Scientific Papers. Series A. Agronomy, Vol. LXIII, No. 2, 2020
ISSN 2285-5785; ISSN CD-ROM 2285-5793; ISSN Online 2285-5807; ISSN-L 2285-5785

MODIFICATION OF PHYSIOLOGICAL INDICATORS WHEN TREATING OIL-BEARING RAPESEED WITH SEVERAL FOLIAR FERTILIZERS, SOWN AT DIFFERENT TIME PERIODS

Zhivko TODOROV

Agricultural University of Plovdiv, 12 Mendeleev Blvd, Plovdiv, Bulgaria

Corresponding author email: jivko99999@abv.bg

Abstract

To determine the changes in the physiological parameters, a field experiment was implemented by plot method, repeated 4 times, with the size of the experimental plot of 20 m^2. The study was conducted in the area of the Training, Experimental and Implementation Base of the Plant Growing Department at the Agricultural University - Plovdiv. The purpose of this study is to provide data on the physiological parameters of winter oil-bearing rapeseed sown at different sowing times, treated with several foliar fertilizers. To achieve this, the following parameters were monitored: net photosynthesis rate (A), transpiration intensity (E), and stomata conductance (gs) determined by the portable photosynthetic system LCA-4 (Analytical Development Company Ltd., Hoddesdon, England). From the results obtained, it can be seen that the high values of net photosynthesis combined with moderate to high levels of transpiration in the tested variants were reported in the variants treated with Fertiactyl Starter.

Key words*: rapeseed, physiological indicators, net photosynthesis.*

INTRODUCTION

Drought is a factor that strongly influences plants throughout the various stages of their development (Yordanov et al., 2000; Wentworth et al., 2006). The effects of drought on the growth of different plants, the water-photosynthesis relationship, and adaptation mechanisms have been the subject of research by a number of scientists (Van den Boogard et al., 1997; Lutts et al., 2004; Zlatev and Cebola Lidon, 2012). One way of stimulating plant development and overcoming adverse climatic conditions in order to improve the values of these indicators is by using foliar fertilizers (Ivanova and Todorov, 2020; Todorov and Ivanova, 2020).

So a task was set: to track the physiological indicators, net photosynthesis, stoma conductance and transpiration intensity of rapeseed sown at different sowing times treated with several foliar fertilizers.

MATERIALS AND METHODS

The study was conducted in the period 2012-2015 in the area of the Training, Experimental and Implementation centre of the Department of Crop Production at the Agricultural University - Plovdiv.

The experiment was based on a block method, repeated 4 times, with size of the experimental plot of 20 m^2, by using Visby hybrid, originating in Germany.

Experiment variants:

- Factor A - sowing dates
- Factor B - foliar fertilizers
- Factor C - treatment phases

I. Sowing date 1-10.IX

- Untreated variant
- Spraying with Lactofol B - 400 ml/da - phenophase - 2-4 leaves.
- Spraying with Litovit® - 200 g/da - phenophase - 2-4 leaves.
- Spraying with Fertiactyl Starter - 300 ml/da - 2-4 leaves.

II. Sowing date 1-10.X

- Untreated variant
- Spraying with Lactofol B - 400 ml/da - phenophase - 2-4 leaves.
- Spraying with Litovit® - 200 g/da - phenophase - 2-4 leaves.
- Spraying with Fertiactyl Starter - 300 ml/da - 2-4 leaves.

III. Sowing date 10-20.X

- Untreated variant

- Spraying with Lactofol B - 400 ml/da - phenophase - 1-2 leaves.
- Spraying with Litovit® - 200 g/da - phenophase - 1-2 leaves.
- Spraying with Fertiactyl Starter - 300 ml/da - 1-2 leaves.

IV. Sowing date 20-30.X

- Untreated variant
- Spraying with Lactofol B - 400 ml/da - phenophase - 1-2 leaves.
- Spraying with Litovit® - 200 g/da - phenophase - 1-2 leaves.
- Spraying with Fertiactyl Starter - 300 ml/da - 1-2 leaves.

Rapeseed is grown after wheat as a precursor by conventional growing technology.

Net photosynthesis (A, μmol m^{-2} s^{-1}), stoma conductivity (gs, mol m^{-2} s^{-1}), and transpiration intensity (E, mmol m^{-2} s^{-1}) of rapeseed grown at different sowing dates and treated with different foliar fertilizers were studied.

The reading was performed in the mass flowering phase with a portable photosynthetic apparatus LCA-4 (Analytical Development Company Ltd., Hoddesdon, England).

During the experiment, mainly meteorological factors (air temperature and precipitation) influence the growth and development of the crop, as well as their combination and distribution during vegetation.

The data characterizing these factors in the study area are shown in Figures 1 and 2. They show that during the experimental period no significant deviations from the values of the average monthly temperatures in the area of the experiment are observed in comparison to the multiannual period.

Greater differences are observed in terms of moisture, but the study period is characterized by sufficient moisture in the critical phases of the crop development, with the exception of the sowing-germination period during the first two years.

During the experimental period, an absolute minimum temperature affecting the number of wintering plants and the sowing density was recorded in December and January (Figure 3).

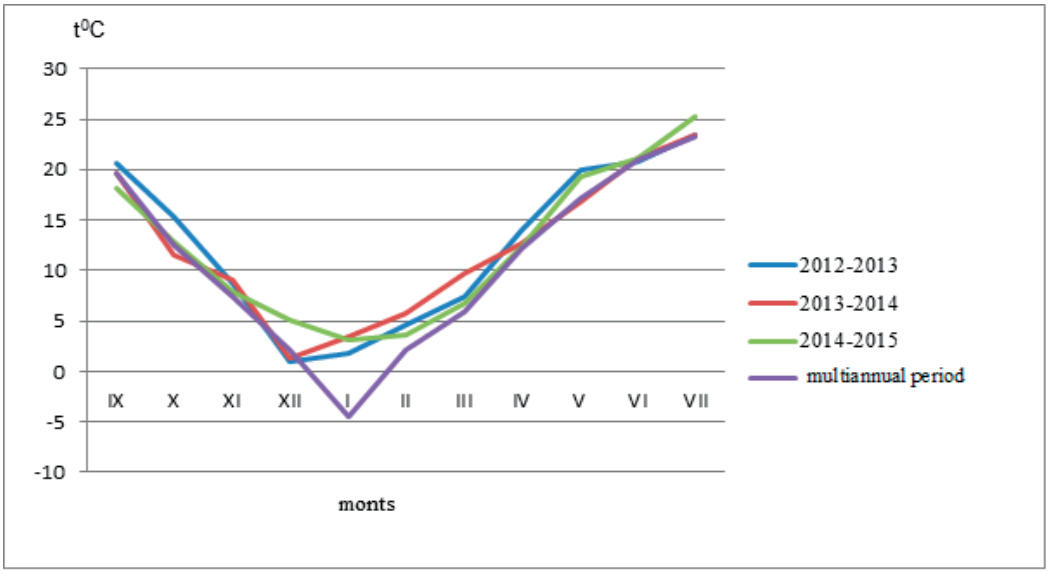

Figure 1. Average monthly temperatures in the region of the Training, experimental and implementation base

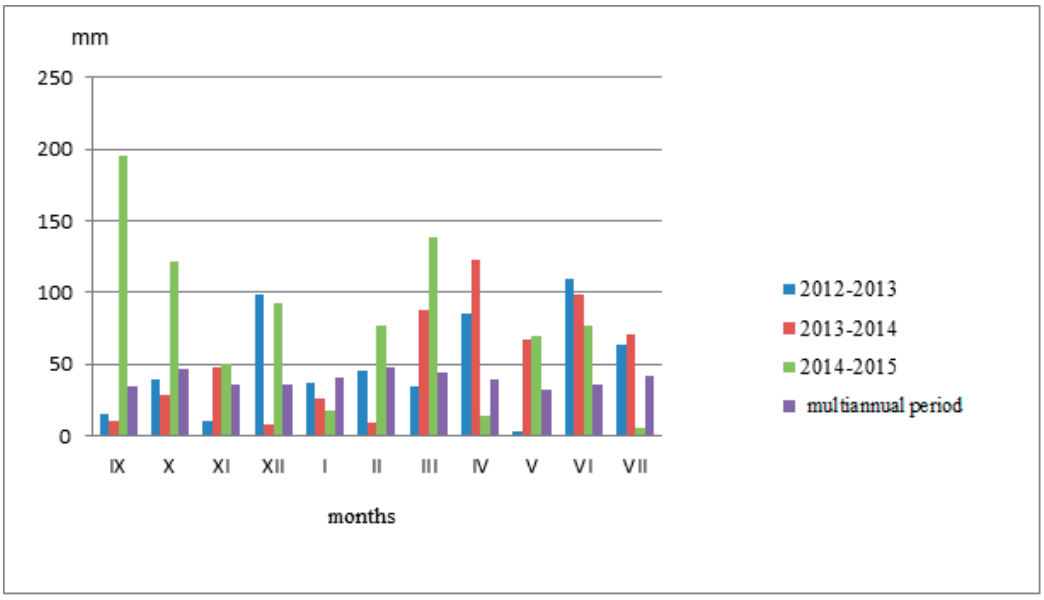

Figure 2. Quantity of rainfall during the years of survey in the region of the Training, experimental and implementation base

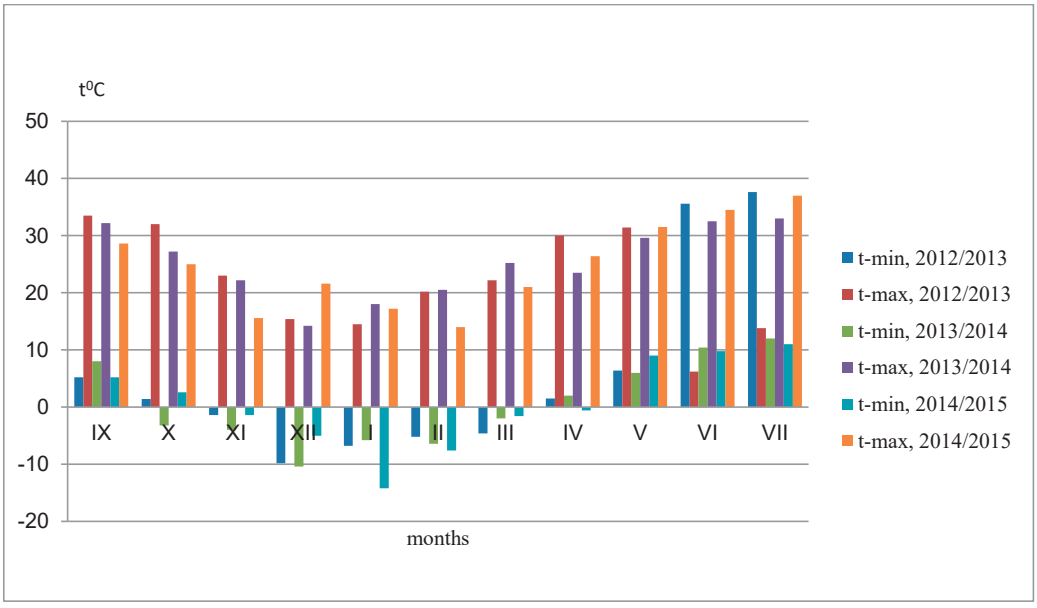

Figure 3. Absolute minimum and maximum temperatures by months 2012/2015

RESULTS AND DISCUSSIONS

The results from the measurements of the net photosynthesis are presented in Table 1.

The results obtained show that the net photosynthesis rate is highest with sowing dates 1-10.IX - from 15.50 to 22.56 μmol m^{-2} s^{-1}, followed by sowing dates 1-10.X - from 14.17 to 18.33 μmol m^{-2} s^{-1}; sowing time 20-30.X - from 13.65 to 17.40 μmol m^{-2} s^{-1} and 10-20.X - from 12.02 to 17.20 μmol m^{-2} s^{-1}.

With regard to the treated variants, the highest net photosynthesis values were reported with Fertiactyl Starter from 17.20 to 22.56 μmol m^{-2} s^{-1}, followed by the Lactofol B treated variants - from 16.48 to 22.26 μmol m^{-2} s^{-1}; Litovit ® - from 15.63 to 17.44 μmol m^{-2} s^{-1}, and control variant from 12.02 to 15.50 μmol m^{-2} s^{-1}.

The Fertiactyl Starter treated variants had the highest percentage increase in net photosynthesis compared to the control variant - from 127.5 to 145.5%, followed by the Lactofol B treated variant - from 119.9 to 143.6%, and Litovit® - from 112.5 to 130.0%.

Table 1. Net photosynthesis rate in rapeseed

	A μmol m^{-2} s^{-1}							
Control	1-10.IX		1-10.X		10-20.X		20-30.X	
	15.50	%	14.17	%	12.02	%	13.65	%
		100.0		100.0		100.0		100.0
Fertiactyl Starter	22.56	145.5	18.33	129.4	17.20	143.1	17.40	127.5
Litovit ®	17.44	112.5	16.46	116.2	15.63	130.0	15.63	114.5
Lactofol B	22.26	143.6	16.99	119.9	16.48	137.1	16.99	124.5
LSD 5%	0.33		0,31		0,29		0,30	

On the basis of the mathematical processing carried out, during the three years of the experiment, at all sowing dates, statistical proof regarding net photosynthesis at LSD of 5% was found between leaf-treated variants and the control variant.

Depending on the sowing date and the foliar fertilizers used, changes are also observed in the indicator stoma conductivity (Table 2).

The results in the table show that at the first sowing dates (1-10.IX) the highest values were reported in the Fertiactyl Starter treated variant (0.11 mol m^{-2} s^{-1}) followed by the control variant (0.09 mol m^{-2} s^{-1}), then Lactofol B and Litovit ® (0.07 mol m^{-2} s^{-1}).

The differences between the variants tested for the other sowing dates are insignificant: for sowing time 1-10.X from 0.06 mol m^{-2} s^{-1} for the Lactofol B treated variant to 0.09 mol m^{-2} s^{-1} in the Litovit® treated variant.

At sowing dates 10-20.X the results of the control variant reported are the lowest 0.06 mol m^{-2} s^{-1} while the other variants do not report differences (0.08 mol m^{-2} s^{-1}).

The combination of climatic factors and foliar fertilizers used during the last sowing date 20-30.X are the preconditions for the highest values to be reported for the control variant (0.10 mol m^{-2} s^{-1}), while for the other variants no differences are observed (0.08 mol m^{-2} s^{-1}).

Table 2. Stoma conductivity

	gs mol m^{-2} s^{-1}			
Control	1-10.IX	1-10.X	10-20.X	20-30.X
	0.09	0.07	0.06	0.10
Fertiactyl Starter	0.11	0.08	0.08	0.08
Litovit ®	0.07	0.09	0.08	0.08
Lactofol B	0.07	0.06	0.08	0.08

Transpiration intensity data are presented in Table 3. The results in the table show that at the first sowing date 1-10.IX the highest values were reported for the control variant (1.53 mmol m^{-2} s^{-1}), while the lowest - for the Litovit® treated variant (1.10 mmol m^{-2} s^{-1}). In the other variants, the reported values are as follows: for Lactofol B (1.20 mmol m^{-2} s^{-1}) and Litovit ® (1.10 mmol m^{-2} s^{-1}).

Table 3. Transpiration Intensity

	E mmol m^{-2} s^{-1}			
Control	1-10.IX	1-10.X	10-20.X	20-30.X
	1.53	1.03	1.15	1.38
Fertiactyl Starter	1.17	1.55	1.37	1.40
Litovit ®	1.10	1.54	1.42	1.42
Lactofol B	1.20	1.16	1.46	1.44

For other sowing dates, higher values were observed for the variants treated with foliar fertilizers compared to the control variant. This is probably due to better-developed plants that form a larger leaf area, leading to increased transpiration.

The highest values of net photosynthesis combined with moderate to high levels of transpiration in the variants tested were reported with Fertiactyl Starter treatment. In this variant, water loss is moderate to large, which provides enough CO^2 for the highest photosynthesis, which is a prerequisite for obtaining high yields.

The variants with the highest photosynthesis support transpiration at intermediate levels, indicating that these plants can regulate both water consumption when needed and maintain a high rate of photosynthesis in low to moderate water deficits.

The other variants treated with Lactofol B, Litovit® have lower net photosynthesis values combined with moderate to high transpiration levels, which is a prerequisite for obtaining lower seed yields.

The lowest net photosynthesis values combined with low to high transpiration levels were observed in control variants. In these variants, water loss is high and photosynthesis is inefficient, and under water shortages this could have a severe negative effect on productivity.

CONCLUSIONS

1. Net photosynthesis is higher in the variants treated with foliar fertilizers: Fertiactyl Starter - from 17.20 to 22.56 μmol m^{-2} s^{-1}; Lactofol B - from 16.48 to 22.26 μmol m^{-2} s^{-1}; Litovit® - from 15.63 to 17.44 μmol m^{-2} s^{-1}, compared to the control variant - from 12.02 to 15.50 μmol m^{-2} s^{-1}.
2. The differences between the variants in relation to the indicator stoma conductivity are insignificant and range from 0.06 to 0.11 mol m^{-2} s^{-1}.
3. The transpiration intensity for the first sowing date is from 1.10-1.53 mol m^{-2} s^{-1}, while in the other sowing dates it varies 1.03-1.55 mmol m^{-2} s^{-1}.
4. The highest values of net photosynthesis combined with moderate to high levels of transpiration in the variants tested were reported with Fertiactyl Starter treatment.

In this variant, water loss is moderate to large, which provides enough CO_2 for the highest photosynthesis, which is a prerequisite for obtaining high yields.

REFERENCES

Ivanova, R., Todorov, Zh. (2019). Influence of foliar fertilization on the phenological development of rapeseed. *Scientific Papers. Series A. Agronomy*, *LXII*(1), 322–330.

Zlatev, Z., Cebola, L.F. (2012). An overview on drought induced changes in plant growth, water relations and photosynthesis. *Food Agric.*, *24*(1), 57–72.

Van den Boogaard, R., Alewijnse, D., Veneklaas, E.J., Lambers, H. (1997). Growth and water-use efficiency of ten *Triticum aestivum* cultivars at different water availability in relation to allocation of biomass. *Plant Cell Environ*., *20*, 200–210.

Lutts, S., Almansouri, M., Kinet, J.M. (2004). Salinity and water stress have contrasting effects on the relationship between growth and cell viability during and after stress exposure in durum wheat. *Plant Sci.*, *167*, 9–18.

Todorov, Zh., Ivanova, R. (2020). Influence of sowing period and treatment with various foliar fertilizers on the productivity of rapeseed. *Scientific Papers. Series A. Agronomy*, *LXII*(1), 456–464.

Wentworth, M., Murchie, M.H., Gray, J.E., Villegas, D., Pastenes, C., Pinto M., Horton, P. (2006). Differential adaptation of two varieties of common bean to abiotic stress. II. Acclimation of photosynthesis. *J. Exp. Bot.*, *57*(3), 699–709.

Yordanov, I., Velikova, V., Tsonev, T. (2000). Plant responses to drought, acclimation, and stress tolerance. *Photosynthetica*, *38*, 171–186.