importance. Consequently, this study evaluates the influence that cultivars, climate, soil and cropping techniques have on this factor. Different agronomic tests were carried out in the Andalusian region between 1984-1987 in order to evaluate cooking quality using the following indexes:

a) Weight of the grain, expressed as the number of grains/ounce or as the weight of 1000 grains.

b) Cooking quality, measured in tenderometric degrees (pounds/inch^2, psi) with or without previous soaking. Standard cooking time was 30 minutes and distilled water at a volume ten times the weight of the sample was used.

c) Protein content, determined by near infrared reflectance (NIR).

d) Ash content, determined by incineration in a muffle oven at 650 °C until constant weight of a previously ground sample was obtained.

e) Seed coat percentage derived as dry seed coat weight as per cent of the total weight of the grain.

f) Water absorption by the grain after 16 hours of soaking, expressed as the percentage of water absorbed with respect to the initial weight of the grain.

The results of the study are shown in the following section.

Influence of cultivars on cooking quality

Five chickpea cultivars were studied; three being of Spanish origin (Fuentesauco, Blanco lechoso and Pedrosillano), one of Mexican origin (Macarena) and one from a line produced by ICARDA (ILC-72). Table 1 shows the average cooking quality indexes of these cultivars.

Table 1. Average cooking quality for different chickpea cultivars.

Indexes	Fuentesauco		Blanco lechoso		Macarena		Pedrosillano		ILC-72	
	M[b]	SD[c]	M	SD	M	SD	M	SD	M	SD
nº grains/ounce	71.0	6.0	58	5.7	59	2.6	117	9.9	104	18.6
Protein (%)	25.3	1.7	24.9	2.0	23.9	1.5	26.1	2.5	26.9	1.3
T.D.[a] without previous soaking (psi)	74	18.2	69	21.7	55	7.8	65	21.5	59	16.6
T.D. with previous soaking (psi)	47	16.1	38	14.3	41	10.1	48	16.8	37	8.4
Ash (%)	3.1	0.3	3.1	0.3	3.2	0.3	3.2	0.3	3.2	0.3
Skin (%)	4.6	0.5	5.1	0.6	5.0	0.5	5.7	0.5	5.1	0.3
Water absorption (%)	120	6.0	126	8.3	117	4.0	127	7.7	114	6.2

[a]/ Tenderometric degree [b]/ Mean [c]/ Standard deviation.

The number of grains/ounce is closely related to genotype, with the largest grains belonging to the Blanco lechoso and Macarena cultivars. The latter also had the lowest protein content whereas the cultivars with the smallest grains, Pedrosillano and ILC-72 had the highest.

Tenderometric degree, with or without previous soaking of the grain, varied greatly with each cultivar. The differences in tenderometric degree, without or with presoaking, were small for Macarena and Pedrosillano and more marked for Fuentesauco and Blanco lechoso.

Ash content was the index which presented the least variations between cultivars, their average values being quite similar. The differences between cultivars regarding seed coat percentage were not very marked either. Pedrosillano and Fuentesauco were the cultivars which showed slightly higher and lesser seed coat percentages, respectively.

Variations between cultivars regarding water absorption are more marked, although the size of the grain does not seem to have any influence. Blanco lechoso, with the largest grain, and Pedrosillano, with the smallest one, were the two cultivars which had the highest percentages of water absorption.

The most significant correlations between the different indexes are shown in Fig. 1 and 2. The relationship between tenderometric degree (with or without previous soaking) and yield, and protein and ash content is negative and quite uniform for all cultivars. The more fertile soils, with potentially higher yield for chickpea, are also the ones which present more favorable characteristics for better cooking quality, hence the negative relationship between chickpea yield and tenderometric degree. The negative relationship between tenderometric degree and protein and ash content is also quite significant.

There is a positive relationship between protein and ash content and between water absorption and ash and seed coat percentage. Each of the cultivars showed a slightly different behaviour (Fig. 1 and 2): Macarena cultivar behaved differently as the tenderometric degree was significantly related neither to protein content nor to ash content and yield. Likewise, Fuentesauco does not show a significant relationship between water absorption and ash and seed coat percentages.

Influence of environment on cooking quality

The influence of climate on the cooking quality of chickpea was studied at the same location for four years. Fig. 3 shows the climatic data for these four years. The spring and May-June of 1984 (coinciding with the flowering period) registered higher minimum temperatures than the other years studied. The maximum temperatures in

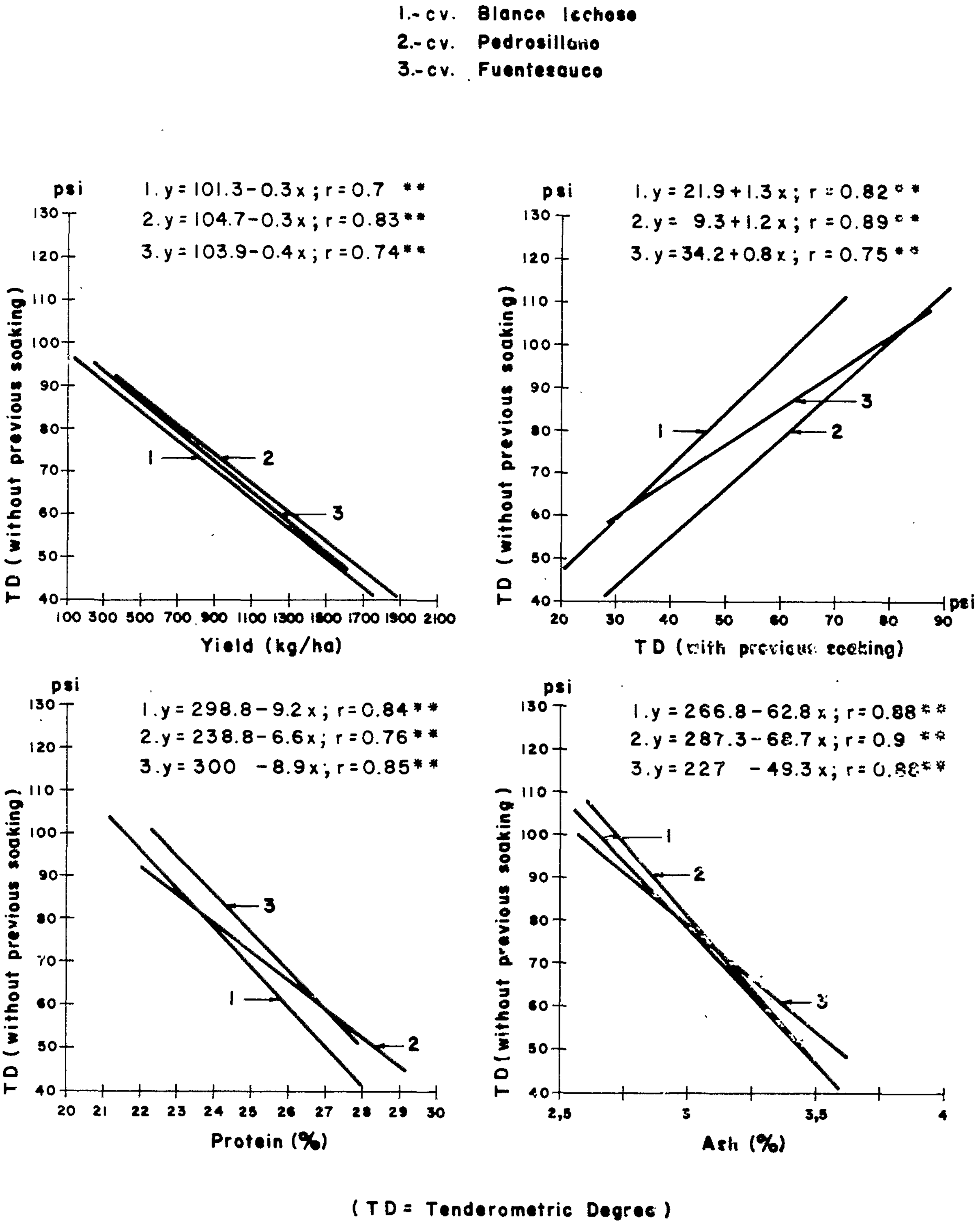


Fig. 1. Relationship between cooking quality indexes in chickpea cultivars.

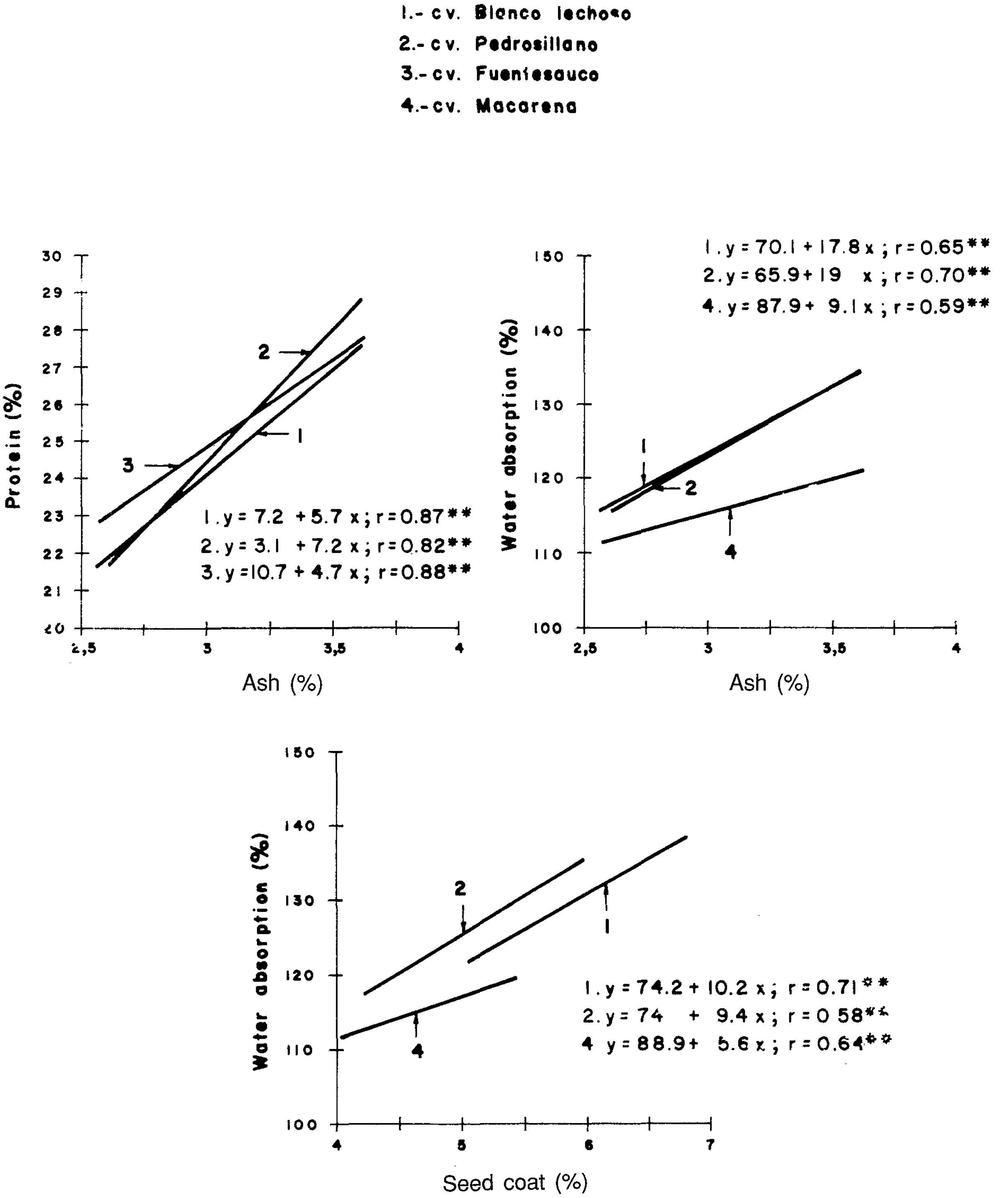
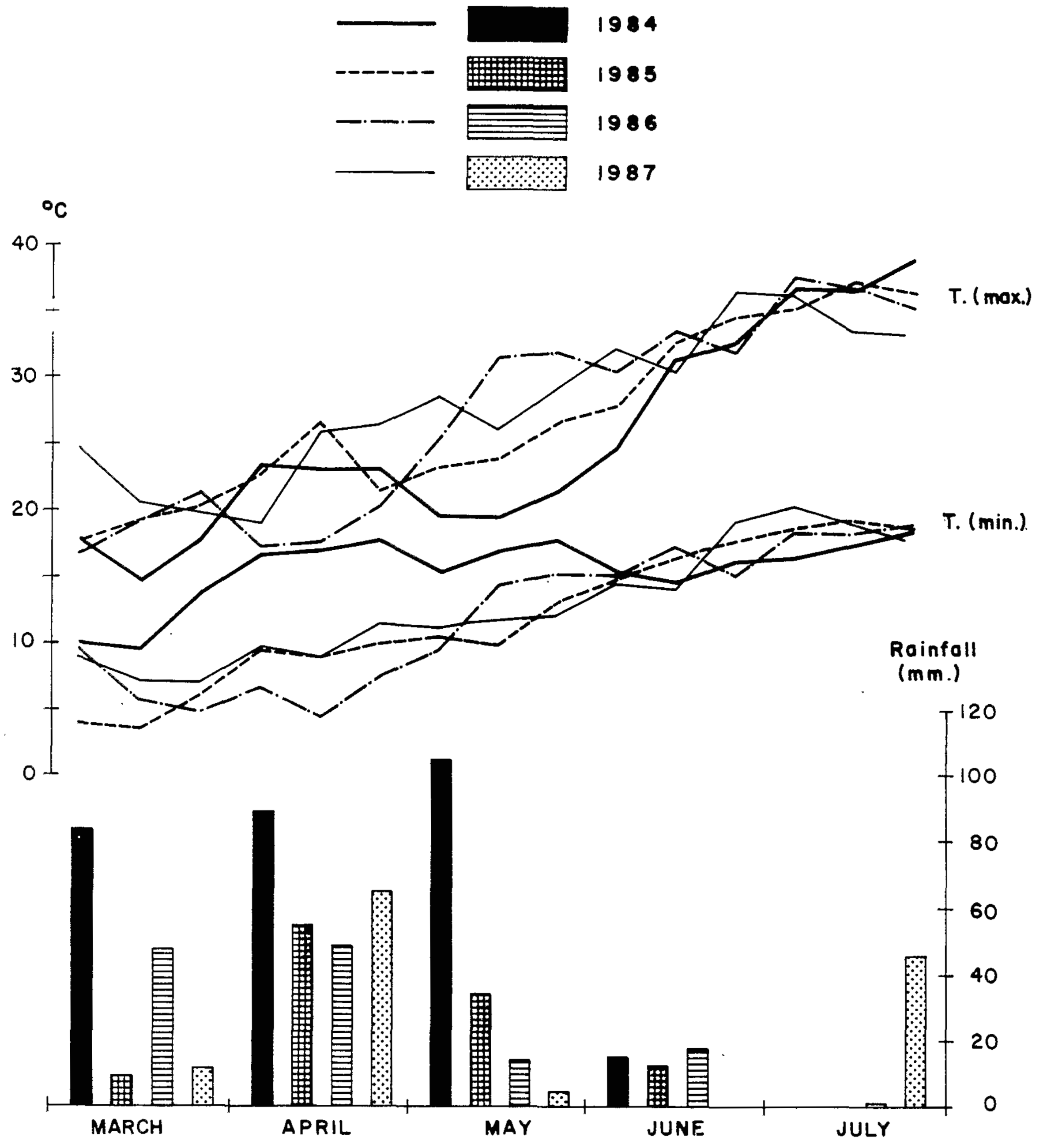


Fig. 2. Relationship between cooking quality indexes in chickpea cultivars.



Rainfall :	Year	Sept. - Feb.	Total
	1984	399	692
	1985	450	562
	1986	362	492
	1987	364	491

Fig. 3. Temperature and rainfall in the tested area (Córdoba, Spain).

1984 were also lower than the other years. The maximum and minimum temperatures during the grain formation period, between June and July, do not show marked differences in the four years. Except for the influence that climate might have had on yield, there were no other significant differences during the grain formation period between climatic conditions in the four years studied which can explain the marked seasonal variations in the different cooking quality indexes analysed.

Fig. 4 shows the annual influence on chickpea yield and on the number of grains/ounce. The size of the grain was smaller in 1985 and larger in 1987. Cooking quality expressed by the tenderometric degree (Fig. 5) was affected more by the year when grain was previousky soaked. 1986 was the year which showed the best cooking quality for all cultivars. The differences in protein content in the different years are not very significant and ash percentage registered lower values in 1986 and 1987 with respect to the first two years (Fig. 6). Likewise, skin and water absorption percentages were also less in the last two years (Fig. 7).

Another aspect studied for two years was the influence of soil type on chickpea cooking quality. Five different soil types were studied and their physical-chemical characteristics are given in Table 2. Variations in protein, tenderometric degree and seed coat percentages were observed in the Blanco lechoso, Pedrosillano, Fuentesauco and Macarena cultivars (Fig. 8, 9 and 10). In crop grown on soils A, B and C the chickpea grain generally showed greater protein content than in the one grown on soils D and E, as well as a lower tenderometric degree, i.e., better cooking quality. Likewise in the first three soils, although with slight differences, the grain had a higher seed coat percentage. From the chemical analysis data of the five soils (Table 2) it may be observed that the first three soils (A, B and C), besides having a higher overall fertility, had a higher assimilable potassium content, a higher capacity of exchangeable cations and higher exchangeable calcium, magnesium and potasium values. Soils D and E were quite different. The former had a high degree of calcium carbonate and active limestone while the latter showed zero values for these two components. Further studies are underway in order to clarify more precisely which soil factors influence directly cooking quality indexes.

Table 2. Soil analysis of the tested fields.

Indexes	Soils				
	A	B	C	D	E
Sand (%)	22	24	11	14	33
Silt (%)	25	30	37	43	41
Clay (%)	53	46	52	43	26
pH (water)	8.5	8.4	8.5	8.5	7.6
Organic matter (%)	1.4	1.4	0.9	0.9	2.9
P (Olsen)(ppm)	8	10	9	8	13
K (NH_4OAc) (ppm)	537	357	430	242	192
Active Ca CO_3 (%)	7.5	6.2	14.4	19.2	0
Ca CO_3 equivalent (%)	12.9	9	27.8	45.2	0
CEC (meq/100 g.)	35.5	26.7	23	18.2	17.1
Exchangeable Ca (meq/100 g)	26.5	20.9	16.3	14.0	13.9
Exchangeable Mg (meq/100 g)	6.1	4.4	5.1	3.1	2.4
Exchangeable Na (meq/100 g)	1.6	0.5	0.5	0.5	0.4
Exchangeable K (meq/100 g)	1.3	0.9	1.1	0.6	0.4

Influence of cropping tecniques on cooking quality

The influence of different cropping techniques on cooking quality was also studied. In tests carried out during the winter and spring sowing periods with the Pedrosillano and ILC-72 cultivars (Table 3) sowing date had a

Table 3. Cooking quality indexes as affected by sowing time of two chickpea cultivars (mean of 2 years).

Indexes	cv. Pedrosillano				cv. ILC-72			
	Nov	Dec	Feb	Mar	Nov	Dec	Feb	Mar
Nº grains/ounce	110	110	113	112	100	102	101	100
Protein (%)	28.2	27.3	27.1	28.1	26.8	27.3	26.9	27.4
T.D.[a] without previous soaking (psi)[b]	46	45	54	52	45	45	53	52
T.D. with previous soaking (psi)	38	38	39	34	35	35	36	34
Ash (%)[c]	3.4	3.3	3.2	3.3	3.4	3.3	3.1	3.2
Skin (%)[c]	5.7	5.5	5.3	5.4	5.3	5.2	5.1	5.0
Water absorption (%)[c]	129	131	124	121	122	126	119	112

[a]/ Tenderometric degree [b]/ Significant differences in 1 year
[c]/ Significant differences in both years

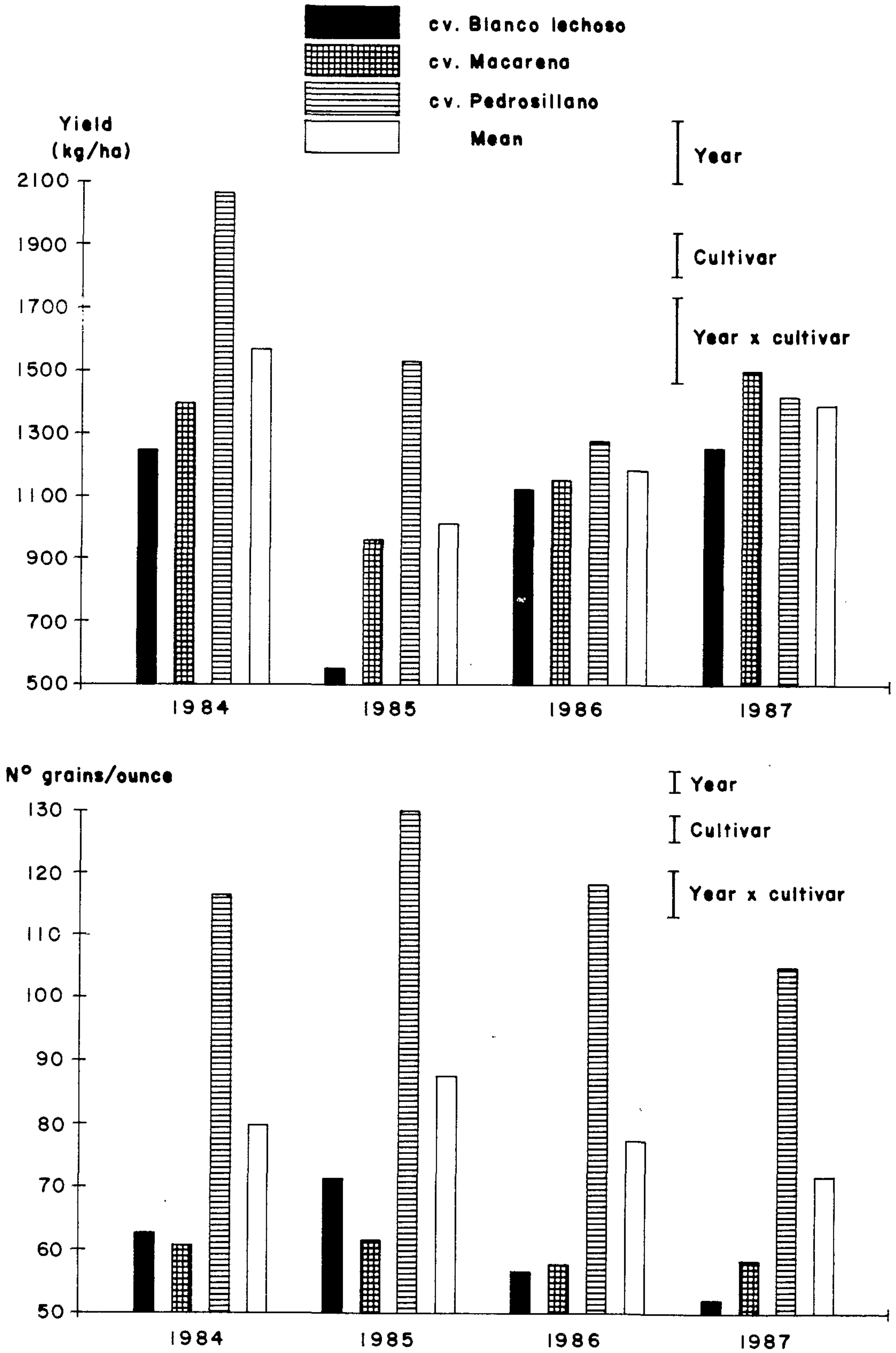


Fig. 4. Yield and no. grains/ounce of three chickpea cultivars (vertical bars represent, LSD < 0.05) as affected by seasons.

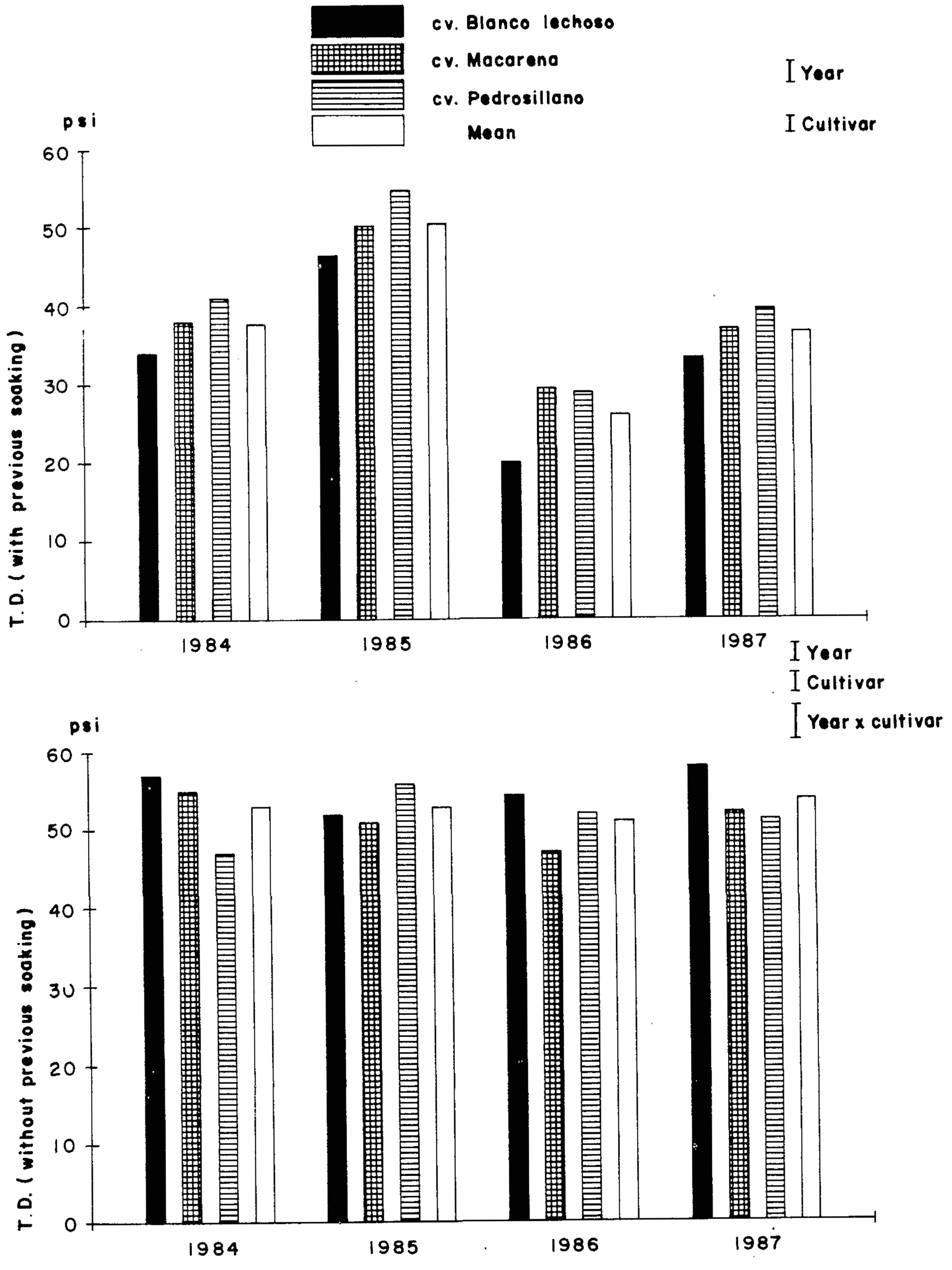


Fig. 5. Tenderometric degree (T.D.) with or without previous soaking of three chickpea cultivars (vertical bars represent, LSD < 0.05) as affected by seasons.

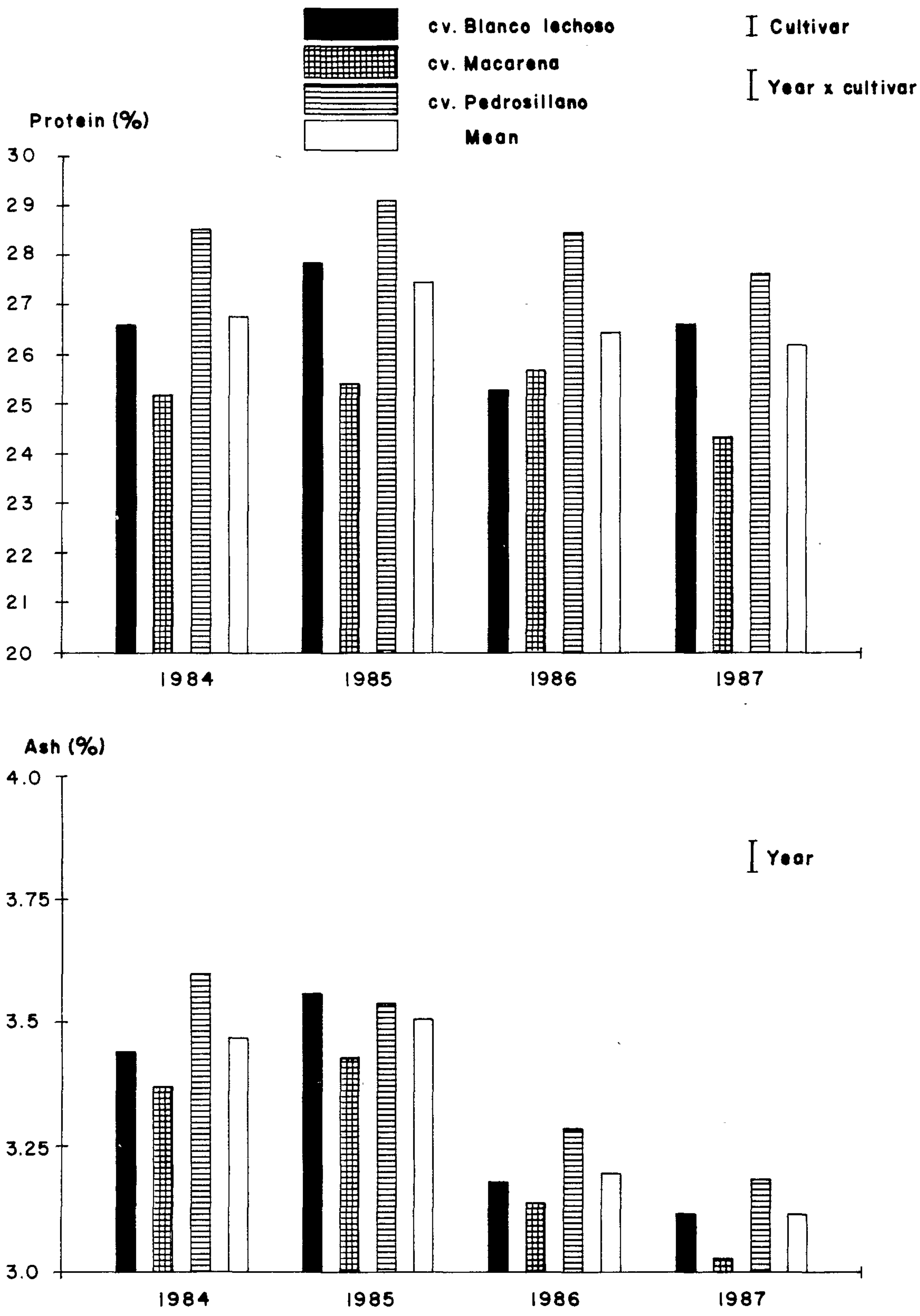


Fig. 6. Protein and ash content of three chickpea cultivars (vertical bars represent, LSD < 0.05) as affected by seasons.

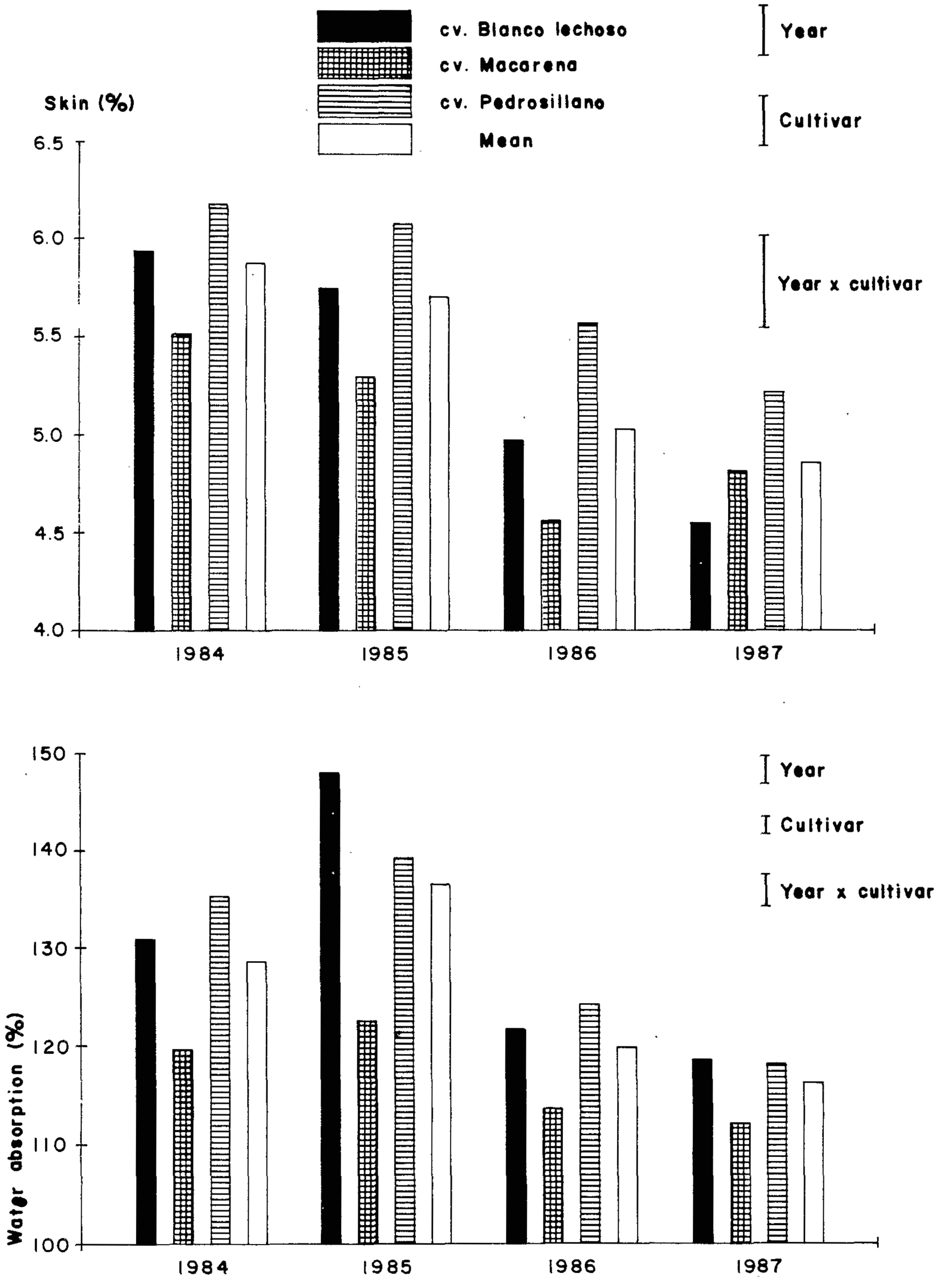


Fig. 7. Skin and water absorption percentages of three chickpea cultivars (vertical bars represent, LSD < 0.05) as affected by seasons.

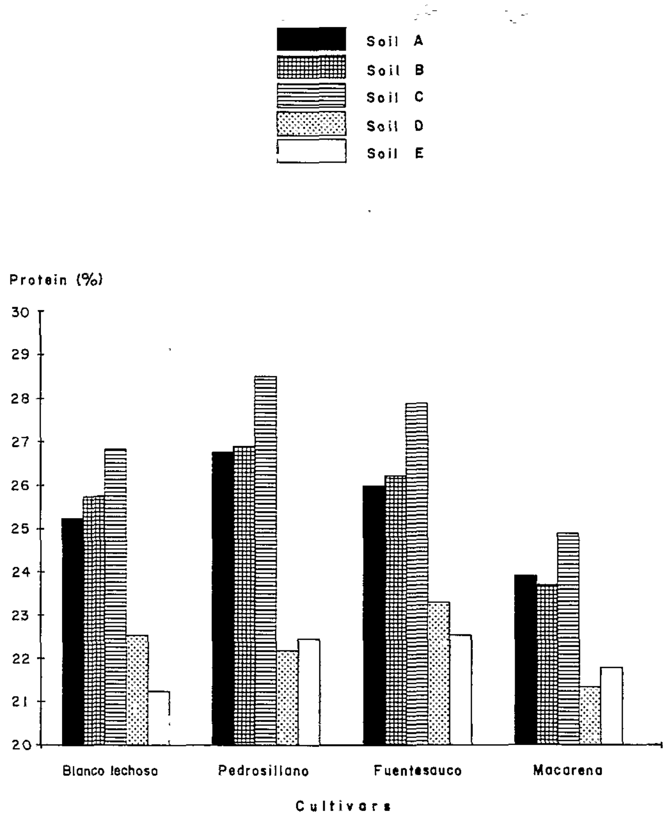


Fig. 8. Influence of soils on the protein content of chickpea cultivars (mean of 2 years).

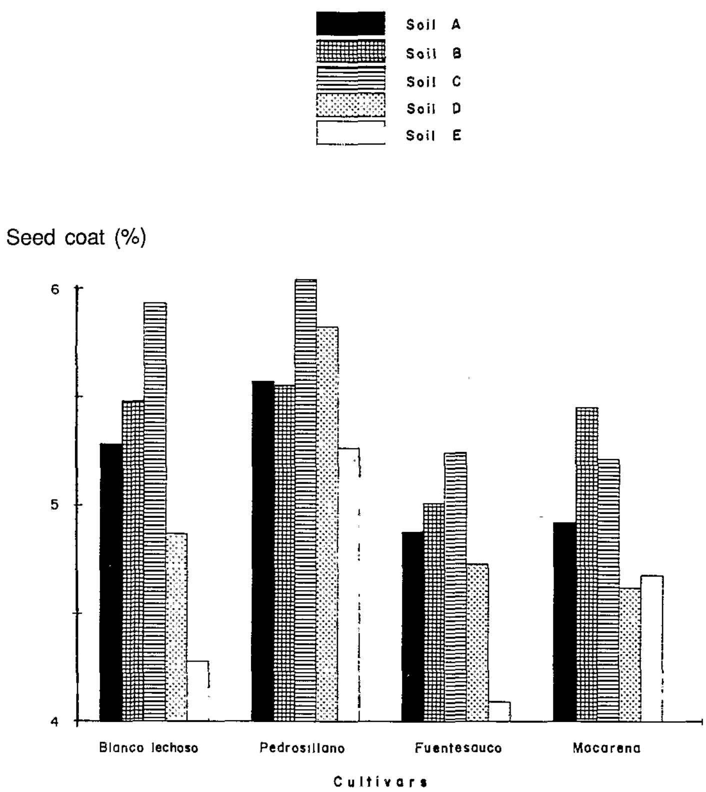


Fig. 9. Influence of soils ón the skin % of chickpea cultivars (mean of 2 years).

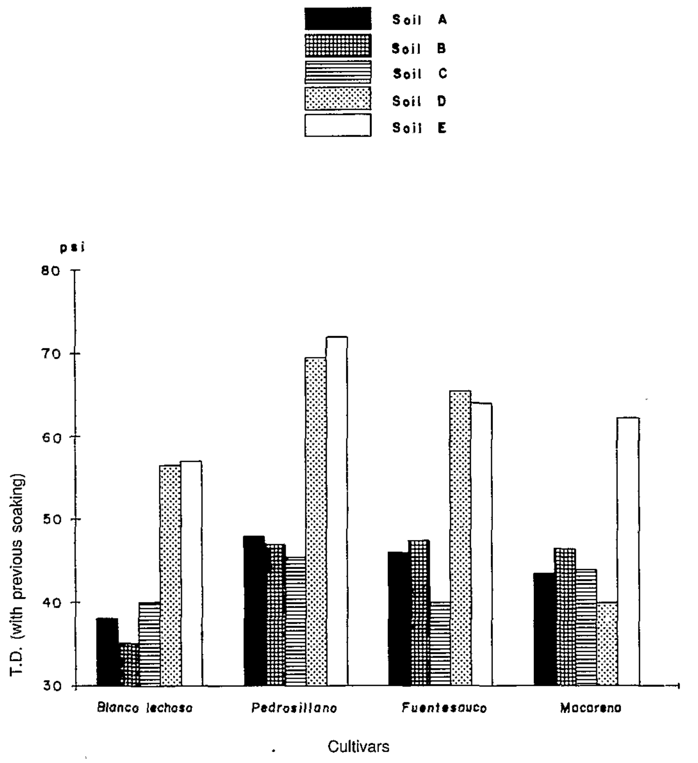


Fig. 10. Influence of soils on the tenderometric degree (T.D.) with previous soaking of chickpea cultivars (mean of 2 years).

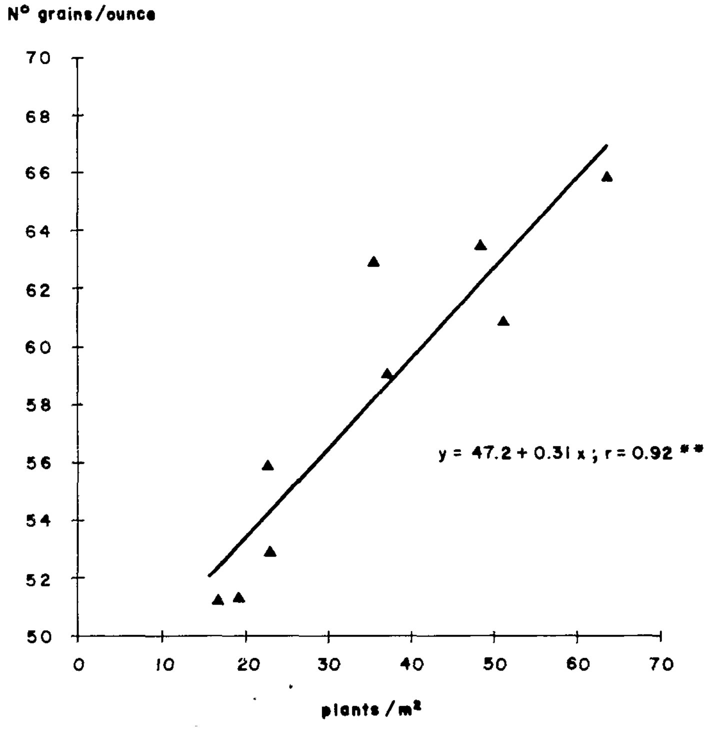


Fig. 11. Relationship between chickpea plant density and no. of grains/ounce.

marked influence on cooking quality: the earlier the sowing date the better the tenderometric degree without soaking, but after soaking of the grain no significant differences were observed. Ash content, seed coat percentage and water absorption were other indexes affected by sowing date. Ash content was reduced by delay in the sowing date, as was also the case with seed coat percentage, Water absorption was higher in the earlier winter sowing dates.

Two different doses of phosphorus fertilizers (50 and 100 kg/ha P_2O_5), were also tested two years on soils with an average available phosphorus content of 8-10 ppm. No influence on the cooking quality indexes was found.

The influence of plant density on cooking quality was tested with the Blanco lechoso cultivar for 3 years. None of the indexes studied showed significant changes with densities which ranged from 16.6 to 63.6 plants/m^2 with the exception of the number of grains/ounce in some tests and in certain years. Fig. 11 shows that the higher the plant density the higher the numbers of grains/ounce.

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