THE GRAIN CROP YIELD IN DIFFERENT CROP ROTATION AND EFFICIENCY OF HERBICIDES AND FUNGICIDES TREATMENT

DAŽĀDAS SĒJUMU STRUKTŪRAS AUGSEKU UN PESTICĪDU IETEKME UZ GRAUDAUGU RAŽU

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Abstract. *Complex field experiments were carried out in Agricultural research institute in 1969. The field trials included five different crop rotation systems. In each 6-field rotation system the specific percentage of cereals (%) varied from 50 to 100%, perennial grass (clover+ timothy) – 16.7 to 33.3%. The highest winter rye yields were obtained from crop rotation systems with cereal proportion up to 66%. Including buckwheat in the crop rotation winter rye cultivation is highly productive in crop rotation systems with cereal proportion even up to 83%. Yield of winter rye in long-term monocultural sowings decreases even up to 0.74ha^{-1}. Winter rye treatment with herbicide Grodil increases its yield up to 0.40 ha^{-1}. Foreplants of barley according to their good influence on barley yield (descending): buckwheat, oats, winter rye. Barley yield in long-term monocultural sowings decreases for up to 1.17 t ha^{-1}*

Oats in crop rotation systems with cereal proportion up to 83% had very low yield amount alterations after different foreplants. Essential oat yield decreasement was noticed in perennial monocultural sowings. The best foreplants for spring wheat are buckwheat and lupine. The highest yield of buckwheat is get from monocultural sowings, but using potatoes as buckwheat foreplant gives essential yield decreasement. Distribution of perennial weeds, especially quickgrass, is 7,4 times more in crop rotation systems with high cereal proportion than in systems where also buckwheat and potatoes are cultivated. Treatment of herbicides and fungicides is more effective in monocultural sowings than in crop rotational systems, however increasement of crop yield after pesticide treatment is less remarkable than if we follow right crop rotation and choose optimal foreplants for each culture. Latest results from years 2002 to 2004 are shown in this article and are considered to be an addition to previous publications.

Key words: *crop rotation, percentage of cereals, foreplants, grain crops, herbicides, fungicides.*

Introduction

Farmers are forced by market economy to become highly specialized on one or few cultures. Different harmful phytosanitary conditions are caused to cultivating technologies of the rest plants. Protractedle cultivation of related cultures in the same place causes breeding of specific weeds and diseases. That is why importance of correct crop rotation and efforts of fighting with specific weeds and diseases increases. Significance of mentioned problems and their solutions are most visible in stationary field trials. Certain experience and results of investigations regarding crop rotation are gained in a long-term stationery crop rotation field trial in Latvia Agricultural University`s Agency: Scientifical Institute of Agriculture in Skriveri. Structure of this field trial as well as main results are summarized in publications of D.Lapins, B.Lejina (1997); A.Lejins, B.Lejina (2000); A.Lejins, B.Lejina (2002); A.Lejins, B.Lejina (2003). Latest results from years 2002 to 2004 are shown in this article and are considered to be an addition to previous publications.

Object and methods of research

Complex crop rotation research was started in Scientifical Institute of Agriculture on 1969, it has expanded in time and space and now consists of five variously structured crop rotations. In different combinations proportion of cereals is 50-100%, perennial grasses – 16.7-33.3%. Characterization of soil: poorly podzolic swad, cultivated with pH 5.4-6.3, content of organic material 19-22 g/kg^{-1}, easy absorbable phosphorus 21-23 mg/ kg^{-1} and potassium 87-99 mg/kg^{-1}. Grading composition of the soil is sandy loam. Following sorts of cultivated plants

were used in researches: winter rye 'Voshod', barley 'Ruja', oats 'Selma', spring wheat 'Planeta', buck wheat 'Anita Beloruskaja'. Total area of the field of one crop rotation is 354.4 m^2, area of split field is 59 m^2. Yield of each field was collected with harvester Sampo500, weighted and equalled to 14% moisture. Differences between variants were evaluated mathematically by variance analysis. Weed follow-up was made in 100 points in each variant, occurance of each weed sort was calculated in % and afterwards modified in pieces per sq.meter (Rasins A., Taurina M., 1982).

Results

The highest winter rye yields are collected from crop rotations where proportion of cereals is 66%. Including lupine and buck wheat in the same crop rotation, winter rye is highly productive in crop rotations where proportion of cereals is 83%. The greatest decreasement – even until 0.74 t ha^{-1}(table 1) of winter rye yield is in monocultural variants and where winter ryes are grown repeatedly. Usage of herbicide Grodil provides on average 0.40 t ha^{-1}yield increasement of winter rye. Same herbicide provides yield increasement of winter rye in monocultural variants even 0.83 t ha^{-1}, but that does not recompense the amount of yield which can be get by cultivating winter rye in correct crop rotation (table 2).

Table 1.

Winter rye yield t ha^{-1} after different foreplants

Number of crop rotation and proportion of cereals in crop rotation.	*Preceding crops*	*Yield t ha^{-1}*	*As compared to 1-st field rotation*	
			+/- t ha^{-1}	*%*
1 -50	Clover+timothy II	4.89		100
2 - 66	Clover+timothy II	4.49	-0.4	92
2 - 66	Rye - barley	4.74	-0.15	97
3 - 83	Buckwheat - barley	4.93	+0.04	101
4 - 83	Lupine– spring wheat	5.38	+0.49	110
5 - 100	Barley+ peas	4.34	-0.55	89
5 - 100	Rye - rye	4.29	-0.6	88
5 – 100	Rye (monoculture)	4.15	-0.74	85
$\gamma_{0.05}$ = 0.41 t ha^{-1}				

Table 2.

Winter rye yield t ha-1 under influence of herbicide Grodil

Number of crop rotation and proportion of cereals in crop rotation	*Preceding crops*	*Control - without herbicides*	*Grodil 30 g ha–1+ MCPA 1.0 l ha–1 at tillering*		
		Yield t ha –1	Yield t ha –1	+/- t ha –1	%
2 - 66	Clover+timothy II	4.63	5.00	+0.37	108
2 - 66	Barley	4.58	4.89	+0.31	107
3 - 83	Barley	4.67	5.47	+0.80	117
4 - 83	Spring wheat	5.33	5.43	+0.10	102
5 - 100	Rye grown repeatedly	3.99	4.82	+0.83	121
Average		4.60	5.00	+0.40	109
γ 0.05 =0.34 t ha –1					

Evaluation of barley foreplants descending (starting from the best) – buck wheat, oats, winter rye (table 3).

Table 3.

Barley yield ha –1 after different foreplants

Number of crop rotation	*Proportion of cereals in crop rotation*	*Preceding crops*	*Control Yield t ha –1*	*As compared to 1-st field rotation*	
				+/- t ha –1	*%*
1	50	Oats	3.93		100
2	66	Rye	3.06	-0.87	92
3	83	Buckwheat	3.91	-0.02	99
4	83	Rye	3.22	-0.71	82
4	83	Oats	3.61	-0.32	92
5	100	Oats	3.89	-0.04	98
5	100	Rarley	3.64	-0.29	93
5	100	Barley grown repeatedly	2.45	-1.48	62
γ 0.05 = 0.34 t ha –1					

Repeated cultivation of barley gives yield decreasement even until 1.48 t ha-1(decreases for 38%). Usage of herbicide Grodil gives lasting yield increasement – average 21%. Usage of fungicides increases yield even more – for about 29%. Same as for winter rye also in barley monoculture the greatest yield increasement: 1.39 t ha –1 (for 79%) is get by complex usage of herbicides and fungicides. Although this does not recompense barley cultivation in correct crop rotation.

Table 4.

Barley yield t ha –1 after usage of herbicides and fungicides

Number of crop rotation	*Preceding crops*	*Control*	*Treatment with pesticides*		
		Yield t ha –1	*Yield t ha –1*	*As compared to control*	
				+/- t ha –1	*%*
		Without herbicides	Grodil 30 g ha–1+ MCPA 1.0 l ha–1 at tillering		
2	Rye	2.71	3.42	+o.71	126
3	Buckwheat	3.48	4.35	+0.87	125
4	Rye	2.91	3.54	+0.63	122
4	Oats	3.34	3.87	+0.53	116
Average		3.11	3.75	+0.64	121
		Without fungicides	Tango 0.8 l ha at stalk-shooting		
1	Oats	3.13	4.34	+0.81	123
5	Oats	3.09	4.69	+1.60	152
5	Barley	3.39	3.89	+0.50	115
Average		3.34	4.30	+0.96	129
		Without pesticides	Grodil 30 g ha–1+ MCPA 1.0l ha–1 at tillering + Tango 0.8 l ha stalk-shooting		
5	Barley grown repeatedly	1.76	3.15	+1.39	179
γ 0.05 = 0.43 t ha –1 for herbicides; γ 0.05 =0.46 t ha –1 for fungicides					

The highest oat yields are when cultivating them after potatoes. A remarkable oat yield decreasement is orbserved cultivating them after winter rye in crop rotations with cereal proportion 66%. Our perennial researches show that in monocultural sowings decreasement of oat yield reaches 1.62 t ha –1or 43%.(table5).

Table 5.

Oat yield t ha –1 after different foreplants

Number of crop rotation	*Preceding crops*	*Yield t ha –1*	*As compared to 1-st field rotation*	
			+/- t ha –1	*%*
1	Potatoes	3.79		100
2	Rye	2.98	- 0.81	78
4	Barley	3.32	-0.47	87
5	Rye	3.59	-0.2	95
5	Oats grown repeatedly	2.17	-1.62	57
γ 0.05 =0.41 t ha –1				

Usage of mix of herbicides Grodil and MCPA increased oat yield for 0.28 t ha –1 or 9 %. Usage of fungicides in oat sowings increased yield even more – for 0.57 t ha –1 or 18%. Complex usage of herbicides and fungicides in monocultural oat sowings, just like in other cereal cultures, cannot cover yield loses if we compare to cultivating them in correct crop rotation (table 6).

Table 6.

Oat yield t ha –1 by various usage of pesticides

Number of crop rotation	*Preceding crops*	*Control*	*Treatment with pesticides*		
		Yield t ha –1	*Yield of oats t ha –1*	*As comperated to control*	
				+/- t ha –1	*%*
		Without herbicides	Grodil 30 g ha–1+ MCPA 1.0l ha–1 at tillering		
2	Rye	2.80	3.05	+0.25	109
4	Barley	3.12	3.44	+0.32	110
Average		2.96	3.24	+0.28	109
		Without fungicides	Tango 0.8 l ha at stalk-shooting		
1	Potatoes	3.34	3.93	+0.59	118
5	Rye	3.19	3.75	+0.56	117
Average		3.26	3.84	+0.57	118
		Without pesticides	Grodil 30 g ha–1+ MCPA 1.0l ha–1 at tillering + Tango 0.8 l ha stalk-shooting		
5	Oats grown repeatedly	1.74	2.34	+0.60	135
γ 0.05 = for herbicides 0.21 t ha –1; for fungicides – 0.33 t ha –1					

Table 7.

Weedyness (pcs/sq.meter) of oats after different foreplants

Number of crop rotation	*Preceding crops*	*Number of weeds total*	*including*		
			annual weeds	*perennial weeds*	*including couchgrass*
1	Potatoes	46	13	34	29
2	Rye	147	57	84	61
4	Barley	169	58	111	106
5	Rye	123	11	112	100
5	Oats grown repeatedly	383	96	287	278

Essential increasement of weed, especially perennial weed, quantity is observed in repeated sowings of all cultures. Main weed is Elytrigia repens (L)Nevski here.

Cultivating spring wheat in crop rotation gives yield increasement for 0.76 – 1.05 t ha-1 if compared to repeat cultivating in the same place. Usage of herbicide Monitor in spring wheat sowings in crop rotation gives yield increasement 23%. Complex usage of herbicide Monitor and fungicide Tango in repeated spring wheat sowings gives yield increasement even 114%, but this yield is still less than it can be get from sowings with correct crop rotation. By repeated cultivation of spring wheat we observed increasement of quantity of perennial weeds, especially Elytrigia repens (L) Nevski.

Table 8.

Spring wheat yield t ha-1 in various crop rotations after various foreplants

Proportion of cereals in crop rotation	*Preceding crops*	*Grain yield t ha-1*	*+/- tha-1*	*%*
66	Buckwheat	3.39	+0.76	129
83	Lupine	3.68	+1.05	140
100	Spring wheat grown repeatedly	2.63		100
γ 0.05 = 0.30 t ha-1				

Table 9.

Weedyness (pcs/sq.meter) of spring wheat after various foreplants

Preceding crops	*Number of weed plants*	*Including*		
		annual weeds	*perennial weeds*	*including couchgrass*
Buckwheat	124	61	63	21
Lupine	127	104	23	19
S. wheat grown repeatedly	142	74	74	33

Table 10.

Spring wheat yield t ha-1 in various crop rotations and by various usage of herbicides

Preceding crops	*Control – without herb.*		*Monitor 0.02 kg ha-1 at 2-3 leaf stage*		
	t ha-1	*%*	*t ha-1*	*+/- t ha-1*	*%*
Buckwheat	3.05	100	3.72	+0.67	122
Lupine	3.30	100	4.06	+0.76	123
Average	3.17	100	3.89	+0.72	123
	Control – without herbicides and fungicides		Monitor 0.02 kg ha-1 at 2-3 leaf stage +tango 0.8 l ha-1 at stalk-shooting		
S. wheat grown repeatedly	1.67	100	3.58	+1.91	214
γ 0.05 =0.33 t ha-1					

The highest buck wheat yield can be get from repeated sowings, but remarkable yield decreasement - 0.25 t ha-1 – cultivating buck wheat after potatoes. Explanation can be that both these cultures are exacting potassium consumers and this way - each others competitors. Usage of herbicides Betanal AM and Butizan 480 in buck wheat sowings increased yield of nutlets in all cases and is advisable in sowings.

Table 11.

Buckwheat foreplants` influence on yield in crop rotation stationery 2002-2004

Preceding crops	*Nutlets yield of buckwheat*		
	t ha-1	*+/- t ha-1*	*%*
Rye	1.76	- 0.04	98
Potatoes	1.55	- 0.25	86
Buckwheat, reiterated growth	1.80		100
γ 0.05 = 0.21 t ha-1			

Table 12.

Yield of buckwheat nutlets t ha-1 in some variants of herbicide usage

Preceding crops	*Control without herbicides*	*Herbicides, dosage of herbicides*		
		t ha-1	*+/- t ha-1*	*%*
		Betanal AM 2.5 l ha-1 for buckwheat at 2-3 leaf stage		
Rye	1.56	1.95	+0.39	125
		Butizan 1.5 l ha-1 before shoots		
Potatoes	1.40	1.68	+0.28	120
Buckwheat, reiterated growth	1.64	1.89	+0.25	115
Average	1.54	1.84	+0.30	119
γ 0.05 = 0.19 t ha-1				

Conclusion

1. The highest winter rye yields are getting from crop rotations where cereal proportion is 66%. Including lupine and buck wheat in the same crop rotation, winter rye is highly productive in crop rotations where proportion of cereals is 83%
2. The greatest decreasement – even until 0.74 t ha-1(1.table) of winter rye yield is in monocultural variants and where winter ryes are grown repeatedly.
3. Usage of herbicides and fungicides in monocultural sowings of all researched cultures give remarkable yield increasement, but that does not recompense yield that can be get by practising correct crop rotation.
4. In barley and oat sowings yield increasement was bigger after usage of fungicides that after herbicides.
5. Including buck wheat in crop rotation provides high yields of cereal cultures.
6. The highest buck wheat yield can be get from repeated sowings, just like other years - cultivating buck wheat after potatoes give yield decreasement.
7. Essential increasement of Elytrigia repens (L)Nevski quantity is in crop rotations where cereal proportion is 83%, especially in repeated sowings.

Kopsavilkums

Tirgus ekonomika piespiež zemnieku saimniecības šauri specializēties, tāpēc tur strauji samazinās audzējamo kultūraugu skaits. Ilgstoši vienā vietā audzējot radnieciskus kultūraugus, parasti savairojas specifiskas nezāles un augu slimības. To labi var novērot ilgstošos augseku izmēģinājumos Lai skaidrotu jautājumus par dažādu augmaiņas nozīmi, Zemkopības zinātniskajā institūtā 1969.uzsākti kompleksie augseku pētījumi Tiek salīdzinātas piecas dažādas sešlauku augsekas ar dažādu sējumu struktūru, kur graudaugi variē no 50 līdz 100%, daudzgadīgās zāles – 16,7-33,3%, rušināmaugi – 0-16,7%. Rakstā atspoguļoti dati, kas iegūti šajā izmēģinājumā no 2002.gada līdz 2004.gadam. Augstākās ziemas rudzu ražas iegūst augsekās ar graudaugu īpatsvaru līdz 66%. Iekļaujot augsekā griķus un lupīnu, tos var

sekmīgi audzēt augsekās ar graudaugu īpatsvaru līdz 83%. Ziemas rudzi bezmaiņas sējumos dod būtisku ražas samazinājumu līdz 0,74 t ha^{-1}. Herbicīda grodila lietošana ziemas rudzos dod līdz 0,4 t ha^{-1} lielu ražas pieaugumu. Miežu priekšaugi pēc ietekmes uz graudu ražu lejupslīdošā secībā sarindojami šādi: griķi, auzas, ziemas rudzi. Mieži atkārtotā audzēšanā dod būtisku ražas samazinājumu līdz 1,17 t ha^{-1}. Auzas augsekās ar graudaugu īpatsvaru līdz 83% maz reaģēja uz to izvietojumu pēc dažādiem priekšaugiem. Būtisks ražas samazinājums ir variantos, kur tās audzē atkārtoti. Augstākās vasaras kviešu ražas ir pēc griķiem un lupīnas. Visaugstākās griķu ražas iegūst atkārtotas audzēšanas variantā, bet būtisks ražas samazinājums novērojams tur, kur tie audzēti pēc kartupeļiem. Būtisks daudzgadīgo nezāļu skaita pieaugums, it sevišķi ložņu vārpatas, novērojams augsekās ar lielu graudaugu īpatsvaru, un tā atsevišķās kultūrās ir 7,4 reizes vairāk kā augsekās, kur audzēja kartupeļus un griķus. Graudaugu bezmaiņas sējumos herbicīdu un fungicīdu efektivitāte ir vislielākā, bet to lietošana nekompensē ražu, ko dod, kultūraugus audzējot augsekā vai augmaiņā.

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