THE EFFECT OF VIBRATION AS A SPACE FLIGHT FACTOR ON WHEAT PLANTS GROWTH AND DEVELOPMENT

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Effect of vibration on plant organisms

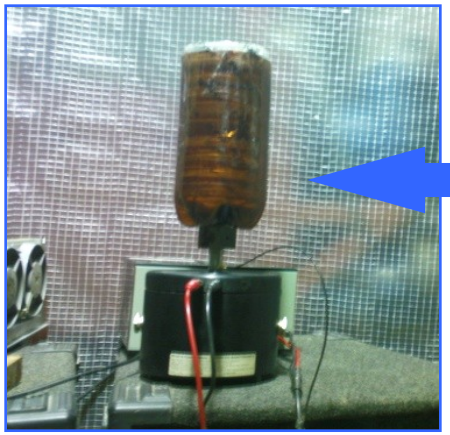
- ***Changes of ethylene synthesis velocity and cell wall peroxidase activity; changes of biochemical state of the cell walls and growth stimulation*** *(Delone et al.,*1968; Siegel S.M. and Siegel B.Z., 1983)
- ***Activization of callusoginesis and rhizogenesis*** *(Chekmarev,* 1986)
- ***Dependence of gravitropic reaction of plants on frequency and amplitude of vibration. In addition, it has been established the hypersensitivity of plants to mechanical impacts at insufficient light or in the dark*** *(Mitchell C., 1992; Zhong Ma and Karl H., 2007)*
- ***Dependence of seeds germination on frequency and amplitude of vibration*** *(*Takahashi H. et.al., 1991; Uchida H.A., Yamamoto K.T., 2002)

The aim of the work

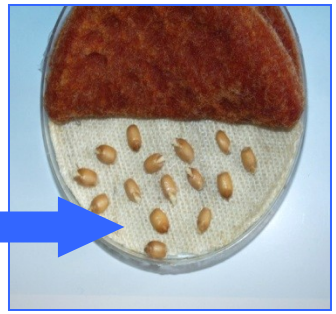
Studying the influence of vibration on ontogenetic characteristics and grain productivity structures of wheat plants (*Triticum aestivum L*.).

MATERIALS AND METHODS

We tested two wheat cultivars: Inna (winter wheat) and Lada (spring wheat). The seeds have been vibrated at 70 Hz and an amplitude of 0.5 mm on vibration bed B&K 4809 (power amplifier B&K 2705 and signal generator B&K 1049) at Rocket and Space Corporation “Energia”. The seeds were sown in 6 hours after the end of vibration.



Vibration test-bed with Petri dishes



Monitoring and control system

Regims of vibration

Cultivar	Object influenced by vibration	Time of exposure, hour
Inna (winter wheat)	Germinated seeds	12
Lada (spring wheat)	Germinated seeds	12, 14

Plant growth method in light culture

Object: *Triticum aestivum L.*
Cultivar: Inna (winter wheat); *Lada* (spring wheat)

Time of exposure, hour: 12

Root module , titanium porous membrane with wheat crop

Vegetation vessel with wheat crop

- Object: winter wheat, cultivar Inna
- Cultivation method: hydroponic
- Mineral nutrition: Chesnokov solution ½ normal dose with microelements (Hogland)
- Water potential in root zone: **(–1,0) ± 0,05 kP**
- Air temperature: **29 ± 1 °C**
- Air humidity: **30 ± 5 %**
- Photoperiod: **24-hours**
- PPF, μM/(m^2·s): **700 ± 50**
- Photoperiod: **24-hours**

- Object: spring wheat, cultivar Lada
- Cultivation method: soil culture
- Mineral nutrition: soil with Chesnokov solution ½ normal dose with microelements (Hogland)
- Soil humidity: **70%**
- Air temperature: **32 ± 3 °C**
- Air humidity: **20 ± 5 %**
- PPF, μM/(m^2·s): **450 ± 20**
- Photoperiod: 24-hours

Plant growth method in field experiments

Object: *Triticum aestivum L. Cultivar: Lada* (spring wheat)

Experimental field with wheat crop

Experiment 2008

- Time of exposure, hour: **12**
- Cultivation method: standart technique of cultivation of grain plants in Non-Chernosem zone of Russian Federation
- The norm of sowing: **70 seeds – length of the line 1 m**
- Total amount of sown seeds for each variant: **420**

Experiment was conducted at the Research Institute of Non-Chernosem Grain Farming

Experiment 2008

- Time of exposure, hour: **14**
- Cultivation method: standart technique of cultivation of grain plants in Non-Chernosem zone of Russian Federation
- The norm of sowing: **70 seeds – length of the line 1 m**
- Total amount of sown seeds for each variant: **3500**

Experiment was conducted at the Russian State Agrarian University

Methods of cytogenetic studies

Objects:
Germinated seeds after vibration ending;
Primary roots of 2 days old plants

Fixation procedure: Carnoy's solution
Study of metaphase plates: squash method using Dapy colorant

Analazing: fluorescent microscope Axioskop 40 (×40)

Date of organogenesis stages of winter wheat in artificial lighting conditions, days after sowing

Cultivar	Variant	Organogenesis stage / phase of development					
		II (seedlings)	III – IV (tillering)	V (nearing the heading stage)	VIII (heading)	IX (blossoming)	XII (full-ripe stage)
Winter wheat	Control	27	52	Not marked	Not marked	Not marked	Not marked
	Experiment	25	55	Not marked	Not marked	Not marked	Not marked

Vibration effect on growth and development of winter wheat in artificial lighting conditions

Fresh biomass dynamic of shoots and tillers

Characters	Plant age, days	Variant	
		Control	Experiment
Fresh shoot biomass, g/plant	27	1,6 ± 0,5	1,8 ± 0,8
	40	5,1 ± 1,4	5,3 ± 1,5
	52	6,9 ± 1,5	15,9 ± 7,0
	70	15,2 ± 5,5	18,6 ± 4,7
Number of tillers, num/plant	27	3,0 ± 0,0	2,7 ± 0,8
	40	4,7 ± 0,7	5,0 ± 1,8
	52	7,0 ± 2,1	14,3 ± 6,6
	70	10,5 ± 3,1	9,1 ± 2,4

Shoot structure of 70 days old plants

Variants	Fresh biomass of main shoot, g/plant	Fresh biomass of all tillers	Part of tillers that fresh biomass similar main shoot, %
Control	2,8 ± 0,8	11,0 ± 4,1	14
Experiment	3,8 ± 0,3	13,4 ± 4,1	39

Date of organogenesis stages of spring wheat in artificial lighting conditions, days after sowing

Cultivar	Variant	Organogenesis stage / phase of development					
		II (seedling)	III – IV (tillering)	V (nearing the heading stage)	VIII (heading)	IX (blossoming)	XII (full-ripe stage)
Spring wheat	control	9	20	29	45	47	70
	experi-ment	9	20	29	42	45	70

Vibration effect on plant structure and grain productivity of spring wheat under cultivation in artificial lighting conditions

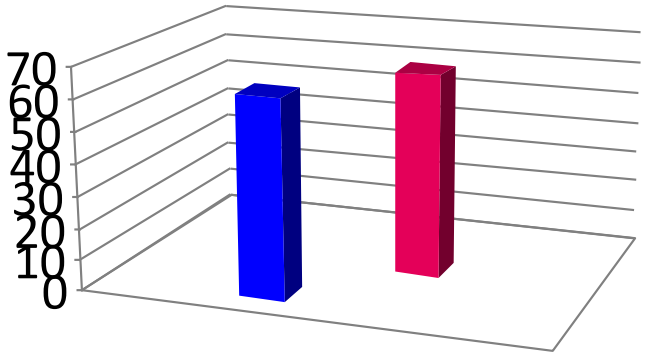
Characteristics	Variants	
	Control	Experiment
Dry mass of the whole plant, g	6,62 ± 0,64	7,38 ± 0,61
Seed's dry mass from the main shoot, g/plant	0,48 ± 0,04	0,49 ± 0,05
Seed's dry mass from the tillers, g/plant	0,56 ± 0,07	0,69 ± 0,16
Root part in total plant mass, %	11,0 ± 1,4	10,4 ± 1,1
Grain part in total plant mass, %	15,7 ± 0,9	15,9 ± 1,7

Vibration effect on seeds germination of spring wheat in field experiments

•Time of exposure,

hour: 12

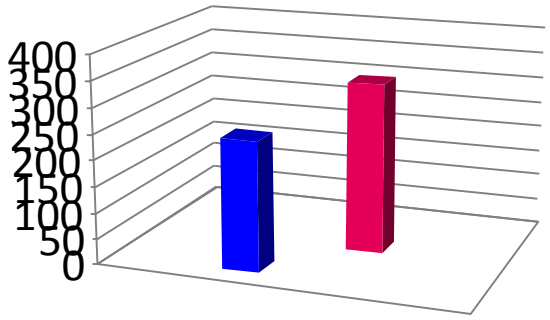
Number of plants per sowing line



•Time of exposure,

hour: 14

Number of plant per м²

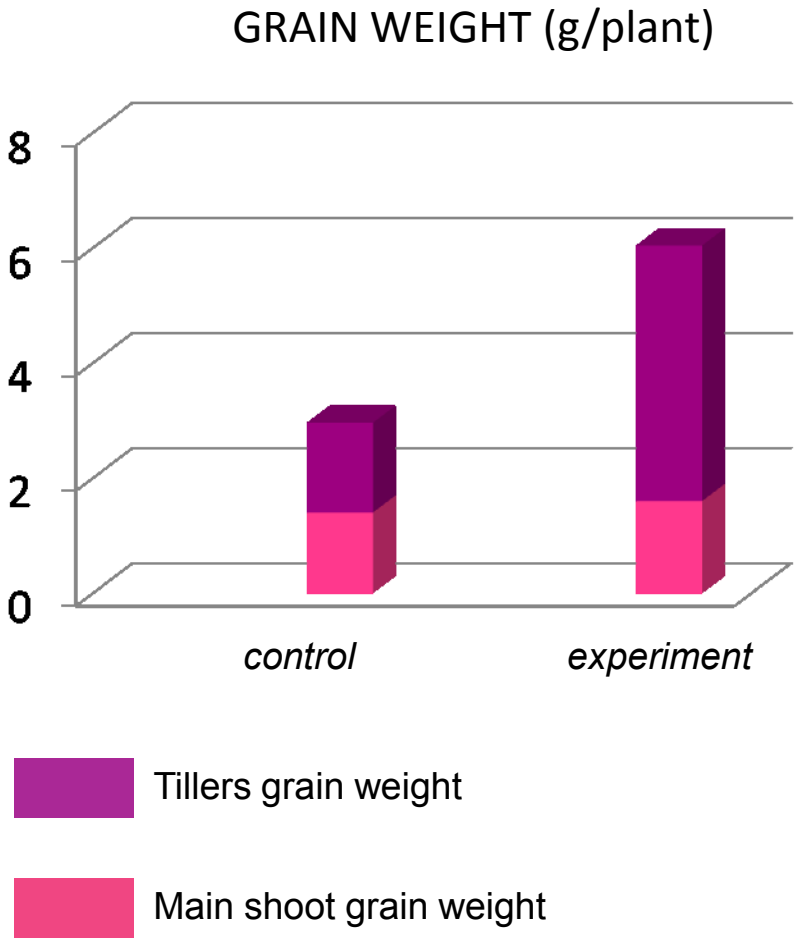


Seeds, sown without vibration

Seeds, sown after vibration

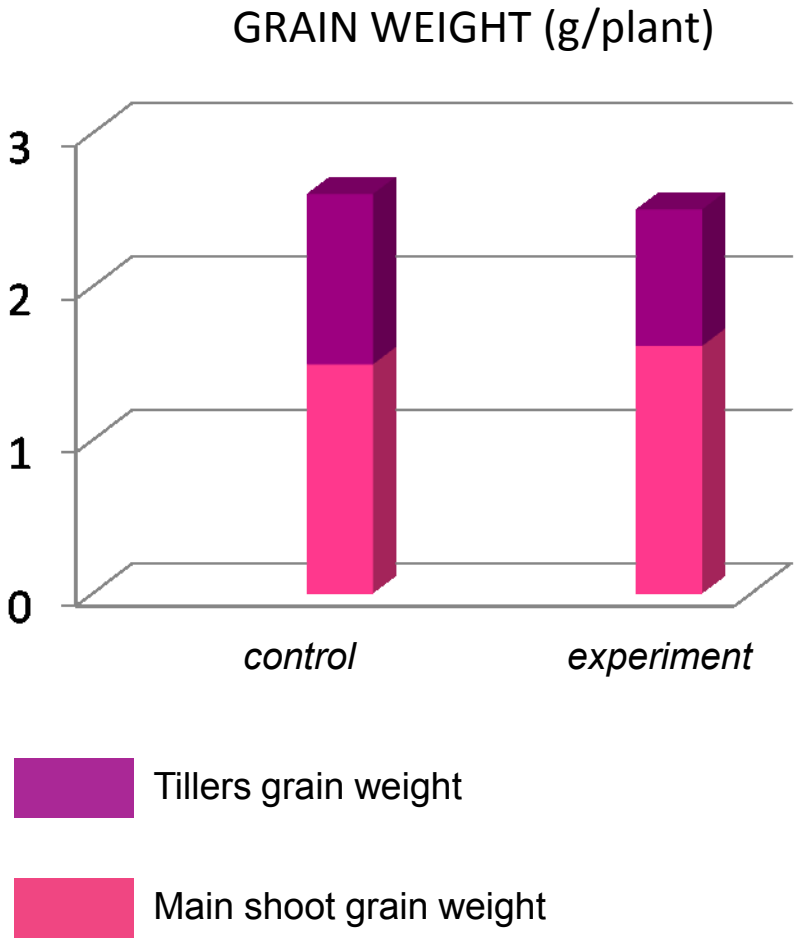
Growth and productivity of spring wheat at the field experiment, Time of exposure, hour: 12.

- There were no distinctions between control and experiment plants in ontogenetic development



Growth and productivity of spring wheat at the field experiment, Time of exposure, hour: 14.

- *There was raising of ontogenetic development at the experiment at the time of IV-IX stages. There are appearing of number of spikles, number of flowers in the spikle, and the part of fertile flowers*



Conclusion

- Influence of vertical vibration on seeds can influence on growth and development of plants in future.

- ***Vibration effect on:***

- Dynamic of ontogenesis development of spring wheat, the time of exposure was 14 hours;

- Raising biological and grain productivity, the time of exposure was 12 hours.

- Vibration stimulated tillering and not effected on ontogenetic development winter wheat under 12-hours vibration.