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An evaluation of biodiversity in *Triticum durum* (*Gramineae*) through measurements of potential productivity

Abstract

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We have studied several parameters in *Triticum durum* Desf., cultivated organically in the same period in two localities with different microclimatic conditions. We particularly investigated phenological parameters such as growth, plant development and net photosynthesis. The aim was to see if there existed any differences due not only to factors commonly involved in biodiversity, but also to factors such as productivity (Waide & al. 1999) and peculiarities of the functional group (Cody 1975; Leonardi 1998).
The observations and measurements carried out on *Triticum durum* Desf. show quite different growth patterns and potential productivity.

Introduction

In these last years, new methodological approaches have been experimented in order to obtain an optimal qualitative and quantitative exploitation of natural resources, without harming the environment (Raimondi & al. 1997; Sequi 1994).

In agriculture, and particularly in the case of cereal crops, great consideration is being given to cultivars grown in cultivated areas that are best suited for an ecocompatible and sustainable production (Raimondi & al. 2000) inspired by the valorization of biodiversity and by the particularity of the functional group for a productivity analysis (Waide & al. 1999; Leonardi 1998).

In this view, many researches justify the use of natural resources in loco, linking more and more each kind of product to its area of production. Indeed, the study of the ecophysiological characters of cultivated plants and of the adaptability pedoclimatic factors are basic for a better use of cultivated varieties in relation to a better land management.

Previous preliminary studies carried out on varieties of durum wheat cultivated on two series of soils have shown that wheat has a different adaptability in relation to the soil, and production is influenced consequently (Raimondi & al. 2000; Poma & al. 1998).

Since the pattern of the developmental stages of a plant and its leaf gas exchanges surely play a significant role in the formation of caryopses and therefore production, we have started investigating some phenological parameters (stages of plant development) and net photosynthesis, in cultivars of *Triticum durum* Desf. cultivated organically with the aim to find any differences among them during various developmental stages, particularly from the stem elongation to the maturation of the ears.

The observations and measurements carried out on *T. durum* cultivated in two different locations, in the same period,could show a different adaptation capacity of the two cultivars to the pedoclimatic conditions characterizing the growing environment. The analysis of potential and effective productivity have shown, in a preliminary way, the diversity of the type cultivars we studied and their role in a hypothetical functional group in the regionally representative localities of cereal crops.

Materials and methods

For the experimental studies in the field, coltural areas representative of the internal part of Sicily were choised on location and with the help of thematic maps (Fierotti & al. 1988), belonging to selected companies. The experimental fields are in two hilly areas, location 1 in the country of Caccamo (PA) and location 2 in the country of Contessa Entellina (PA), at of 500 m above s.l., with an east-west exposition, a 12–15% inclination, in an area with little wind, sown with durum wheat of the certified varieties "Simeto" and "Creso". The two locations have different annual thermopluviometric values, and different pedological characters. At location 2 the mean annual air temperature is 16,4 °C and the mean annual rainfall is 714 mm, while in location 1 the mean annual air temperature is 15,2 °C and the mean annual rainfall is 610 mm. In location 2 the soil has a balanced texture, while the soil in location 1 is clayish. The same organic culture techniques have been used in both locations.

The following parameters were measured: phenological characters (plant growth), morphological characters (height of plants, ear production), physiological characters (gas exchange measurements).

The height of plants was measured every week. The measurement of gas exchange was conducted on the flag leaf, using a Portable Photosynthesis System HCM – 100 (Walz) with an incorporated IRGA detector, supplied with da-1000 software system for the direct reading of the gas exchange process and elaboration of the data. The apparatus instantly monitors environmental parameters such as light intensity, R.H., external temperature and leaf temperature, through microreceptors allowing instant measurements in actual environmental conditions. Together with net photosynthesis and transpiration we measured environmental parameters. CO_2 gas exchange was calculated according to Parkhust 1994; net photosynthesis and transpiration according to Von Caemmerer & Farquhar 1981. Measuring photosynthesis in the field with the IRGA method avoids problems with high CO_2 concentrations that interfere with the stomatal activity of the leaves of C_3 plants (Corelli Grappadelli & al. 1989; Farqhuar & Sharkey 1982; Sharkey 1985) since atmospheric CO_2 at known concentration is used. To study the components of diversity in the ecophysiological field, in order to quantitatively analyse the measured diversities, after analysing the mean values obtained from the ecophysiological measurements we applied the model studied by Leonardi (1998), to the values obtained using the following formula adapted for calculating the diversity index:

$$\beta = \gamma/\alpha$$

α = local diversity

γ = regional diversity

β = diversity or turnover describing how diversity varies from one habitat to another.

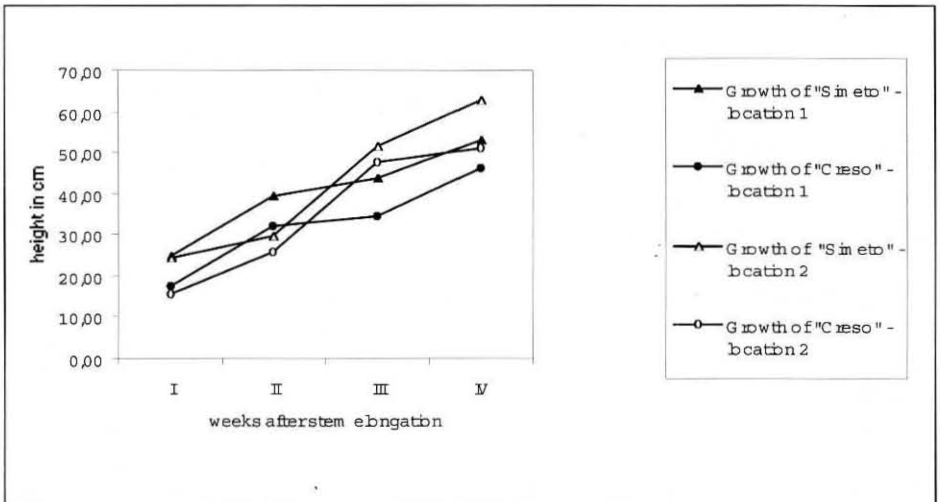

Fig. 1. Elongation of the stem of the two cultivars of *Triticum durum* Desf. in the two locations considered, in the different phenological stages.

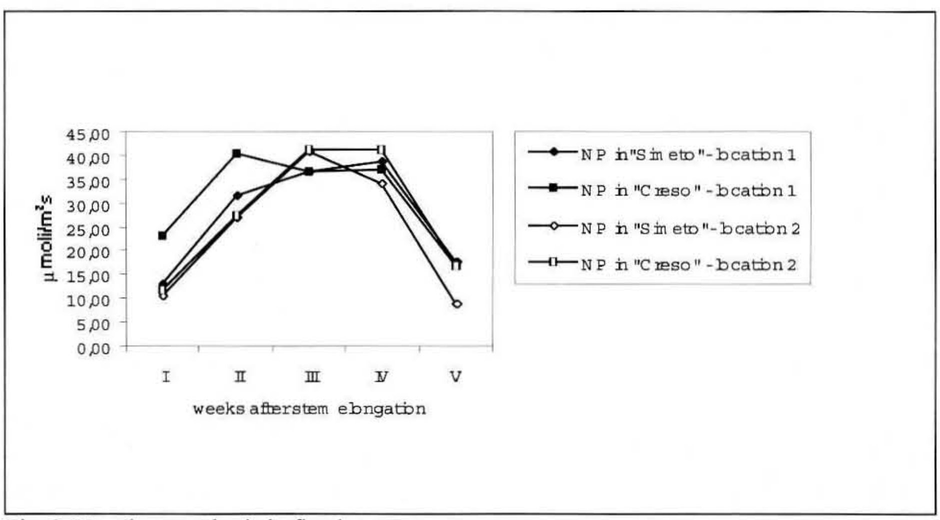

Fig. 2. Net photosynthesis in flag leaves.

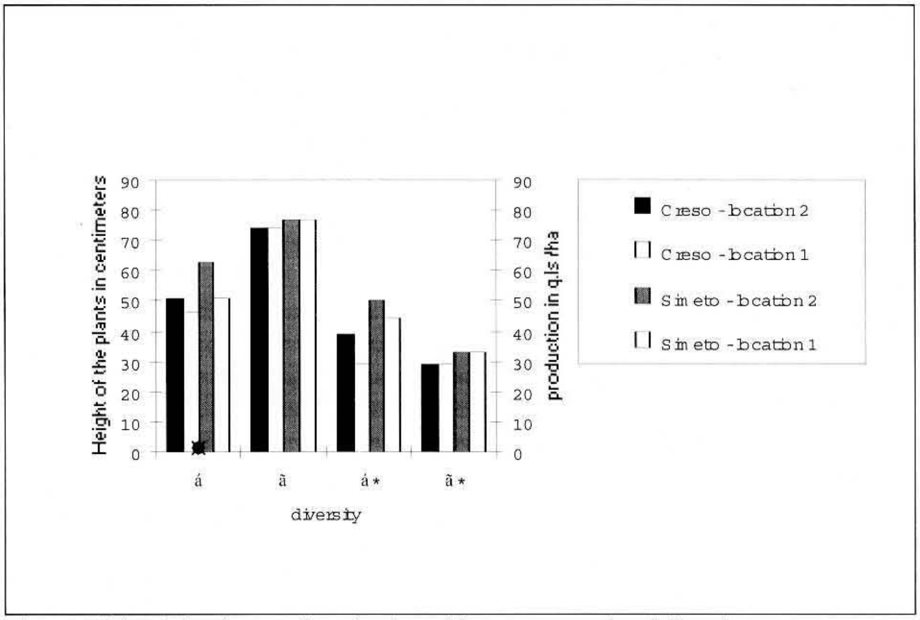

Fig. 3. Height of the plants and production with respect to regional diversity.

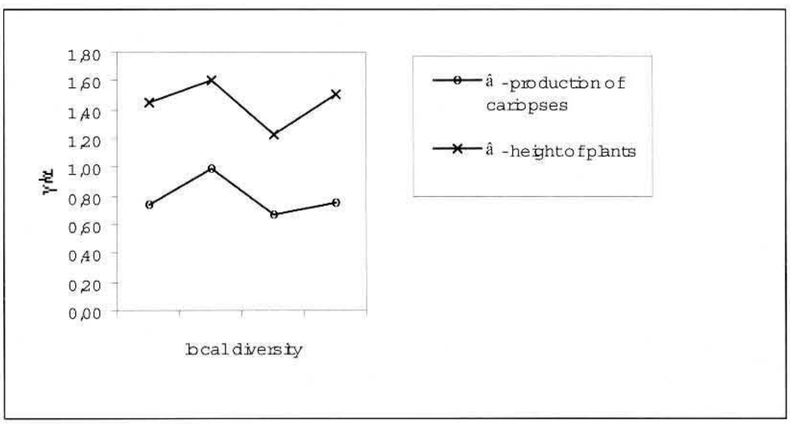

Fig. 4. Diversity or turnover for the height of plants and the production of caryopses.

Results and discussion

Elongation was measured at regular weekly intervals, from the beginning of the stem elongation stage until the formation of the ears. In both localities, the cultivar "Simeto" develops more than the "Creso". The plants growing in location 2 are always higher than those cultivated in location 1. Furthermore the different developmental stages of *Triticum durum* Desf. are reached in different moments in the two localities and in the different cultivars. Indeed, after the shooting that occurred contemporaneously in both locations for

Table1. Diversity index (β) for the production of caryopses.

Locality	Cultivar	Diversity index
Location 2	Creso	$\beta = 0{,}74$
Location 1	Creso	$\beta = 0{,}99$
Location 2	Simeto	$\beta = 0{,}67$
Location 1	Simeto	$\beta = 0{,}75$

Table 2. Diversity index (β) for the height of the stem.

Locality	Cultivar	Diversity index
Location 2	Creso	$\beta = 1{,}45$
Location 1	Creso	$\beta = 1{,}61$
Location 2	Simeto	$\beta = 1{,}23$
Location 1	Simeto	$\beta = 1{,}51$

both cultivars, that is eleven weeks after seed germination, the following stage of stem elongation, occurred in different moments, in the two locations and within the two cultivars considered. In location 2 the stem elongation is at least one week earlier than in location 1. The standard deviation ranges between 1 and 4 (Fig. 1).

Net photosynthesis was measured at regular weekly intervals, from the beginning of the stem elongation stage until the formation of the ears. In location 2 the pattern of net photosynthesis is quite similar in both cultivars. They both show a greater increase in the first three weeks after the beginning of the stem elongation. Net photosynthesis decreases earlier in the cultivar "Simeto". In location 1 at first "Creso" has a higher net photosynthesis than "Simeto", but after the second week "Creso" shows a decrease in net photosynthesis. After the third week the pattern is the same in both cultivars in the two locations (Fig. 2).

"Simeto" shows higher values both for height and production in the two locations, compared to "Creso".

The local diversities α e α^* are more variable than the regional diversities γ e γ^*. On the x axis the values of diversities are reported:

α = local diversity for height;

γ = regional diversity for height;

α^* = local diversity for the production of caryopses;

γ^* = regional diversity for the production of caryopses (Fig. 3).

The pattern of β for production is similar to that of the height of the plants

To calculate β we used the equation $\beta = \gamma/\alpha$ (Fig. 4).

Within each habitat β is higher in "Creso" than in "Simeto" (Table 1).

Within each habitat β is higher in "Creso" than in "Simeto" (Table 2).

In the two locations considered the development pattern of plants of *Triticum durum* Desf. is different. Location 2 seems more favourable since both "Simeto" and "Creso" develop more, have a higher photosynthetic activity and when they are ripe the ears have a larger number of caryopses than in location 1. Furthermore, in location 2, the formation of ears and the ripening of caryopses occurred earlier than in the other location.

The pedoclimatic environment may influence the succession of the stages, delaying or anticipating them, the ripening time of caryopses and therefore the quantity and quality of production, as has been seen in other cultivars by Poma & al. 1998, and by Raimondi &

al. 2000. Because of organic culture methods, the study locations have the character of a semi natural habitat, even in a cultivated environment.

In both localities and cultivars there is a higher net photosynthesis during the first two weeks of observation, and this coincides with the stem elongation stage during which the plant reaches the highest vegetative development.

In location 1 the decrease in photosynthesis in "Creso" coincides with an earlier yellowing of the flag leaf with respect to "Simeto" (Table 1), probably because of an earlier formation of the ears. In fact net photosynthesis shows a less regular pattern especially between the second and third week in both cultivars in location 1 than in location 2 (Fig. 2). This could be due to the fact that in this location the substrate, mainly clay, showed in the spring the typical cracks of clay soils, since rainfall was scarce, a frequent condition in a Mediterranean type climate like the Sicilian one.

In location 2, instead, the substrate did not show cracks in that period. Furthermore the leaves of both cultivars in location 1 showed stress symptoms, in the same period, since the leaf margins were slightly curled during the first hours of the day.

From the results on the biological development and the pattern of gas exchanges, the cultivar "Simeto" seems more adaptable than the "Creso" from the ecophysiological point of view, since it has a rather regular cycle in both locations. This appears to be confirmed by the value of β that is higher in "Creso" than in "Simeto" both for the production of caryopses and for the height of the stem (Table 1 & 2).

These preliminar results could be completed by a study on the quantitative and qualitative productivity of the caryopses. Furthermore, since there are not any strictly ecophysiological data at a regional level, it would be interesting to apply β to the potential productivity and not only to the effective productivity.

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