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Some Growth Traits and Durum Wheat Production

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Abstract

Durum wheat production in our environmental conditions is realized by the diffusion of cultivars with high adaptability to environmental stresses. Some of the traditional cultivars posses this characteristics, but they have low productivity, even in favorable conditions. On the other hand, the durum wheat cultivars, created these last years, have high productivity compared with the traditional ones. But sowing these new cultivars in traditional environments, is associated with some problems, because they are considered as cultivars with high demands in relation to growing conditions. These new cultivars, anyhow, have a physiological construction suitable to response better in different environments.

The aim of this study was to determine eventual changes in dry matter accumulation and size of leaf area, and to determine the influence of NAR, LAD, G/LAD, HI values on grain production of four durum wheat genotypes. According to the achieved results, it was evident that the above mentioned physiological traits, have influence on plant productivity. The values of LAI, LAD and G/LAD after heading had higher effect on productivity. Some of the studied genotypes (Valforte, 5/11-1) realize their productivity due to high values of LAD, while some others (Creso, N-24) due to better values of G/LAD. Finally, cultivars (or genotypes) like 5/-11-1, with high values of LAD after heading are suitable for optimal environments, while cultivars with short vegetative period, small values of LAD, LAI, and with high values of G/LAD like N-24 are suitable for limited environments

Keywords: cultivar, dry matter, environment, genotype, harvest index, physiological traits.

1. Introduction

In suitable conditions, all living organisms, may be grown and developed in size and structure. These processes are an important part of the plant life cycle and along with natural systems, they might contribute to distinguish living and non-living organisms [4]. Even for living organisms, it is not easy to give a right definition of “growth”. Growth is a vital function of plants and indicates the gradual increase in number and size of cells. The processes of growth and development are considered to begin with germination, followed by large complex series of morphological and physiological events [18].

The plant physiological definition of growth is an irreversible increase in mass, weight or volume of a living organism, organ or cell. The growth and development of wheat occurs during two main periods, named vegetative and reproductive period. The first period is characterized by formation of a large number of tillers and leaves, the second one which is characterized by the heading, signifies the end of rapid growth phase and indicates onset of flowering. This phase is marked by a reduction in growth rate until growth ceases at maturity. The stored assimilates in plant leaves and stems, are redistributed to partially sustain seed growth. At the end of this growth period, water is lost from aerial plant parts, photosynthesis stops and crop ripens. For each of these two periods, plant requires different environmental conditions [1,3].

Durum wheat production in our environmental conditions is realized by the diffusion of cultivars with high adaptability to environmental stresses. Some of the traditional cultivars posses these characteristics, but they have low productivity, even in favorable conditions. On the other hand, the durum wheat cultivars, created these last decades, have high productivity compared with the traditional ones. But sowing these new cultivars in traditional environments, is associated with some problems, because they are considered as cultivars with high demands in relation to growing conditions. These new cultivars, anyhow, have a physiological construction suitable to response better in different environments [20].

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Grain yield is a complex multi component character and is greatly influenced by various environmental conditions. Various morphological and physiological characters contribute to grain yield [1,2,17]. Each of these component characters has its own genetic systems. Further these yield components are influenced by environmental fluctuations [9,11,16]. Zajac et al. (2005) found a positive relation between dry matter yield and growth indices like CGR and LAD [22]. Also, other authors reported that rice grain yield can be increased by selection on the basis of physiological growth indices like LAD, CGR, relative growth rate (RGR) and net assimilation rate (5,7).

Plant growth analysis is considered to be a standard approach to obtain a deeper knowledge of plant growth and productivity [14]. Knowing the plant growth and development principles and physiological processes in durum wheat cultivars leaded to the evaluation of growth characters. Studies of growth pattern and its understanding, not only tell us how plant accumulates dry matter, but also reveal the events that can make a plant more or less productive as an individual plant or as a plant population [3,13]. The growth parameters like optimum LAI, LAD and NAR at flowering have been identified as the major determinants of yield [6,11]. A combination of these growth parameters explains different yields better than any individual growth variable [5]. Growth processes i.e. CGR, RGR and NAR directly influenced the economic yield of plant (10). Other authors [8,15,16] emphasize that higher accumulation of dry matter, higher LAI, LAD during reproductive stages were closely related to high yield genotypes. Thakur and Patel (1998) reported that dry matter production, LAI, LAD, CGR, NAR and RGR are ultimately reflected in higher grain yield [17]. Tasfaye et al (2006) reported that attainment of high LAI that reduces soil water evaporation, intercepts and converts into dry matter more efficiently and improves the partitioning of dry matter to the seed [16,19]. That`s why it is a major requirement of a high seed yield in durum wheat grain in semiarid environments. The present study was taken up in newly developed lines of durum wheat for evaluation for their growth and yield to get better lines for higher crop productivity under Albanian conditions for future breeding programmers’ as there is very less research on physiological aspects on this crop.

2. Material and Methods

In this study are included four cultivars of durum wheat, two of them are cultivars created by former IKB Lushnje. The experiment was set up in Fushe Kruja ATTC, according to the randomized block scheme with three replications. The surface of each variant was 15 m2. From tillering stage until full maturity were conducted 10 measurements in 2009 and 12 in 2010, every 15 days from one to another. The measurements have been conducted in 10 plants in three replications. It's been calculated the leaf area, the wet and the dry weight, placing the plants in the thermostat at 60^0 C. temperature and from the above data were calculated the following indicators:

-LAI (Leaf area index)

-LAD (leaf area duration, m^2 / day). It is the function of duration of leaf area, and can be expressed as the average integral of duration of leaf area in m2 / day (4).

-NAR (net assimilation rate, g / m^2 / day)

-G / LAD, index of photosynthetic effectiveness after heading (4) is calculated as the ratio between the grain dry weight in the last measurement (G) and LAD's values after the heading and expressed in g / m2 / day (4,10)

- Hi (harvest index), expresses the ability of the plant to use the assimilates produced in the direction of useful grain production [12] and calculated as the ratio of grain production to biological production.

Data processing is performed by analysis of variance and validation of changes is based on Fisher's test

3. Results and Discussion

The dry matter accumulation. The dry matter accumulation express the potential opportunity of a cultivar for a particular product [3,21]. The data obtained show that the accumulation of dry matter has an exponential trend, where maximum value reaches at the end of the maturity milk stage and gradually diminishing to the physiological maturity. By cultivars of our study, more dry matter, accumulates L 5 / 11-1 and Valforte cultivar, compared with Creso cultivar and No.24. But the accumulation intensity of dry matter changes in two periods, germination-heading and heading- maturity. So in the first period the amount of dry matter is higher to No.24 and Valforte cultivar, while in the second period, this indicator is higher in L 5 / 11-1 and Creso cultivar (Figure 1).

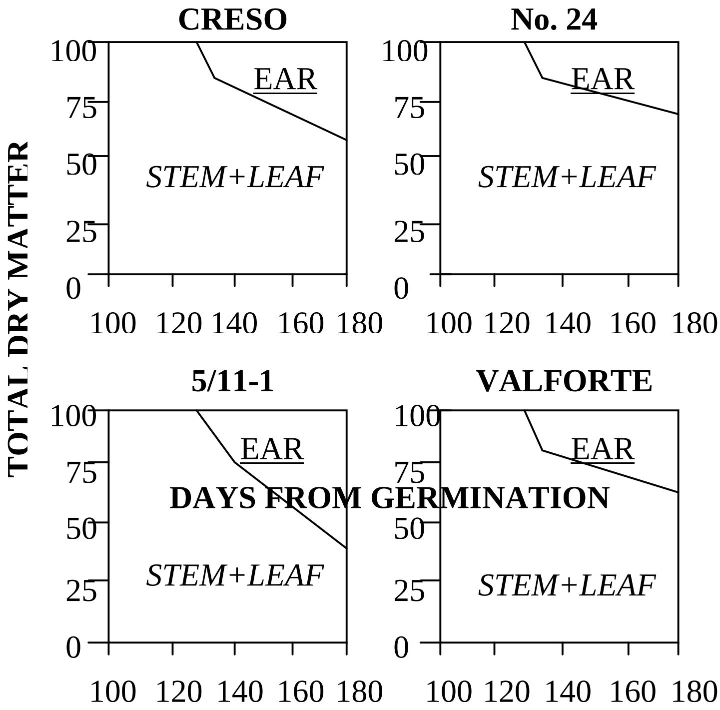

Figure 1. Ratio in % of total dry matter which occupy different parts of the wheat plant

This fact can be explained by architectural construction of plant in these cultivars, characterized by excessive vegetative growth in the first phase, which does not always leads to a higher yield. The cultivars 5 / 11-1 and Creso, have a higher effectiveness of the use of dry matter production in favor of grain production.

Leaf area index (LAI) and its duration (LAD). It's found a strong positive correlation between the accumulated dry matter and leaf surface index (0.9). For high values of LAI's can be distinguished L5 / 11-1 and cultivar Valforte, respectively 6.39 and 6.37. To create a better idea about the LAD's values in final production, its values are shown for two phenological periods (Table 1). During the period of germination - heading the highest values of LAD's have L-5 / 11-1 and Valforte cultivar, which, in above mentioned period can't be distinguished from the other cultivars for dry matter accumulation. Unlike occurs during the second period (heading – maturity). Higher values of LAD in these genotypes (in second period), express their higher production potential, which is realized for 5/11-1, while production of Valforte is not in the expected level, because it has a physiological defect that will be explained below.

Table 1. LAD's values before and after heading (m^2/day).

Cultivars	Values of LAD till heading			Values of LAD after heading		
	2009	2010	Average	2009	2010	Average
Creso	48.23	48.23	48.23	36.78	35.37	36.12
Nr. 24	46.73	42.63	44.68	32.56	30.20	31.38
5/11-1	59.20	55.00	57.10	42.20	38.87	40.43
Valforte	56.63	54.70	55.70	39.40	37.43	38.41
$D_{0.5}$	2.7	3.9	3.8	2.3	2.3	2.5
$D_{0.1}$	3.1	4.3	4.4	2.8	3.1	3.0

Net assimilation rate (NAR) and photosynthetic efficiency after heading (G /LAD). NAR is conceptualized as the ability of cultivars or lines to accumulate carbohydrates i.e. as their opportunities to provide higher production values . In cultivars and lines, where the NAR's values are higher and photosynthetic efficiency or economic production should be higher. On the Table No. 2, are evidenced that higher values of NAR, reached at L 5 / 11-1 and at Valforte, while lower values at Creso and Nr 24 cultivars. To have a better estimation for economic production are analyzed values of G / LAD after heading. It is more determining indicator than NAR, because it express more clearly the way of assimilates distribution during the second period (heading-maturity). For high values of this indicator are evidenced the L 5 / 11-1 and Creso (Table No.2). This is the reason why Valforte, despite other physiological indicators in higher value, gives a lower production than L 5 / 11-1 and Creso.

Table 2. NAR and G/LAD (g / m^2 per day) values

Cultivars	NAR's values			G/LAD's values		
	2009	2010	Average	2009	2010	Average
Creso	3.65	3.94	3.79	9.78	9.26	9.52
Nr. 24	3.48	3.75	3.61	8.67	8.91	8.69
5/11-1	3.79	4.15	3.97	10.29	9.24	9.76
Valforte	3.67	4.06	3.86	8.10	8.63	8.36
$D_{0.5}$	0.22	0.31	0.24	0.29	0.16	0.23
$D_{0.1}$	0.26	0.38	0.27	0.32	0.21	0.30

The harvest index (HI). The data for this indicator explain that L 5 / 11-1 and Creso have the highest harvest index, respectively with 40.45 and 40.36. The other two cultivars have lower values of this indicator due to the high biological production (high stem height).

Grain production and growth indicators. Line 5 / 11-1 and Creso cultivar had high grain production compared to the other two cultivars (Table No. 3). This ranking shows clearly the influence of growth indexes on production. In line 5 / 11-1 the grain production is related with LAD's values and photosynthetic effectiveness (G /LAD) after heading. In Creso cultivar, despite the LAD's values are smaller, the higher production was result of photosynthetic effectiveness after heading. In Valforte cultivar the production values are relatively lower due to the low photosynthetic efficiency after heading, (despite the high LAD). So, we can emphasize that the most powerful influence in cultivar production had LAD's values and ratio G / LAD

The above data show that the photosynthetic activity of the foliar apparatus and distribution of assimilates before heading constitute only the potential opportunity of plant production, while the degree of realization of this production, is determined by the reorganization of assimilates that synthesized after heading. So, analyzing the impact of growth indicators on the productivity of durum wheat, we may conclude that depending on the growth conditions, the analysis of growth indicators for each cultivar, constitutes an important factor to achieve the photosynthetic effectiveness of cultivars [8].

Table 3. The harvest index values and production g /100 plants.

Cultivars	Harvest Index (%)			Production (g/100 plants)		
	2009	2010	Average	2009	2010	Average
Creso	40.62	40.10	40.36	360.3	325.5	342.9
Nr.24	35.08	36.96	36.02	275.7	269.1	272.4
5/11-1	41.47	39.44	40.45	430.3	359.1	394.9
Valforte	32.35	36.78	34.65	318.3	323.1	320.7
$D_{0.5}$	2.3	2.4	2.6	34.5	28.7	36.9
$D_{0.1}$	3.1	3.5	3.4	38.7	33.8	41.4

4. Conclusions

- There are differences among genotypes in study for growth traits and final production. For higher production are distinguished the line 5 / 11-1 and Creso

- The high values of dry matter, LAI and LAD, during the germination - heading period, do not exert a significant impact on grain production, but these have a determinant effect in heading-maturity period.

- The most positive impact on grain production of "Valforte" and "5 / 11-1" genotypes, had the values of LAD's, while for "Creso" and "Nr. 24" , was photosynthetic effectiveness, which affect their production.

- On suitable conditions should be expended genotypes with high values of LAD' during heading - maturity period, as L-"5 / 11-1 and "Valforte", or with most photosynthetic effectiveness as " Creso "etc.

- Cultivars with short vegetative cycle and with small values of LAD and LAI, but with high photosynthetic effectiveness and with high ability for redistribution of assimilates in the grain (Nr 24) are more suited for areas with limited environments.

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