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Relationship between some quality traits and yield of durum wheat under southern Spain conditions

Y. Rharrabti, S. Elhani, V. Martos Núñez and L.F. García del Moral

Dpto. Biología Vegetal, Facultad de Ciencias, Universidad de Granada, Avda. Fuentenueva s/n,
18071 Granada, Spain

SUMMARY – A major problem for durum wheat production in the Mediterranean region is yield fluctuation, as a result of year to year variation in precipitation and heat stress during grain growth. Ten durum wheat cultivars differing in drought resistance were grown during 1998, both under rainfed and irrigated conditions in three sites of southern Spain. Vitreousness was positively correlated with TW ($r = 0.48^{**}$) and semolina colour ($r = 0.46^{**}$). An inverse relationship was found between grain yield and protein content. Regression of cultivar mean values of protein content and grain yield showed a negative relationship ($r = -0.724^{***}$) due probably to dilution of protein by non-nitrogen compounds and reduced starch accumulation in the grain under drought conditions.

Key words: Protein content, grain yield, quality, durum wheat.

RESUME – “Relation entre certains caractères de qualité et le rendement du blé dur en conditions du sud de l’Espagne”. Le problème majeur qui s’oppose à la production du blé dur dans la région Méditerranéenne est la variation du rendement par suite à la variation entre années des précipitations et des hautes températures pendant la croissance du grain. Dix cultivars de blé dur, différents dans leur résistance à la sécheresse, ont été cultivés pendant l’année 1998, en sec et en irrigué dans trois sites du sud de l’Espagne. Le taux de vitrosité a été positivement corrélé avec le poids spécifique ($r = 0,48^{**}$) et la couleur de la semoule ($r = 0,46^{**}$). Un rapport inverse a été trouvé entre le rendement en grain et le contenu en protéine. La régression des valeurs moyennes du contenu en protéine sur celles du rendement en grain a révélé une relation négative ($r = -0,724^{***}$) entre les deux caractères dû probablement à la dilution des protéines par les composés non azotés et la réduction de l’accumulation de l’amidon dans le grain sous les conditions de sécheresse.

Mots-clés : Contenu en protéine, rendement du grain, qualité, blé dur.

Introduction

Durum wheat is one of the cereals most cultivated in the Mediterranean basin, essentially for pasta making. This leads the quality breeding and evaluation to be a main trend in the research area of durum wheat. Many quality parameters have been investigated such as protein content, test weight, SDS sedimentation test, flour (or semolina) colour, and vitreousness. Environmental conditions are known to have a significant influence on end-use quality characteristics of wheat, but the relative magnitude of environmental, genetic and G x E effects on quality is unclear (Peterson *et al.*, 1992). Protein content, which is the most important trait in quality evaluation and breeding of durum wheat, is known to be influenced mainly by environment, cultivar, nitrogen fertilizer rate and time of nitrogen application (Rao *et al.*, 1993).

The objectives of this work were: (i) to determine the magnitude of variation present in a set of durum wheat cultivars and the degree of additive and multiplicative effects on the traits studied; and (ii) to investigate the relationship between grain yield and some quality parameters, with emphasis on protein content.

Materials and methods

Three experimental field trials were conducted during 1997-1998 season in a representative area of cereal-growing region of southern Spain. Ten durum wheat cultivars were sown at a seed rate of 350 viable seeds/m² in plots 10 m long by 1.2 m wide, with six rows 20 cm apart. Each plot received fertilizer according to the standard recommendation. The experimental design at each site was a randomized complete block with four replications. Different commercial and technological characteristics other than

grain yield were considered: thousand grain weight (TGW), test weight (TW), protein content, SDS test, vitreousness and semolina colour. Statistical Analysis System (SAS Institute, 1996) procedures and programs were used for data analyses.

Results and discussion

Correlations among characters

Table 1 shows the matrix of correlations calculated over cultivar means in each site (i.e. n = 30). Protein content was negatively correlated with grain yield ($r = -0.72^{***}$) and TGW ($r = -0.65^{***}$). The inverse relationship between protein content and grain yield was found in numerous works in bread wheat (Campbell *et al.*, 1981; Pleijel *et al.*, 1999) and triticale (García del Moral *et al.*, 1995).

Vitreousness was positively correlated with TW ($r = 0.48^{**}$) and semolina colour ($r = 0.46^{**}$). Novaro *et al.* (1997) underlined that the increase in yellow-berry percentage (= 100 - vitreousness) determines a significant decrease of TW and then negatively influences the semolina yield.

Table 1. Coefficients of correlation among characters studied of durum wheat grown in three sites of southern Spain during 1997-1998 growing season (n = 30)

	TGW [†]	TW [‡]	Semolina colour	SDS [§]	Vitreousness	Protein content
Grain yield	0.50**	0.01ns	- 0.14ns	0.16ns	0.35ns	- 0.72***
TGW		- 0.33ns	- 0.38*	- 0.10ns	- 0.20ns	- 0.65***
TW			0.66***	- 0.05ns	0.48**	0.15ns
Semolina colour				0.09ns	0.46**	0.07ns
SDS					0.13ns	- 0.20ns
Vitreousness						- 0.10ns

[†]TGW = Thousand grain weight.

[‡]TW = Test weight.

[§]SDS = Sodium dodecylsulfate.

^{||||}ns : Non significant at 0.05 level of probability.

*,**,***Significant at 0.05, 0.01 and 0.001 levels of probability, respectively.

Relationship between protein content and grain yield

Regression of cultivar mean values in each site for protein content on grain yield (Fig. 1) shows a high negative correlation between this two traits. This relationship had been encountered in many similar works. Dilution of protein by non-nitrogen compounds in the grain seemed to be the primary cause for the negative association between grain yield and protein content (Pleijel *et al.*, 1999). Conditions that promote leaf senescence during grain growth, such as drought or higher temperatures, favour protein deposition over starch accumulation in the grain (Campbell *et al.*, 1981). Under conditions that shorten the duration of grain filling period, starch deposition appears to be more affected than protein deposition (Bhullar and Jenner, 1985; García del Moral *et al.*, 1995). Therefore, the increase in grain protein percentage obtained in our work due to drought conditions, may be mainly attributed to reduced starch accumulation.

Conclusions

The negative relationship between grain yield and protein content was probably due to a dilution effect and reduced starch accumulation under drought conditions. More field trials over years are needed to establish right conclusions and recommendations for breeders and cereals growers in southern Spain about adaptation of durum wheat cultivar to such conditions and its relation with quality parameters.

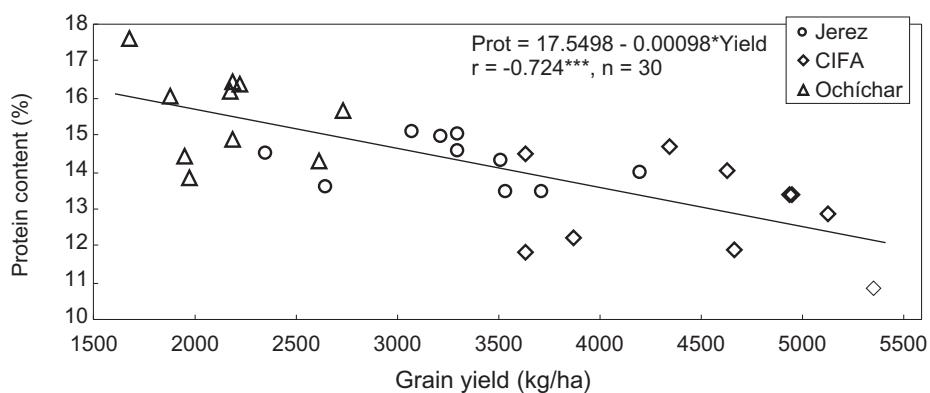


Fig. 1. Regression of protein content on grain yield in durum wheat.
Individual values are the cultivar means in each site.

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