AGRONOMIC CHARACTERISTICS OF EMMER WHEAT VARIETIES

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ABSTRACT

Production parameters (number of productive tillers per m², stem length, weight of grains per spike, TGW, share of glumes and yield) of four emmer wheat varieties – Aegone, Farvento, Molise sel Colli, Guardiaregia cultivated under the conditions of organic farming system in the south region of the Slovak republic during 2010 – 2011 and 2011 – 2012 growing seasons were evaluated. Weather conditions during experimental years showed higher influence on selected production parameters than tasted varieties. Statistical analysis confirmed significant differences between varieties only in parameters: weight of grains per spike and TGW. The average theoretical yield of emmer wheat varieties was 7.09 t/ha, TGW averaging about 47.67 g, average weight of grains per spike was 1.63 g. The stem length varying from 84.78 cm to 87.65 cm, average share of glumes was 28.16 %. Numbers of productive tillers was averaging about 445 per m². Generally spoken, emmer wheat varieties are suitable for organic farming from the point of its morphological features.

Keywords: Emmer wheat varieties, organic farming system, production parameters

INTRODUCTION

Production of healthy foodstuffs and elimination of negative effects of the farming on the environment are the main purpose of the organic farming system. As the organic farming is limited by a lot of legislative regulations the use of supportive instruments (e.g. soluble nitrogenous fertilizers, pesticides, etc.), the efficiency of growing of cereals decreases. Therefore, organic farmers aim to take advantage of a wide diversity of cultural crops and find such crops able to provide a sufficient yield rate and good – quality products, even if grown in low – input conditions. Wheat genetic resources do not usually manage to achieve the productivity of modern bred dominating cultivars (Edhia et al., 1991; Konvalina et al., 2010). In spite of this fact farmers are interested in them because landraces are less demanding and more adaptable to the environmental conditions. They provide lower but more stable yield rate (Collins, Hawtin, 1998). In organic farming, yield is much more influenced by the interaction of genotype and environment than in conventional farming. Therefore, an evaluation of the suitability of a variety for a certain environment should be ideally carried out under the local conditions (Moudry, 2003). According to Wolfe (2002), varieties suitable for organic farming are characterized by good absorption of nutrients, high competitiveness to weeds, resistance to diseases and pests and the required qualitative and quantitative parameters of production. The tetraploid emmer wheat – *Triticum dicoccum* (Schrank) Schuebl – is one of the crops considered suitable for low – input and organic farming systems where modern conventional varieties are not able to develop its production potential very well because they had been selected for different land and climatic conditions. It is one of the hulled wheat species which have been grown and uses as a part of the human diet for a very long time (Marconi, Cubadda, 2005). As people are paying more attention to the diversity and good quality of food products, they have become more interested in this cereal species (Hammer, Perinno, 1995). Emmer wheat landraces have a number of advantages which assure them an important place in the interest of farmers and consumers: they are resistant and tolerant to drought, the roots system are able to better absorb nitrogen (Trčková et al., 2005). The emmer wheat is a suitable alternative crop to the durum wheat, which has similar characteristics and is suitable for low – input and organic farming system (Konvalina et al., 2011).

This paper presents the results of a study of influence of growing season and varieties on production parameters (the number of productive spikes, stem length, the weight of grains per spike, the weight of thousand grains – TGW, share of glumes and theoretical yield) of selected emmer wheat varieties grown under the conditions of organic farming in the south Slovakia.

MATERIAL AND METHODS

A field stationary experiment was carried out at the Research Experimental Station of the Slovak University of Agriculture in Nitra situated in south region of Slovakia near village Dolná Malanta (48°19′N, 18°07′E). Field experiments were establishment during 2010 – 2011 and 2011 – 2012 growing seasons on a Haplic Luvisol developed at proluvial sediments mixed with loess. The altitude of experimental base is 178 meters above sea level. Experimental location has continental climate, belongs to warm agro – climatic region, arid subregion with predominantly mild winter with average long – term (1961 – 1990) annual precipitation 532.5 mm, for a vegetative period 309.4 mm. The average long – term temperature is 9.8°C and for vegetative period it is 16.4°C. The field trial was ordered into randomized blocks (the average plot size was 10m²) in three repetitions. Pre – crop was pea. Emmer wheat was cultivated in organic farming system without fertilization and any chemical treatment. Production parameters were analyzed in four varieties of emmer wheat – Aegone, Farvento, Molise sel Colli, Guardiaregia in three repetitions. The production parameters – the number of productive spikes (pc), the stem length (cm), the weight of grains per spike (g), the weight of thousand grains – TGW (g), share of glumes (%) and theoretical yield (t/ha) were determined. Theoretical yield was determined as weight of grain in spike x number of spikes per area unit. Parameters the weight of grains per spike, TGW and yield were recalculated to a humidity of 14%. The achieved data were statistically evaluated by STATISTIC 7.0. by using multifactor analysis of variance (ANOVA). Significant differences were evaluated by Fisher’s least significant difference (LSD) test at P < 0.05.
RESULTS AND DISCUSSION

Results of a two – year evaluation of production parameters are shown in Table 3.

Number of spikes per m²

Emmer wheat varieties were characterized by 445 pieces of productive tillers per m² in average (Table 3). Agnone variety was characterized by the highest number of productive tillers per m² (468 pcs). When concerned year of growing, significantly the highest number of productive tillers per m² was found in 2011 (496 pcs) compared with 2012 (394 pcs). Since the seeds were sown equal in each plot, the spikes per m² were affected by germination rate and tillering capability. Pagnotta et al. (2009) noted that the number of spikes per m² had a wide range and varying from 233 pcs to 498 pcs, with an overall average of 319 spikes per m². It was interesting to note the non – significant differences among replications indicated that, in the same macro environment (year and location), the germination rate and the tillering capability were about the same within each accession. According to Troccoli et al. (2005) the “Farro” best fitted to the environmental conditions of south Italy, in regard to yield, higher grains weight and a great number of spikes per square meter. Emmer wheat reached 442 numbers per m², einkorn had 419 spikes per m² and spelt wheat had 354 spikes per m². Results are in agreement with Codinni et al. (1996) and Troccoli et al. (1997), which found that emmer had under the same environmental conditions, the best performance in comparison to einkorn and spelt. Marino et al. (2011) found out the number of spikes per m² increased as the N rate increased. Nitrogen fertilization increased the number of spikes per m² linearly: about 30% for N10, 74% for N20 and 90% for N30.

The weight of thousand grains

As mentioned above emmer wheat varieties were characterized by 445 pieces of productive tillers per m² in average, where spikes contained more than 36 grains with the weight of 1.63 g in average. The weight of grains per spike is also characterized as the yield component and could predict the wheat production. This quantitative parameter was significantly depended on variety. Significantly the highest weight of grains per spike – 1.88 g was achieved by Guardiaregia variety. The remaining three varieties had lower weight of grains per spike – 1.59 g (Agnone), 1.53 g (Farvento) and the lowest weight of grains per spike had Molise sel Colli (1.50 g). Konvalina et al. (2010) noted that the weight of grains per spike of spring emmer wheaat plant (0.8 g) reached a half weight of grains in the spikes of the check plant – intermediate bread wheat (1.6 g). The lower weight of grains in their spikes than the weight of grains in the spikes of the check varieties should be compensated for by a higher number of productive tillers.

The weight of thousand grains

The weight of thousand grains (TGW) is an important yield forming parameter. It is indicating seed dimension, which in hulled wheat is usually small. TGW averaging for emmer wheat about 47.67 g. Statistical evaluation of TGW indicated statistically significant influence of the variety. Significantly the highest TGW was observed in Guardiaregia (54.45 g) and the lowest in Molise sel Colli (44.84 g). Weather condition had no significant influence on TGW. Most literature reports for TWG of winter emmer values similar to the presented data. TGW of Italian grown winter landraces varied between 19.1 and 55.8 g (Gallerio et al., 2003; Pagnotta, 2004). Also the results of Jantsch and Trautz (2001) for German grown emmer are in the same range (40 – 50 g) (Mondini et al., 2014). Significantly higher TGW are reported for north Spanish emmer wheat landraces by Oliveira (2001), who measured a mean TGW of 65.4 g. Konvalina et al. (2008) noted that TGW of spring landraces is by 10 g lower (33 g) than TGW of the spring modern varieties (45 g). Generally, spring emmer accessions showed lower grains weights than winter types (Mondini et al., 2014). Marconi and Cubadda (2005) stated the same figures, they indicated TGW varying between
30 – 45g and they emphasised it was influenced by the genotype and environment. The TGW of emmer wheat cultivar was lower than that of the modern common and durum wheat cultivars. According to De Vita et al. (2006) landraces had the lowest TGW (37.5 g) higher TGW reached genotypes selected from landraces (T. dicoccum) and the highest TGW reached modern cultivars (e.g. Agnone or Padre Pio (44.2 g). Only one genotype (PLV 12) obtained by selection from landraces showed similar value (45.6 g). The results of Mondini et al. (2014) for thousand grains weight of winter emmer accessions analysis of variance showed highly significant environmental and genotypic effects. In contrast to yield, TGW was stable over environments and no serious cross – over interactions was observed.

Yield

Italian authors present yields for emmer landraces ranging between 0.65t/ha and 6.10t/ha (Galterio et al., 2003; Pagnotta et al., 2009). Theoretical yield in our research was varying between 6.54t/ha (Morile sel Colli) to 7.66t/ha (Guardiaregia). Variety had no significant influence on yield. Statistical evaluation of yield indicated statistically significant influence of the weather conditions. When compared the years of growing, significantly the lowest yield was found in 2012 (6.03 t/ha) when compared with 2011 (8.16 t/ha). Mondini et al. (2014) noted the highest yield was reached in the environments, which received also the highest rates of N fertilizer, while the lowest yields were observed in the environment with low N input trials. Despite the increase of yield with increasing N fertilization, a significant levelling off was observed; locality with fertilization 107 kg N ha⁻¹ had yield variation with N fertilization 35 kg N ha⁻¹ by only 0.03t/ha⁻¹. It is supposed that emmer wheat is not suitable for too high N fertilization rates. Most probably high input of N will result in severe lodging, resulting in ear breakage and poor grain filling and therefore, yield loss. Under Italian conditions yields of emmer are comparable to those of spelt wheats, which ranged between 1.6 to 5.50t/ha (Galterio et al., 2003). Bulinska – Radomska et al. (2006) conducted a survey where in seven certified organic farms of central and northern part of Poland, field performance and yielding potential of emmer were studied. Yield of winter emmer wheat cultivars were ranging from 0.75t/ha⁻¹ to 4.99t/ha⁻¹. According to Konvalina et al. (2007) when compared theoretical yield of varieties of emmer wheat and modern varieties, found out the average theoretical yield (weight of grain in spike x optimal number of spikes per area unit) reached 3.78t/ha⁻¹, therefore, 72.4% of theoretical yield of modern varieties.

The share of glumes

Emmer wheat is hulled wheat species in which grain is strongly closed in glumes. Typical emmer character is high share of glumes. It is believed that higher share of glumes played an important role by protecting the grain against negative influences of the environment. Emmer wheat varieties cultivated without fertilization and any chemical treatment achieved results reflect the adaptability of this ancient hulled wheat to growing conditions as well as good resistance against weeds and diseases. Share of glumes varied during 2010 – 2012 growing seasons between 26.56% (2011) and 29.77% (2012). Statistical evaluation of share of glumes indicated statistically significant influence of weather conditions (Table 3). The variety did not affect this parameter. The highest share of glumes had variety Triticum dicoccum Schroeder (26.81%). Konvalina et al. (2011) found out share of glumes to grains varied between 72.63% and 78.75% in the case of the emmer wheat landraces. It means share of glumes varied between 21.25% and 27.37%.

The length of stem

Important factor according to lodging resistance is the length of stem. In more dry conditions of southern Slovakia, as compared with Western Europe, the stem length of emmer wheat ranged from 84.78 cm (einkorn) to 110 cm (durum wheat). According to our results the length of stem (2006) was ranging from 84.78 cm (einkorn) to 110 cm (durum wheat). Mean data for modern common and durum wheat cultivars was 112 cm. Landraces (109 cm) and genotypes selected from landraces (112 cm) were generally tall then modern cultivars (mean 94cm). Troccoli et al. (2005) compared plant height of three hulled wheats – spelt, emmer and einkorn during 1995 – 1996 growing seasons. The highest plant was emmer with an average height of 127 cm, lower was einkorn with an average height of 116 cm and the lowest was spelt (112 cm). They found out that seeding rate had significant influence on height of plant. The lowest seeding rate (100 seeds per m²) resulted in significant increase of plant height (120 cm) compared with seeding rate 200 seeds per m² (117 cm). Konvalina et al. (2010) mentioned the mean height of variety T. dicoccum (einkorn, spelt) were very long (112.7 cm on average), but 25% of them were longer than 125 cm. The shortest was einkorn – 101 cm on average, emmer had 107 cm and spelt 112 cm on average. The plants were long enough to be able to compete with weeds, but on the other hand, the long plants were more inclined to lodging.

Conclusions

In our study were analysed agronomic properties of four emmer wheat varieties cultivated in organic farming system in the south region of Slovak republic. Weather conditions during experimental years showed higher influence on selected production parameters than tasted varieties. Statistical analysis confirmed significant differences between varieties only in parameters: weight of grains per spike and TGW. Guardiaregia variety had the highest theoretical yield, weight of thousand grains and weight of grains per spike but the lowest number of productive tillers per m². The highest number of productive tillers per m² had Agnone variety with theoretical yield 7.40 t/ha. The average yield of emmer varieties was 7.09t/ha. TGW averaging about 47.67 g and average weight of grains per spike was 1.63 g. Generally spoken, emmer wheat is suitable, advantageous and profitable crop when cultivated in marginal areas and under conditions of sustainable and organic agriculture, where modern wheats are unable to develop their full productive potentials because they have been genetically selected for favourable pedoclimatic and agromonic conditions. It is only under these conditions that emmer cultivation is justified and its agronomic performance – yield becomes profitable with respect to modern free – threshing wheats.

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