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2013

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Dry matter accumulation in the varieties of wheat (*Triticum aestivum* L.) according to previous crop

A. Ivanova*, N. Tsenov

Dobrudzha Agricultural Institute, 9520 General Toshevo, Bulgaria

**Abstract.** The constant interest in common wheat investigations is determined by the main share this crop has in agriculture and by the unique properties it possesses. This investigation was carried out under field conditions for a three-year period (2009 – 2011) in the trial field of Dobrudzha Agricultural Institute – General Toshevo (DAI). The trial was designed according to the split plot method in four replications, the size of the trial plot being 12 m². Five common wheat genotypes developed at DAI were subjected to investigation (Iveta, Enola, Pryaspa, Bolyarka, Dragana). The trial involved four previous crops: oilseed rape, pea, sunflower and maize, and three norms of mineral fertilization depending on the type of previous crop. Fertilization with phosphorus and potassium was used as a background (P₉K₉). nitrogen was tested at the following fertilizer norms: N₀, N₆, and N₁₂ kg/ha after previous crops oilseed rape, sunflower and maize, and N₀, N₆, and N₁₂ kg/ha after pea, with check variant N₉P₉K₉. The effect of the type of previous crop on dry matter accumulation in the investigated common wheat varieties was analyzed. It was found that dry matter accumulation continued throughout the entire growth season, the year conditions being decisive for its amount. Dry matter accumulation during the individual stages of growth and development was specific for each investigated cultivar. The investigated cultivars accumulated higher total biomass than the standard Pryaspa. After the early previous crops (oilseed rape and pea), the amounts of dry matter formed were higher at the end of the growth period (after heading). After the late previous crops (sunflower and maize) the new wheat varieties formed higher total biomass as early as the beginning of spring growth. After predecessor pea the highest amounts of dry matter were formed.

**Keywords:** wheat, previous crop, dry matter, accumulation

**Introduction**

Primary data on the accumulation of both dry matter and N at various growth stages are necessary to understand the processes of assimilation and partitioning of C and N in the context of plant growth and development (Corbellini and Bordghi, 1985; Cox et al., 1985; Papacosta and Gagianas, 1991; Dordas, 2009).

The relative importance of current assimilation and remobilization changes among genotypes is strongly related to agricultural factors (Éhdaie and Waines, 2001; Sabet et al., 2009). Moreover, in durum wheat stem carbohydrate reserves have been estimated to contribute 25% to 34% of the final grain yield under optimal growing conditions, while under drought or heat stress these parameters are expected to be greater (Arduini et al., 2006; Pampana et al., 2007; Ercoli et al., 2008). Research on comparison of the old and modern cultivars was mostly aimed at above ground dry matter, grain yield and its components (Charment et al., 2005). The higher biological potential of the grain yield of modern cultivars is attributed to plant height reduction and increasing biomass distribution into grain what was manifested in rapid increasing of the harvest index (Nankova et al., 2005; Pepo, 2005; Weisz et al., 2007). Sources of assimilates for grain formation can come from current assimilation from anthesis to maturity, but also from assimilates produced till anthesis and temporarily accumulated in vegetative organs (Uzik and Zořáfova, 2007; Fang et al., 2010).

The aim of this investigation was to determine the main effect of various previous crops on the accumulation of dry matter in the new common wheat genotypes in different phases of their ontogenetic development.

**Material and methods**

The investigation was carried out during 2009–2011 in the trial field of Dobrudzha Agricultural Institute – General Toshevo. Five common winter wheat varieties, developed in Dobrudzha Agricultural Institute, were studied, as follows – Iveta, Enola, Pryaspa, Bolyarka, Dragana. Pryaspa variety is used as a standard. The trial was designed by the split plot method in 4 replicates, the trial area being 12 m². The sowing was planned during the optimum for the region agricultural term with sowing norm 500 germinating seeds/m². The investigated genotypes were sown after four previous crops – rape, peas, sunflower and grain maize. The study included three levels of fertilization. Mineral fertilization was applied according to the type of the previous crop. Fertilization with phosphorus and potassium was background (P₉K₉) kg/ha and nitrogen fertilizer was tested at the following rates: N₀, N₆, and N₁₂ kg/ha after rape, sunflower and grain maize, N₀, N₆, and N₁₂ kg/ha after peas, with check variant N₉P₉K₉. Dry matter yield was determined separately by organs and as a sum in total biomass in t.ha⁻¹ in different phases of individual development of the studied varieties. The occurrence of phenological phases is registered by the scale of Zadoks et al. (1974):

- 26-29 – tillering
designated I phase
- 34-36 – stem elongation II phase
- 57-59 – heading III phase
- 69 – 10 days after heading IV phase
- 73 – 20 days after heading V phase
- 83 – 30 days after heading VI phase
- 94-95 – ripening VII phase

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The data were processed by analysis of the variance (ANOVA) and analyzed with Statistica 7. The means were compared using the LSD test. Dry matter yield of the new genotypes Iveta, Enola, Bolyarka and Dragana was calculated in percentage of standard Pryaspa.

Results

Wheat productivity is determined to a high extent by the accumulation of dry matter in the plant parts. The results from the multi factor analysis revealed that the main factors determining the formation of dry matter were the growth stage and the year conditions (Table 1). During the separate stages of their individual multi factor analysis revealed that the main factors determining the accumulation of dry matter in the plant parts. The results from the LSD test and analyzed with Statistica 7.

Table 1. ANOVA – main effects of factors

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig. (p-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrected Model</td>
<td>18</td>
<td>62756841.150</td>
<td>713.159</td>
<td>0.000</td>
</tr>
<tr>
<td>Intercept</td>
<td>1</td>
<td>3120802952.562</td>
<td>35464.333</td>
<td>0.000</td>
</tr>
<tr>
<td>Phase</td>
<td>6</td>
<td>135308591.554</td>
<td>1537.626</td>
<td>0.000</td>
</tr>
<tr>
<td>Variety</td>
<td>4</td>
<td>520808.974</td>
<td>5.918</td>
<td>0.000</td>
</tr>
<tr>
<td>Previous crop</td>
<td>3</td>
<td>613905.093</td>
<td>6.976</td>
<td>0.000</td>
</tr>
<tr>
<td>Fertilization</td>
<td>3</td>
<td>11190098.421</td>
<td>127.163</td>
<td>0.000</td>
</tr>
<tr>
<td>Year</td>
<td>2</td>
<td>140138172.467</td>
<td>1592.509</td>
<td>0.000</td>
</tr>
<tr>
<td>Error</td>
<td>3341</td>
<td>87998.354</td>
<td>87998.354</td>
<td>3360</td>
</tr>
</tbody>
</table>

The mean amounts of dry matter formed by the investigated wheat genotypes were different (Table 2). By their mean values, the varieties can be divided into separate statistical groups. Averaged for the entire growth period, variety Pryaspa formed the lowest total biomass. Varieties Iveta and Enola accumulated similar amounts of dry matter. Variety Dragana was referred to a separate group and variety Bolyarka demonstrated maximum amount of total biomass.

The type of previous crop also affected dry matter accumulation. Table 2 shows the mean amounts of total biomass depending on the type of previous crop, the other factors being presented as mean values. This trait clearly distinguished grain maize as a predecessor after which the investigated varieties accumulated the lowest total biomass, from peas, after which the formed total biomass reached a peak. Oilseed rape and sunflower had intermediate position, although sunflower accumulated more dry matter. The role of the previous crop has been considered in our previous investigations on wheat productivities, as well (Ivanova and Tsenov, 2010; Ivanova et al., 2011; Ivanova and Tsenov, 2012).

Table 2. Dry matter accumulation according to varieties and previous crops (t ha⁻¹)

<table>
<thead>
<tr>
<th>Variety</th>
<th>Previous crop</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pryaspa</td>
<td>Grain maize</td>
</tr>
<tr>
<td>Enola</td>
<td>Rape</td>
</tr>
<tr>
<td>Iveta</td>
<td>Sunflower</td>
</tr>
<tr>
<td>Dragana</td>
<td>Peas</td>
</tr>
<tr>
<td>Bolyarka</td>
<td>1.006*</td>
</tr>
</tbody>
</table>

* Values with the same letter do not differ significantly

Discussion

Dry matter accumulation in winter wheat occurs till the end of the growth season but is the most intensive during the period from permanent spring vegetation till heading. The plants enter the period of spring vegetation with different contents of dry matter depending on the conditions during the preceding autumn and winter (Panayotova, 2004; Pepo, 2005). According to Gospodinov (1988) at tillering stage the growth and development of plants are more intensive after early previous crops (bean and wheat). Thus after previous crop oilseed rape varieties Bolyarka and Dragana formed higher total biomass at the beginning of spring vegetation in comparison to the standard Pryaspa, while varieties Iveta and Enola had significantly lower values (Figure 1). The maximum of accumulated dry matter of varieties Enola, Bolyarka and Dragana occurred 10 days after heading, and of variety Iveta it was 30 days after heading. From the beginning of spring vegetation till heading the new wheat cultivars accumulated total biomass similar to that of the standard. Variety Bolyarka formed markedly higher amounts of total biomass during the entire growth period as compared to the standard Pryaspa.

The investigated varieties accumulated different amounts of dry matter after previous crop pea (Figure 2). At the beginning of spring vegetation (Phase 1) the genotypes formed lower total biomass in comparison to the standard, with the exception of Bolyarka. With the progress of the growth season the new wheat varieties as a rule accumulated higher amounts of dry matter. Bolyarka and Enola reached a maximum at full maturity (phase VII), while variety Dragana marked a maximum 30 days after heading (phase VI). Variety Iveta was characterized by constant weight of the total biomass after heading. Cultivar Bolyarka was forming higher amounts of dry matter than the standard during the entire growth season.

According to Gospodinov (1988), the rate of organic matter accumulation is a little slower after sunflower and maize. After previous crop sunflower, the investigated varieties accumulated less dry matter than the standard at the beginning of spring vegetation (phase I) (Figure 3). In their further development (phases II, III and IV) Iveta, Enola and Bolyarka exceeded Pryaspa and formed total biomass many times higher than the standard, while at the end of the growth period (phases V and VI) these amounts became lower and closer to the standard. Iveta, Enola and Bolyarka reached a maximum at the second phase. At full maturity all cultivars accumulated more dry matter. Variety Dragana exhibited an interesting behavior by increasing its total biomass and reaching a maximum 10 days after heading (phase IV).

After previous crop maize dry matter accumulation was also variable in the respective varieties (Figure 4). At the beginning of
spring vegetation (phases I and II) they formed an amount of total biomass many times higher than the standard, while at heading stage these amounts sharply decreased. At the next stage, 10 days after heading (phase IV), varieties Bolyarka and Dragana, and 20 days after heading (phase V) varieties Iveta and Bolyarka formed more total biomass than Pryaspa. Thirty days after heading (phase VI) all genotypes again exceeded the standard by accumulated dry matter.

In spite of the high variation of the investigated trait as a result of the complex multi factor field trial, it was proved that each of the investigated cultivars accumulated specific amounts of biomass in each individual stage in direct relation to the previous crop. This direct effect was the reason for the different ratios of biomass between the varieties at each stage and between the stages within the same previous crop.

After the early previous crops oilseed rape and peas, dry matter accumulation in the varieties was similar to the model variety Pryaspa (with the exception of variety Bolyarka), then gradually increased to reach a maximum 10 days after heading (phase IV). At this phase all varieties had more dry matter than the standard. Variety Dragana was an exception, having significantly less dry matter than Pryaspa at phases I and II, but at phase IV already
exceeded it many times. During the next phases (V-VI) the tendency remained more or less stable, with the exception of variety Enola at phases V and VI after oilseed rape. Variety Bolyarka demonstrated different behavior. During all phases after both previous crops it accumulated significantly more dry matter than the standard (Bourgeois and Entz, 1996; Anderson, 2008). Ratios between dry matter of the varieties and the standard varied strongly over phases (Rieger et al., 2008; Zhemela and Kurochka, 2012).

After the late previous crops sunflower and grain maize, the amount of dry matter in the varieties over phases was analogous during the first four phases. The peculiarity here was that at the second phase the rate of accumulation was very intensive, while it became significantly slower in the third stage approximating the respective stages of growth and development was specific for each investigated variety. It is probably affected not only by the

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**Figure 3.** Dry matter accumulation after sunflower

**Figure 4.** Dry matter accumulation after grain maize

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investigated factors but also by the specific combinations of temperature and moisture reserves in soil during the respective seasons. The high significance of the factor year should be further analyzed in more details to more thoroughly clarify the dynamics of dry matter accumulation in each variety. Furthermore, the varieties were selected with differences in their earliness (early: Enola and Iveta; medium early: Bolyarka and Pryaspa; late: Dragana), and in their stem height (short-stemmed: Enola and Dragana; medium high: Bolyarka and Pryaspa; high-stemmed: Iveta). Although it was not discussed here, this inevitably affected dry matter accumulation. Variety Pryaspa, which is used as a standard of productivity, can be involved as a model cultivar in similar investigations in the future as well.

**Conclusion**

Dry matter accumulation continued throughout the entire growth period, the effect of the year conditions being decisive for its amount. During their growth period, the new varieties Iveta, Enola, Bolyarka and Dragana accumulated higher total biomass than the standard Pryaspa.

After the early predecessors (oilseed rape and pea), the amounts of formed dry matter were higher at the end of vegetation (after heading), being maximum after peas. After the late predecessors (sunflower and maize), the new wheat varieties formed higher total biomass as early as the beginning of spring vegetation.

**References**


Panayotova G, 2004. Dry matter accumulation in durum wheat variety Progress depending on the level of nitrogen nutrition. Field Crops Studies, 1, 2, 305-311.


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Conclusion: The most important consequences for the science and practice resulting from the conducted research should be summarized in a few sentences. The conclusions shouldn’t be numbered and no new paragraphs be used. Contributions are the core of conclusions.

References: In the text, references should be cited as follows: single author: Sandberg (2002); two authors: Andersson and Georges (2004); more than two authors: Andersson et al. (2003). When several references are cited simultaneously, they should be ranked by chronological order e.g.: (Sandberg, 2002; Andersson et al., 2003; Andersson and Georges, 2004).

Acknowledgements (if any), References, Tables, Figures.

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