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EFFECT OF PREDECESSOR AND SEEDING RATE ON GRAIN YIELD OF OATS IN URALS REGIONS OF RUSSIA

SUMMARY

Spring oats (*Avena sativa* L.) are one of the most important crops in Russia. Grain Oats is a complete concentrated feed for farm animals. Furthermore, manufactured from a highly oat groats, oat flour and other products. One of the main ways to increase the production of grain oats is to increase the yield of this crop through the development and implementation of adaptive technology of cultivation. Development and implementation of quality agrotechnics oats with the resource-saving technologies in Russia is an important task to increase the production of high-quality grain. And so the article shows the change in the yield of grain oats depending on predecessor and seeding rate. To study taken four predecessors (winter rye, barley, red clover and peas) and three seed rates (four, five and six million seeds per hectare). The introduction reflects the relevance of research, and a brief literature review on the research questions. The questions of the value of evidence-based crop rotations in agricultural production, the efficiency of different predecessors, stories predecessors choice for cultivation of oats. The object of the study was spring oats, "Dens" cultivar. This cultivar is the most common in Russia. As a result of two years of research found that in contrasting weather conditions better than its predecessor was red clover. Change in yield due to the formation of a different number of productive stems and in florescence's productivity. Also found on the influence of predecessors contamination of crops with weeds. The optimum seeding rate for oats is six million seeds per hectare. Increase in yield due to the large number of productive stems.

Key words: spring oats, seeding rate, predecessor, grain yield.

INTRODUCTION

Oats is a culture whose grain is used to produce full-fledged foodstuff and well-balanced forage. The popularity of processed oats is concerned with high content and nutrient availability of nutrition and vitamins which makes it a high value product for baby and functional food for various population groups (Khaletsky, 2008). The cultivar is a manufacturing basis of any vegetable production and it's a major factor determining the increase of culture productivity with over 40% share. (Kosyanenko, 2002). The cultivation

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technology is responsible for uncovering the cultivar's productivity potential. The cultivation technology of oats developed for a specific cultivar is usually applied to another cultivar "as is", without concerning the cultivar's peculiarities with respect to certain elements of cultivation technology. One of such elements is a sowing rate. As stated by a famous plant breeder academician Yuriev (1925), each cultivar has an intrinsic optimal sowing rate (Kolesnikova, 2002). The optimal sowing rates for well-known oats cultivars were experimentally determined on the trial plots back in 50s and 60s of the XX century. As stated by scientists Rusinov (1955), Prokoshev (1968), Kuryшева and Sobennikov (1969) the optimal sowing rate determined from the data obtained from trial plots as well as from other scientific institutions of the Urals region is 6-7 mil. seeds per hectare. This rate was later confirmed by V. Svetlakova (1979) and A. Anisimova (1983). The refinement of the sowing rate of large grain cultivars allows making adjustments to the oats agro-technology in order to develop adaptive cultivation technologies.

MATERIAL AND METHODS

Field trial

The field trials were conducted in experimental fields of Perm agricultural academy during years 2013-2014 aimed at developing the basics of agro-technology of oats able to increase the yield in the Urals region of Russia. The goals were: 1) to determine the effect of predecessor on the formation of the productivity of grain, 2) to reveal the optimum sowing rate, 3) to give scientific substantiation of the formation of productivity. In order to accomplish the above goals the double factor field trial was conducted on a turfic-podzolic heavy loamy soil with the humus content of 2,2-2,4%, with close to neutral pH factor of soil (pHKCl 6,3-6,5), with the labile phosphorus content of 309 mcg/kg and the exchangeable potassium content of over 180-205 mg/kg. The trial scheme is as follows: A factor – predecessor: A1 - winter rye, A2 – 1st year red clover, A3 – peas, A4 – barley. B factor – sowing rate, mil. seeds per hectare: B1 – 4, B2 – 5, B3 – 6. The trial was repeated four times. The employed agro-technology was common for early spring cultures in the Urals region of Russia (Akmanaev, 2012). The object of the study was spring oats, the "Dens" cultivar. The cultivars placement was systematical employing the split plot pattern with the 2nd order plot square of 54 m².

Weather conditions

The seasons 2013-2014 had varying weather conditions. The vegetation period of year 2013 was dry and hot during the critical period of the plants growth and development which negatively affected the yield. In contrast, the year 2014 had unusually hot and dry May followed by heavy rainy and cold June and July led to increased overall yield.

Statistic analysis

The obtained results were statistically processed by MS Excel program package using the methods of descriptive statistics; arithmetic

mean value and standard deviation were calculated for each measured and calculated parameter. ANOVA procedures were used for data analysis. P-values less than 0,05 were considered to be statistically significant.

RESULTS AND DISCUSSION

The obtained oats yield (Table. 1) during years 2013-2014 ranged from 1.51 tons per hectare in case of the barley predecessor and the sowing rate of 4 mil. seeds per hectare to 2.52 tons per hectare in case of the red clover predecessor and the sowing rate of 6 mil. seeds per hectare.

Table 1. Effect of predecessor and sowing rate on the yield of oats, tons per hectare, years 2013-2014

Predecessor (A)	Sowing rate, mil. seeds per hectare (B)	2013	2014	Mean
Winter rye	4	1.02	2.74	1.92
	5	1.19	2.97	2.08
	6	1.36	3.26	2.31
Mean A ₁		1.19	2.99	2.10
Red clover	4	1.07	3.02	2.04
	5	1.26	3.32	2.29
	6	1.42	3.62	2.52
Mean A ₂		1.25	3.32	2.28
Peas	4	1.01	2.58	1.79
	5	1.10	2.69	1.89
	6	1.29	3.04	2.17
Mean A ₃		1.13	2.77	1.95
Barley	4	0.97	2.06	1.51
	5	1.18	2.37	1.78
	6	1.09	2.54	1.82
Mean A ₄		1.08	2.32	1.70
Mean B ₁		1.02	2.60	1.82
Mean B ₂		1.18	2.84	2.01
Mean B ₃		1.29	3.12	2.21
HCP ₀₅ discrepancies	vs. A factor	0.06	0.09	0.03
	vs. B factor	0.07	0.13	0.07
HCP ₀₅ major effects	vs. A factor	0.03	0.04	0.01
	vs. B factor	0.03	0.08	0.04

Table 2. Formation of stems density and inflorescence productivity of oats with respect to predecessor and sowing rate, years 2013-2014

Predecessor (A)	Sowing rate (B)	Stems density, 1/m ²	Weight of 1000 grains, grams	Number of grains in inflorescence	Inflorescence weight, grams
Winter rye	4	241	33.4	35.5	1.19
	5	284	32.1	34.6	1.11
	6	333	31.4	33.0	1.04
Mean A ₁		286	32.3	34.4	1.11
Red clover	4	253	36.8	37.1	1.37
	5	290	36.0	36.2	1.30
	6	331	35.6	35.5	1.26
Mean A ₂		291	36.1	36.3	1.31
Peas	4	216	33.2	33.8	1.12
	5	246	30.9	33.6	1.04
	6	285	29.6	30.9	0.91
Mean A ₃		249	31.2	32.8	1.03
Barley	4	209	30.3	30.7	0.93
	5	229	29.3	29.2	0.86
	6	264	28.1	30.1	0.85
Mean A ₄		234	29.2	30.0	0.88
Mean B ₁		230	33.4	34.3	1.15
Mean B ₂		262	32.1	33.4	1.08
Mean B ₃		303	31.2	32.4	1.02
HCP ₀₅ discrepancies	vs. A factor	30	1.2	1.7	0.06
	vs. B factor	11	1.3	1.4	0.05
HCP ₀₅ major effects	vs. A factor	12	0.5	0.7	0.02
	vs. B factor	6	0.7	0.7	0.02

It worth noting that the attained yield in year 2014 was significantly higher than in year 2013. The predecessor kind was found to substantially affect the yield. Considering the predecessors studied the highest average yield was attained after the red clover with 2.28 tons per hectare which is 0.18, 0.33 and 0.58 tons per hectare higher than after the winter rye, peas and barley

predecessors, respectively ($HCP_{05} = 0.01$ tons per hectare). This trend can be explained by the greater number of productive stems – 291 per m^2 , which is 42 and 57 stems per m^2 greater in case of the pear and barley predecessors, respectively ($HCP_{05} = 12$ stems per m^2). However, no substantial difference in stems density in cases of the winter rye and red clover predecessors was obtained. The highest oats yield trend is also confirmed by the highest productivity of inflorescences – 1.31 grams which is 0.20, 0.28 and 0.43 grams higher than in case of the winter rye, peas and barley predecessors, respectively ($HCP_{05} = 0.02$ grams). The overall yield after the winter rye was 2.10 tons per hectare which is 0.15 and 0.40 tons per hectare higher than in cases of the peas and barley predecessors, respectively.

The yield increase of oats after the winter rye predecessor as opposed to the barley and peas predecessors is mainly attributed to the higher density of productive stems – 286 per m^2 which is 37 and 52 stems per m^2 higher as well as the inflorescence weight of 1.11 grams which is 0.08 and 0.23 grams higher. The observed trends are found to be consistent despite the varying weather conditions. The sowing rates studied also had the substantial effect of the oats yield. In general the highest yield of 2.21 tons per hectare was obtained in the case of 6 mil. seeds per hectare which is 0.40 and 0.20 tons per hectare higher than in cases of 4 and 5 mil. seeds per hectare sowing rate ($HCP_{05} = 0.04$ tons per hectare). The obtained yield increase due to stems density of 303 per m^2 which is 73 and 41 stems per m^2 higher than in cases of 4 and 5 mil. seeds per hectare sowing rate ($HCP_{05} = 6$ stems per m^2). This trend is generally consistent across all predecessors.

The highest yield of oats during two year trials was obtained with 6 mil. seeds per hectare sowing rate after the red clover predecessor with 1.42 tons per hectare in year 2013 which is 0.06, 0.13 and 0.33 tons per hectare higher in case of the winter rye, peas and barley predecessors, respectively ($HCP_{05} = 0.06$ grams). The year 2014 yield of oats was 3.62 tons per hectare which is 0.36, 0.58 and 1.08 tons per hectare higher in case of the winter rye, peas and barley predecessors, respectively ($HCP_{05} = 0.09$ tons per hectare).

CONCLUSIONS

The two year field trials on a turfic-podzolic heavy loamy soil in varying weather conditions of years 2013-2014 have shown that the best predecessor for oats is the red clover which provided the highest average yield of 2.28 tons per hectare due to the highest stems density and inflorescence productivity. The optimum sowing rate for the “Dens” cultivar was found to be 6 mil. seeds per hectare which provided the overall average yield of 2.21 tons per hectare. The increase in yield is attributed to substantially higher stems density.

REFERENCES

- Akmanaev E.D., Zubarev U.N., Eliseev S.L., Renev E.A. (2012) Innovative technologies in agricultural business. Perm State Agricultural Academy. Perm. Russia. 335 p.
- Anisimov A.A. Productivity of oats depending on the nitrogen doses and seeding rates of Southern Urals (1983). Perm. Russia. 14 p.

- Kolesnikova V.G., Fatihov I.S., Stepanova M.A. Oats are sown in adaptive plant Ural region (2006). Izhevsk. Russia. 190 p.
- Kosianenko L.P. Cultivar as a leading factor in the effectiveness of grain production. Grain farming. Vol. 5. P. 18-19.
- Kurisheva V.G., Sobennikov E.V. Cultivar, seedgrowing, harvest (1969) Izhevsk, Russia. 96p.
- Prokoshev V.N. The field crops Ural region (1968). Perm. Russia. 365 p.
- Rusinov S.P. Effect of sowing, seeding rates and methods of preparation of seeds for the harvest and sowing of grain quality of spring wheat, oats and barley in the Northern Ural region (1955). Perm. Russia. 15 p.
- Svetlakova V.I. The action of nitrogen fertilizer on the yield of oats depending on the moisture level in the different soils (1979). Impact of agricultural techniques and fertilizers on productivity and quality of forage crops. 127. Perm State Agricultural Academy. Perm Russia. P. 49-56