Evaluation of Photosynthesis Capacity of Some Winter Wheat Genotypes in Transylvanian Plain Conditions

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Abstract

Leaf photosynthetic capacity is a key parameter determining crop yield; it is enhanced by moderate soil moisture and reduced in both severe water deficit and excessive water conditions. The aim of this work was to evaluate the wheat variety photosynthetic capacity in two main phenological stages. The evaluation of photosynthesis capacity of studied winter wheat varieties in Transylvanian Plain conditions offer relevant information on Romanian genetic material type and paving the way of new research directed to a new wheat breeding program criteria and for improvement of those.

Key words: *plant phenology, photosynthesis, winter wheat*

Introduction

More than 90% of crop biomass is derived from photosynthetic products (Makino, 2011). The differences of photosynthesis processes between wheat varieties are determined by capacity and efficiency of those to converse the light energy into plant dry matter. Drought is one of most important environmental factors inhibiting photosynthesis and decreasing growth and productivity of plants. Wheat leaves, especially flag leaf, are important photosynthetic assimilation organs during a jointing stage and anthesis period (Jia et al., 2015). Leaf photosynthetic capacity is a key parameter determining crop yield; it is enhanced by moderate soil moisture and reduced in both severe water deficit and excessive water conditions (Xu and Zhou, 2011). The aim of this work was to

evaluate the wheat variety photosynthetic capacity in two main phenological stages.

Materials and Methods

The biological materials were composed of twelve representative Romanian winter wheat genotypes. Ear emergence (Zadoks 55-59) and kernel development (Zadoks 73-77) were the phenology stages established for measurement, being two main phenophases with high influence on final grain yield. The evaluation of wheat plant photosynthetic capacity were made based on measurement using a CIRAS-3 Portable Photosynthesis System (PP-Systems, Hitchin, UK) on five flag leaves under natural conditions with 390 $\mu\text{mol CO}_2 \text{ mol}^{-1} \text{ air}$ and 24–30°C from each experimental plot. All measurements were made

Table 1. Assimilation rate, transpiration rate, water use efficiency and stomatal conductance in relationship with grain yield during two main winter wheat phenophases

Genotype	Assimilation (P_n)		Transpiration rate (T_r)		Water use efficiency (WUE)		Stomatal conductance (g_s)		Grain yield ($t\ ha^{-1}$)
	Z. 55-59	Z. 73-77	Z. 55-59	Z. 73-77	Z. 55-59	Z. 73-77	Z. 55-59	Z. 73-77	
V 1	26.1	20.98	2.81	2.04	9.32	10.83	176.3	342.7	5.78
V 2	27.93	16.72	3.21	1.5	8.7	11.19	236.3	195.7	6.33
V 3	27.8	30.01	2.84	1.29	9.8	23.33	155.7	257.3	6.36
V 4	28.3	26.93	5.82	0.78	4.87	37.76	412	181	5.82
V 5	35.27	23.12	3.31	1.27	10.67	23.25	260	196.7	5.94
V 6	37.3	28.9	6.71	0.93	5.56	31.42	520.3	177	5.82
V 7	29.93	23.17	6.03	0.77	4.96	36.44	519	195.9	6.03
V 8	38.77	14.57	6.57	1.49	5.9	9.72	423	240.6	6.34
V 9	34.63	19.48	6.65	1.37	5.9	14.76	371	254.4	6.42
V 10	35.97	18.36	2.95	1.39	12.18	13.08	225.7	164.1	6.73
V 11	39.2	22.02	3.12	1.85	12.57	13.88	238	267.7	5.32
V 12	39.2	23.63	3.13	1.49	12.51	16.96	252	375.8	5.71
Mean	33.37	22.32	4.43	1.35	8.58	20.22	315.8	237.4	6.05
CV	14.98	21.10	38.83	28.89	35.31	50.05	40.47	28.16	6.48
St. dev.	5.00	4.71	1.72	0.39	3.03	10.12	127.80	66.86	0.392

between 9:00 and 11:00 on days with natural full sunlight.

Results and discussions

The behaviour regarding the photosynthesis parameters of wheat genotypes during the two main phenophases highlights significant differences. The photosynthesis capacity before anthesis stage indicate a high activity (assimilation rate, transpiration rate and stomatal conductance) compared with the post anthesis measurement. The high intensity values of photosynthetic activity before anthesis can be explained by unfinished process of vegetative stages, when the biomass accumulation needs more energy such as transport of nutrients and respiration, meaning about only 10-15% is allocated to yield. During the ear emergence stage the plant physiological parameter were higher than grain filling period, except WUE which range at kernel development stage. The assimilation values at ear emergence stage were between 26.1 at the first genotype to 39.2 $\mu\text{mol CO}_2\ \text{m}^{-2}\ \text{s}^{-1}$ by V_{11} and V_{12} , while at kernel development stage the variation of this parameter were between 14.57 by V_{14} and 30.01 $\mu\text{mol CO}_2\ \text{m}^{-2}\ \text{s}^{-1}$ at third genotype studied. Transpiration rate mean values range from 1.35 $\text{mmol H}_2\text{O}\ \text{m}^{-2}\ \text{s}^{-1}$ at kernel development stage to 4.43 $\text{mmol H}_2\text{O}\ \text{m}^{-2}\ \text{s}^{-1}$ at spike emergence which highlights an intensive activity of plant dry matter accumulation on this vegetative stage. WUE is the only parameter whose

variation is amplified at the second studied stage, the mean value of those being 20.22 $\text{mmol CO}_2\ \text{mol}^{-1}\ \text{H}_2\text{O}$ at kernel development stages compared with 8.58 $\text{mmol CO}_2\ \text{mol}^{-1}\ \text{H}_2\text{O}$ at head emergence stage.

Conclusion

Based on the data from this study could have been highlight some performant winter wheat genotypes for physiological proprieties as a breeding material and can be established technical actions intervention to reduce the effect of unfavourable climatic influence. The evaluation of photosynthesis capacity of studied winter wheat varieties in Transylvanian Plain conditions offer relevant information on Romanian genetic material type and paving the way of new research directed to a new wheat breeding program criteria and for improvement of those.

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