# CLIMATE CHANGES INFLUENCE AT OATS VEGETATION IN EUROPEAN PART OF RUSSIA

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Climate changes are the important factor of modern crop production. To turn losses into the profit, it's necessary to adapt agriculture to changes of a bioclimatic potential of regions. The first task is analysis of the factors essential for cultivated plants.

**Goal of investigation** Identification of factors which caused the dynamics of economic valuable characters of oats in last decades.

**Material** Long-term data (1980 – 2011) of economic valuable characters of oats varieties, used as standards in research of oats collections at four VIR branches at St.-Petersburg, Moscow, Tambov, Krasnodar regions were studied. In addition vegetation of 16 accessions of wild oats species in St. Petersburg in 1987 – 1999 was analyzed.

**Method** Linear trends in the dynamics of vegetation duration, plant high, mass of 1000 grains, productivity were revealed by regression analysis. Regression models for their dependence from agro-climatic indices was constructed, united models in differences were made. The analysis in differences imply the investigation the relationships between increments of variables per year (signed as Δ). This method allows to derive additional information from several time-series (so-called "panel data"), to exclude non-climatic trends from observations and thus to improve models quality.

## Results

**Trends** In all points from 1980 growth of summer temperatures and precipitation was observed. Sum of effective temperatures above 15°C ($\Sigma T_{ef15}$) was growing with mean rate 90°C per 10 years. Precipitation at period with temperatures above 15°C ($P_{15}$) increased with mean rate 27 mm per 10 years, most active growth was in Tambov region. In St. Petersburg and Moscow the spring time with temperatures 10 – 15°C ($L_{10-15}$) was increasing and in other points it was decreasing. Mean trend was positive 0.2 days per 10 years.

Date of temperatures transition above 10°C ($T_{10}$) moved to earlier dates at 1-5 days per 10 years. Date of sowing in St. Petersburg moved for earlier dates, but more slowly (1.1 day/10 years), than $T_{10}$ (3.8 days/10 years).

Dates of germination, heading and maturity moved for earlier time (**fig.**) in all points, except of Tambov region, at the mean at 1.4; 2.7; 2.9 days per 10 years correspondingly.

**Table. Assessment of the linear trend of economically significant characters in oats in 1980 – 2011. Underlined significant trends**

| Location | Variety | Trend, units per 10 years | | | |
|---|---|---|---|---|---|
| | | Vegetation, days | Height, cm | Mass of 1000 grains, g | Yield from 1m², g |
| Pushkin Laboratories (St. Petersburg) | Borrus | -4,0 | -2,6 | -4,0 | 19,0 |
| | Mean of wild species accessions | -22,3 | — | — | — |
| Moscow branch (former) | Gambo | 1,8 | -3,7 | -1,5 | 22,5 |
| | Nemchinovskii 2 | 1,9 | -5,5 | -1,6 | 23,3 |
| Ekaterinino Experimental Station (Tambov region) | Gorizont | 2,1 | 10,2 | 0,9 | 44,8 |
| Kuban Experimental Station (Krasnodar region) | Krasnodarskii 73 | 1,4 | -2,2 | -3,6 | 109,6 |
| | Otter | 3,1 | -23,1 | 1,9 | -250,7 |
| | Валдин 765 | - | -11,0 | -1,4 | -135,5 |

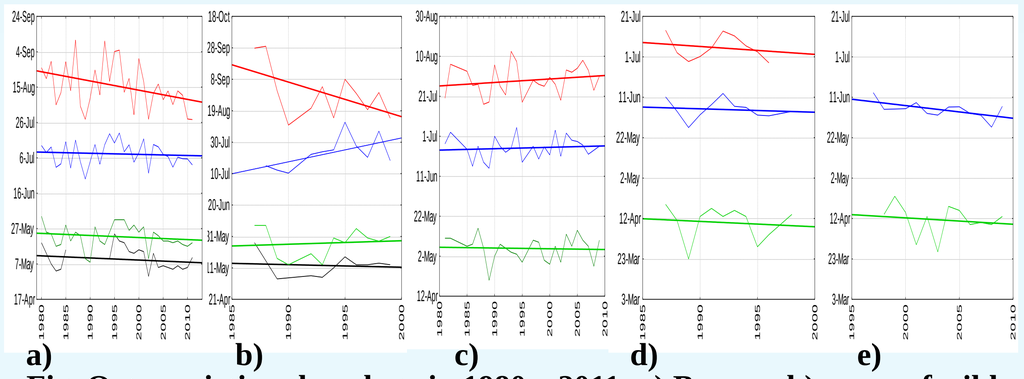


**Fig. Oats varieties phenology in 1980 – 2011: a) Borrus; b) mean of wild species accessions; c) Gorizont; d) Otter; e) Valdin 765.**
**Dates: sowing, germination, flowering, maturity**

There were significant shortening of periods from heading to maturity (**table**) at St. Petersburg (-4.6 days/10 years), and vegetation at all (-4.0 days/10 years). In other points vegetation of standard varieties was weakly elongating, as has shown the analysis, for various reasons. Most investigated varieties had negative tendencies in dynamics of plant height and mass of 1000 grains, and positive of yield. In Tambov region all trends were positive.

**Regression analysis** revealed the main factor of vegetation duration dynamics is growth of $\Sigma T_{ef15}$ In addition in drought conditions of Tambov region the growth of $P_{15}$ was influencing. In Moscow and Krasnodar regions duration of spring time with temperatures 10-15°C or 5-15°C had an affect. United model of vegetation duration for oats varieties in the European part of Russia (L) : :

$$\Delta L=-0.06-0.04\Delta\Sigma T_{ef15}+0.15\Delta L_{10-15}+0.01\Delta P_{15} \qquad R^2=0.45$$

Forecasting according this model gave negative climate-dependent trend of vegetation duration for oats -3 days per 10 years.

Model of date of full maturity (D) had better explanatory ability and did not depends from $L_{10-15}$:

$$\Delta D=-0.16-0.05\Delta\Sigma T_{ef15}+0.03\Delta P_{15} \qquad R^2=0.54$$

Thus intensive development of oats was connected with temperatures above 15°C, lower temperatures elongated vegetation.

**Plant height (H)** had weak and middle correlations with $\Sigma T_{ef15}$ for all varieties, and for Gorizont it was correlated with precipitation $P_{15}$ (r=0.44) too. The united model for all studied varieties:

$$\Delta H=-0,50-0,07\Delta\Sigma T_{ef15} \qquad R^2=0,32$$

Dependence of **mass of 1000 grains** from climatic indexes haven't been revealed, perhaps, as a consequence of conservatism of this character.

**Yield (Y)** was determined by efficiency of vegetative and generative stages and therefore correlated with plant height and mass of 1000 grains ($M_{1000}$). United equation:

$$\Delta Y=-3,48+4,02\,\Delta H+7,77\Delta M_{1000} \qquad R^2=0,32$$

**Wild oats accessions** was studied in Pushkin in 1987 – 1999. They differed by vegetation duration from 80 to 104 days, but all accessions was reducing vegetation with rate from 0,5 to 3,3 days per year **(fig.b).** Reduction of vegetation period of as well as at a standard variety Borrus was due to reduction of the period from heading to maturity with the speed 0,2 – 3,2 days per year. Regression analysis revealed this reduction was caused by growth the $\Sigma T_{ef15.}$ But there was one more significant factor for wild accessions - mean temperature of 15 days after sowing ($T_{s15}$), rising this temperature slowed vegetation. United model for all accessions:

$$\Delta L=-1,82+2,92\Delta T_{п15}-0,04\Delta\Sigma T_{эф15} \qquad R^2=0,77$$

## Conclusions

- ✓ The major climate factor of oats vegetation in European part of Russia is sum of effective temperatures above 15°C. Their rising caused shortening of oats vegetation in North-West of Russia in 1980 - 2011. In Central and Southern Federal districts temperature growth was compensated by growth of precipitation, length of spring with temperatures 10 – 15°C.
- ✓ Temperatures 10-15°C are favor for vegetative growth, they elongate vegetation period.
- ✓ For the accessions of wild varieties spring temperature rising slows vegetation by more long vernalization.
- ✓ Method of consecutive differences lets to construct well determined united models of vegetation duration.
- ✓ In case of further rising of temperature the shortening of vegetation duration is predicted for zoned in XX century varieties..
- ✓ In conditions of climate warming may be treated earlier sowing of oats and cultivating of more late-ripening varieties.