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Performance of durum wheat varieties (*Triticum durum* desf.) under conventional and organic agriculture

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Abstract

Field experiments were conducted for four years to determine the effects of organic and conventional systems and fourteen varieties on growth, yield and quality of durum wheat crop. The experiments were laid out in a split-plot design with four replicates. Studied parameters included (i) grain yield, (ii) technological and nutritional quality of the whole grain.

Results of the agronomic traits indicated that grain yield is on the average lower under organic cultivation compared to conventional methods (2.32 and 2.98 t/ha respectively). Data analysis indicated high production potential of some varieties such as Khiar, Ben Bechir and INRAT69 (2.47, 2.46 and 2.44 t/ha respectively) under organic farming method.

Results of the nutritional quality were influenced by the cultivation method. The organic method affected positively proline contents (1.154 vs 1.146 g/100g of FM) and cystein (0.216 vs 0.186 g/100g of FM) and gluten index (64.73 vs 61.46 %). Contrary to the organic method, grain protein content is better in the conventional method (13.9 vs 13.5 %/FM).

Based on these results, only INRAT69 variety could be potentially used in organic agriculture, it could also be adapted for manufacturing organic pasta and couscous.

Introduction

In Tunisia, organic cereals represent a sector that can easily be adapted to conversion into organic agriculture. The area which is reserved does not exceed the 1200 ha (DGPA, 2012). Currently, Tunisian and foreign consumer expectations related to organic cereals quality and in particular durum wheat, are numerous and their request is increasing continuously. Tunisia has so many advantages to produce and export organic products mainly to Europe. These advantages include the persistent demand of European countries in organic cereals, geographical proximity of Tunisia to the place of the request, the quality (high protein), especially from some old varieties of durum wheat (Ben Salem et al., 1995).

In order to contribute to identifying some varieties adapted to organic agriculture, we undertook a research project that focuses on 14 varieties old and recent. The objectives were the effect of organic mode on: i) wheat grain yield, and ii) wheat grain quality.

Material and methods

The comparison trial of durum wheat varieties was carried out during four years at two sites. The first site is part of the experimental farm of ESAK located in the semiarid region and the second site is at the experimental station "El Kodja" in National Institute of Field Crops of Boussalem located in the higher semi-arid region.

Fourteen durum wheat varieties were tested in this work (9 old varieties: Chili, Biskri, Hamira, Swabaa Algia, Jnah Khortifa, INRAT69, Badri, Bechir Ben and Maghrebi and five improved varieties: Karim Razzak, Khiar, Om Rabia and Nasr).

The experimental design used during the four years of trial, was "split plot" with four repetitions. The method of cultivation (organic vs conventional) is the main factor. The variety randomized in each treatment is the secondary factor.

The seeding was done during the second half of November each year. The seed rate calculated was 600 seeds per plot (120 kg / ha).

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The development of weeds was controlled by hand for organic plots and chemical control for conventional plots.

Fertilization consisted:

- For the conventional plot: application of ammonium nitrate ammonium 33.5% in two fractions at 100 kg / ha: the first contribution was made after emergence, the second in early tillering stage.

- For the organic plot: an application of a nitrogen organic fertilizer (liquid) that is composed of 5.9% organic nitrogen, organic carbon 22.2% and 36.9% amino acid in a proportion of 2 l / ha.

The parameters studied are grain yield, protein, total amino acids and gluten contents.

Results

Grain yield of durum wheat varieties in organic agriculture

The comparison of the grain yields of fourteen durum wheat varieties grown for four seasons in organic and conventional methods shows that the grain yield over all varieties was in favor of the conventional, with 28% increase. However, the difference was not stable and it varied from the first growing season to the fourth, making organic cultivation competing well when it is relatively a dry season.

Based on results of this particular experiment, three varieties were distinguished in organic cultivation for four growing seasons in grain yield, ie Khiar (improved variety), Ben Bechir and INRAT69 (old varieties) with average grain yield of 2.47, 2.46 and 2.44 t/ha respectively. In fact, the distinction of old varieties in organic mode is expected. These varieties are known by their local adaptation, rusticity and productivity.

Some varieties are well adapted to many environments, while others are particularly adapted to specific environments. These conclusions could be applied especially for the varieties Khiar, Ben Bechir and INRAT69 which have behaved well with very satisfactory performance in organic method for four years of trials combined.

Technological quality of grains

Crude proteins

The protein content is affected by the method of cultivation. In effect, there is a significant difference between the two methods of cultivation ($P < 0.001$), 13.91 and 13.51% / FM for conventional and organic methods respectively. This result can be attributed to nitrogen that is different both in quantity as the method of its application. Woëse *et al.* (1997) reported similar results indicating that the low crude protein should be obtained in varieties conducted organically.

Contrary to what these authors have suggested, we recorded values of crude protein high in organic method compared to conventional in six varieties. This is the case of Chili and Razzak varieties with a difference of 20.54 and 5.51% respectively for the organic conducting. This could be explained by better use of these varieties of regular inputs of organic fertilizer nitrogen (5 fractions) from the lifted stage which allows them to escape to nutritional stress. In other words, these varieties are characterized by better absorption and remobilization of nitrogen. However, plants conducted in conventional method only benefited from nitrogen fertilizer ammonium-nitrate into two fractions only. In addition, Gate (1995) indicated that the fractionation of fertilization during the cycle of durum wheat affects the protein.

Total amino acids content

Most amino acids analyzed (76.47%) are more frequent in conventional than organic method with the exception of histidine (0.300 vs 0.297 g/100 g FM), phenylalanine (0.549 vs 0.546 g/100g FM), proline (1.154 vs 1.146 g/100 g FM) and cysteine (0.216 vs 0.186 g/100 g FM). This last amino acid is higher in most varieties conducted organically.

Among the fourteen varieties studied, eight showed a total amino acids composition higher in organic than conventional method. These varieties in decreasing order are: Jnah Khortifa, Hamira, Chili, INRAT69, Swabaa Ilgia, Nasr Razzak and Karim with 14.803, 14.787, 13.116, 12.858, 12.115, 10.956, 10.874 and 10.404 g/100g FM respectively. Remember that the first five varieties are old and are characterized by a remarkable protein quality in organic method and their constitution of amino acids. In general, cereal products contain varying amounts of free amino acids, depending largely on the species, varieties and growing conditions (Abdel-Aal & Hucl, 2002).

Gluten content

In the case of conventional and organic methods, gluten index average of all varieties showed a slight difference in favor of organic method compared to the conventional mode with 64.73 and 61.46% respectively. In general and according to Perten (1990), this is a balanced gluten. Garrido-Lestache *et al.* (2005) report that gluten index of durum wheat responds positively to temperatures during grain filling.

Still referring to the work of Perten (1990), we can say that in organic method, and in decreasing order, the varieties Jnah Khortifa, Hamira, Biskri, Badri, INRAT69, Chili, Swabaa Algia, Nasr, Om Rabia and Maghrebi have a balanced gluten reflecting good technological value. In effect, the gluten proteins (prolamins), with their spiral and elastic structures, giving the soft bakery products and excellent cooking. It is well known that a deficient gluten in semolina has negative consequences on the rheological properties and hydration of the pastes obtained. For varieties Ben Bechir, Khiar, Karim, and Razzak, gluten is soft, extensible and inelastic implies little technological value. In fact, and as was previously planned and announced, varieties with high protein content (Jnah Khortifa, Badri Chamira, Chile and INRAT69) are suitable for good behavior to make pasta or couscous. This is confirmed by their balanced gluten. Moreover, He & Hosenev (1992) report that the elasticity and extensibility of gluten wheat semolina are determined by the quantity and quality of protein.

Discussion

The combined analysis of the four growing seasons showed that Khiar (improved variety), Ben Bechir and INRAT69 (old varieties) had the best grain yield potentials in organic agriculture with 2.47, 2.46 and 2.44 t / ha respectively. These varieties may be promising to be conducted in organic method because they showed a great aptitude to accommodate in terroirs and climatic conditions vary widely. Finally, the grain quality of the fourteen varieties from organic and conventional production was also determined. The analysis revealed that the variety INRAT69 has better quality than Ben Bechir especially protein content (14.19 and 10.67% / FM respectively), amino acids (12.86 and 10.14 g/100 g FM respectively) and gluten index (77.32 and 38.86% respectively). These characteristics are considered support for organic farmers to choose and conduct the variety INRAT69 guaranteed since both a satisfactory yield with good quality. This variety could be recommended to making organic pasta and couscous and even bread, since it showed good baking quality.

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