Usage of Bioorganic Nano-fertilizer Nagro as Opportunity of Ecologization for Winter Rye Development (Secale Cereale)

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Abstract. On the basis of research of winter rye productivity dependence of Vlada and Tetra short cultivar from exposure of seed treatment and sowing with bioorganic nano-fertilizer Nagro in Kuznetskaya forest steppe of south-east in West Siberia (2015 – 2018 years), there was found out increasing of yield activity respectively to control (sowings without fertilizer) for Vlada cultivar – 15-28% and Tetra short – 4-13%. Number of falling increased for 5-23%. Wasn’t spotted correlation between hydrothermal conditions of vegetation and influence of biologics on studied productivity index.

1. Introduction

Intensification of agricultural development must be realized with allowance to ecological implication and challenges, and it must be directed to not only increase productivity of agricultural plants, but to optimize biospheric process.

Organic (ecologic) agriculture - responsible minimization for usage of synthetic fertilizer, pesticides and plant growth regulators. One of the way to increase amount and quality of plant production is production development of organic product in the Russian Federation [1]. Annually world market of management organic form production is growing by a mean of 15%. In spite of higher prices, more people want to buy organic products [2].

“All advanced technologies of plant science will be directed to ecologizate production and increase non-wastefulness” [3]. For this necessary to use agro-technologies to decrease man-made burden on agrobiocenosis. One of promising trends of agricultural products production ecologization is usage of bioorganic, which have complex-positively effect on crop productivity and their environment [4, 5].

Modern market of biologicals gives opportunity to choose most effective, based on influence on quality and quantity productiveness of agricultural crop, especially during cultivation of bread crops.

Goal research – on the basis of dependence research of formatting yield and seed quality from seed treatment and sowing exposure, optimization of bioorganic fertilizer Nagro usage in Kuznetskaya forest steppe.

Bio-fertilizer Nagro is a next generation of fertilizer, which determined as nano-fertilizer and characterized by high efficiency, prolonged and selective ability on microbiological activity of soil [6, 7]. Also used by this fertilizer active materials of mineral fertilizer [8] has influence on germination of vegetative plant mass and their productivity [9, 10, 11].

2. Terms, materials and methods of research

Experimental part of research was conducted in 2015 – 2018 years in natural climatic conditions of Kuznetskaya forest steppe (north forest steppe zone of West Siberia’s south-east foothill, Kemerovo region) [12]. Target of research – cultivars of winter rye (Vlada and Tetra short). Experimental design included six options: I option – seed treatment by bio-energetic, treatment after vegetation: universal + bio-energetic during tillering period at spring. II option – seed treatment with bio-energetic, first treatment – after vegetation – universal + bio-energetic during tillering period at spring; second
treatment – universal during paniculation period; III option – seed treatment with bio-energetic, first treatment after vegetation – bio-energetic during tillering period at spring; II option – universal during paniculation period; IV option – treatment after vegetation – universal + bio-energetic during tillering period at spring; V option – first treatment after vegetation – universal + bio-energetic during tillering period at spring, second treatment – universal during paniculation period; VI option – first treatment after vegetation – bio-energetic during tillering period at spring, second treatment – universal during paniculation period. Control group – sowings without bio-fertilizer. Pre-seeding treatment was conducted with bio-energetic Nagro with norm 1 l/ton, universal Nagro with norm 1 l/ha and bio-energetic – 0.2 l/ha. Volume of spray material 250 l/ha. Replication – threefold. Plot allocation – randomized. Size - 100 м². Precursor – clean steam.

Bio-fertilizer Nagro contain vitamins, amino-acids, phytohormones, bio-solvents, nano-silicium, bio-calcium, anti-oxidants, adapt-genetic materials, metabolites, nitrogen-fixer, anti-pheromone – thoribon, bacterial spores (Pseudomonas aureofaciens), express fungicidal activity, increase progression of plants rhizosphere’s microbiota [13]. For treatment of seeds and sowings were used two forms of fertilizer: bio-energetic and universal bio-fertilizer.

Cultivation technology is realized in accordance with zonal recommendation [14]. Seed treatment was conducted with spraying device MAROLEX MINI 1000 7 days before planting. Sowings were labored by shoulder sprayer ECHO DM-4610. Harvesting was realizing in full ripe stage. Yield activity considered by continuous method with furthering translation on standard moisture regain (14%) and 100% purity. Falling number was evaluated in accordance with GOST methodic 27676-88 [15]. For mathematical treatment were used elements of analysis of variance[16].

Soil – black earth leached, average-deep, medium-humic, granulometric texture – hard-loamy [17]. Prosperity by labile forms of phosphorus and potassium (according to Chirikov) corresponding to 140 and 154 mg/kg of soil (GOST 26204-91) [18]. pH – faintly-acid (salt extract 6.0) (GOST 26483-85) [19], mass fraction of mould 8.9 % (GOST 26213-91) [20].

Hydrothermal conditions of plants vegetation during summer period (may – august) in terms of warm and moisture, estimated by value of hydrothermal index – HTI [21] characterized as semi-arid in 2015 and 2016 (HTI = 0.69 and 0.83 correspondingly). 2017 and 2018 years – closer to optimum needs of rye plants (HTI = 1.02 and 1.04 correspondingly) (Table 1).

### Table 1 - Hydrothermal index, HTI Krasnoye, Kemerovo region

| 3. Month | 4. Long time average annual 5. | 6. Year 7. 2015 | 8. 2016 | 9. 2017 | 10. 2018 |
|----------|-------------------------------|----------------|--------|--------|---------|
| 11. May  | 12. 0.94                      | 13. 1.19       | 14. 0.89 | 15. 0.82 | 16. 2.00 |
| 17. June | 18. 1.00                      | 19. 0.41       | 20. 0.49 | 21. 0.76 | 22. 0.70 |
| 23. July | 24. 1.37                      | 25. 0.38       | 26. 1.40 | 27. 1.42 | 28. 1.75 |
| 29. August | 30. 1.07                     | 31. 0.78       | 32. 0.53 | 33. 1.07 | 34. 0.45 |
| 35. May - August | 36. 1.09                  | 37. 0.69       | 38. 0.83 | 39. 1.02 | 40. 1.04 |

### 3. Results and discussion

Winter rye Vlada cultivar yield activity has changed between 2.70 and 3.00 ton/ha, making 2.34 ton/ha in control, at a time when were used biologics Nagro in every experiment options for four years of research (Figure 1). In all experiment options was found out increasing of yield activity respectively to control group for 0.36 – 0.66 ton/ha which is 15 – 28 %.

Tetra short cultivar also was responding to usage of biologics Nagro, but its reaction for yield activity was weaker in comparison with Vlada cultivar. And its increasing respective to control sowing (2.61 ton/ha) varied in all experiment options from 0.11 to 0.33 ton/ha (2.72 – 2.94 ton/ha). In this way excess was 4 – 13%.
Figure 1 – Yield activity of winter rye and its departure from control weigh (ton/ha), 2015 – 2018 years. (Vlada cultivar HCP<sub>95</sub> = 0.36; Tetra short cultivar HCP<sub>95</sub> = 0.27).

Vlada cultivar has more effective sowing in third option – seed processing with bio-energetic, first processing after vegetation – bio-energetic during tillering period at spring, second treatment – universal during paniculation period. In Tetra short cultivar in third option – seed treatment with bio-energetic, first treatment after vegetation – bio-energetic during tillering period at spring, second treatment with bio-fertilizer universal during paniculation period, and first option – seed treatment with bio-energetic, treatment after vegetation: bio-fertilizer universal + bio-energetic during tillering period at spring. Herewith Vlada cultivar yield activity reach 3.00 ton/ha, exceeded control for 0.66 ton/ha (28%) then Tetra short cultivar correspondingly 2.94 and 2.93 ton/ha, 0.33 and 0.32 (13 and 12%). But it must be noted that Tetra short cultivar was less stable to response almost in all treatment options except fourth, providing formation of near to yield activity level.

Strong dependence of yield activity on year of research was spotted in both cultivars (V = 35 – 51 %), which is evident of strong influence of weather conditions on formation of yield activity. Both cultivar gave high yield activity in control and in test sowing in all options in 2016 year. (3.36 – 3.94 ton/ha), lowest in 2018 year (1.69 – 2.26 ton/ha). In comparison with other years, conditions have negative influence on yield activity, may be lower temperature (17.2°C) in July with intense rainfall (90.3 mm), severe drought and cold weather of August - seed-filling period. Also toward other years of research was early formation of snow cover (second decade and up to first decade was 9 mm). This can lead to strong decrease of temperature for tillering node and lose of productivity of further yield.

Therefore, usage of bio-fertilizer Nagro during cultivation of winter rye in all studied options has provided increase of yield activity for both cultivars for 4 – 28% with bigger response of Vlada cultivar. With strong dependence of yield activity from condition of research year (V = 35 – 51 %), synergies between nature heat supply infrastructure and water availability for plants and activity of biologics without finding.

In nature of response on treatment with bio-fertilizer Nagro to this order of falling for winter rye cultivars, Vlada and Tetra short were close (Figure 2). Both cultivars have positive influence of biologics in sowings from second to fifth, with increasing of control on 5 – 23 %.
Figure 2 – number of falling of winter rye contrasted with usage of Nagro and its departure from control sowing, 2015 – 2018 years. (Vlada cultivar HCP$_{05}$ = 15; tetra short cultivar HCP$_{05}$ = 11).

Maximum increasing of number of falling, for Vlada cultivar, spotted in sowings that was treated with bio-fertilizer Nagro with options three, and number of falling for four years was 186 s on average, which is correspond to second-class seed in accordance with GOST R 53049-2008 [22]variety in years: from 112 to 254 s. Tetra short has biggest number of falling – 217 s in sowings, which were growled with second option, which is corresponding to first-class seed quality (variety in years: from 150 to 292 s). Also was noted strong variety of number of falling in years (V = 22 – 66 %) and in options (V = 64 – 68 %).

4. Conclusion
Usage of bioorganic nano-fertilizer Nagro during cultivation of winter rye of Vlada and Tetra short cultivars helped to increase yield activity for 4 – 28 %. in edaphoclimatic conditions of Kuznetsklaya forest steppe in south-east of West Siberia. With bigger respond of Vlada cultivars, most effective was sowing with third option. Yield activity reach 3.00 ton/ha, in years 2.26 – 3.93 ton/ha. Tetra short cultivars’ yield activity reach 2.94 ton/ha, in years 2.13 – 3.94 ton/ha.

Biggest increase of number of falling for Vlada cultivar was spotted in sowings with third options (186 s – second-class seed, in years from 112 to 254 s) and for Tetra short cultivars – second option (217 s – first-class seed, in years from 150 to 292 s). Yield activity (V = 35 – 51 %), number of falling (V = 22 – 66 %). Between nature of moisture mode and influence of bio-fertilizer on yield activity and number of falling, and also between productivity index wasn’t spotted big correlation.

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