PARTICULARITIES OF HARVESTER SETTINGS DURING THE HARVESTING OF HULLESS BARLEY
KOMBAINA REGULĒŠANAS ĪPATNĪBAS KAILGRAUDU MIEŽU RAŽAS NOVĀKŠANAI

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Kopsavilkums

Kailgraudu mieži ir Eiropā netradicionāls graudaugs, kam raksturīga paaugstināta barības vērtība izmantošanai lopbarībā un veselību uzlabojošas īpašības izmantošanai pārtikā. Kailgraudu miežu selekcija tiek veikta vairākās Eiropas valstīs, ieskaitot Latviju. Kombaina regulēšana, novācot kailgraudu miežu ražu, ir atšķirīga no plēkšņainajiem miežiem. Patēriņa un sēklas materiāla iegūšanai nepieciešami atšķirīgi kombaina noregulējumi.

Kanādā, kur kailgraudu miežu platības ir vislielākās, kvalitātes prasības kailgraudu miežiem pārtikai ir: maksimāli 5% graudu ar neatdalītām plēksnēm, tilpummasa 773 g L^{-1} un augstāka, sašķelti graudi maksimāli 4%; lopbarības graudiem prasības ir zemākas: maksimāli 15% graudu ar neatdalītām plēksnēm, tilpummasa vismaz 742 g L^{-1}, sašķelti graudi maksimāli 15% (McLelland, 1999). Kailgraudu miežu sēklas kvalitātes prasības Eiropā neatšķiras no plēkšņainajiem miežiem, kaut arī pētījumu rezultātā dota rekomendācija samazināt minimālo pieļaujamo dīgtspēju no 85 uz 75% (Legzdiņa, 2003). Austrālijas un Kanādas zinātnieki iesaka kailgraudu miežu ražu vākt ar mazākiem kuļtrumuļa apgriezieniem nekā plēkšņainajiem miežiem, lai samazinātu graudu un dīgļu traumēšanos, kā arī ar mazāku attālumu starp kuļtrumuli un kuļkurvi, lai sekmētu plēkšņu atdalīšanu no graudiem (Box, Barr, 1997; McLelland, 1999).

Mūsu pētījuma mērķis bija noteikt optimālos kombaina regulēšanas parametrus kailgraudu miežu ražas novākšanai Latvijas apstākļos, analizēt atšķirības starp genotipiem un meteoroloģisko apstākļu ietekmi. Četrus gadus (2003.-2006.) analizējām trīs genotipus (Kanādas šķirni 'CDC Freedom', čehu selekcijas līniju KM-2084 un zviedru selekcijas līniju SW-1291). Lauka izmēģinājumi tika veikti LLU MPS „Vecauce", izmantojot izmēģinājumu kombainu Hege-140. Katru gadu pārbaudīti 5 kulšanas režīmi (1.tabula), variējot kuļtrumuļa apgriezienus (800-1250 min) un attālumu starp kuļtrumuli un kuļkurvi jeb kuļspraugu (2-5 mm). Tika analizēti patēriņam un sēklas materiālam nozīmīgi rādītāji (graudu daudzums ar neatdalītām plēksnēm, tilpummasa, sašķelto graudu daudzums, dīgtspēja un graudu daudzums ar traumētiem dīgļiem). Meteoroloģiskie apstākļi pirms ražas novākšanas pa gadiem bija atšķirīgi un ietekmēja graudu mitrumu ražas novākšanas laikā. 2003. un 2006. gadā graudi tika novākti sausi, ar optimālu mitruma saturu, 2004. gadā graudu mitrums bija paaugstināts, bet 2005.gadā, kaut arī kulšanas laikā mitrums nebija augsts, graudi bija izmirkuši nedēļu ilgās lietavās un daļēji sadīguši vārpās.

Rezultāti rāda, ka kuļtrumuļa apgriezienu palielināšana ietekmēja graudu un sēklas kvalitāti lielākā mērā nekā kuļspraugas izmaiņas. Pārtikas un lopbarības vajadzībām atbilstošāku ražu izdevās iegūt, kuļot ar lielākiem kuļtrumuļa apgriezieniem (1250 apgriezieni minūtē) un 4 mm kuļspraugu. Apgriezienu skaita palielināšana būtiski samazināja graudu daudzumu ar neatdalītām plēksnēm un līdz ar to palielināja graudu tilpummasu un arī sašķelto graudu daudzumu (3. tabula). Paaugstinot apgriezienu skaitu minūtē no 900 uz 1250, šķirnei 'CDC Freedom' 2004. un 2005. gadā samazināts graudu daudzums ar neatdalītām plēksnēm un līnijai KM-2084 2003. gadā palielināta tilpummasa līdz pārtikas prasībām atbilstošiem, bet lopbarības prasībām atbilstoša tilpummasa divos gados iegūta abām selekcijas līnijām. Sašķelto graudu daudzums pārsniedza pārtikai pieļaujamo vienīgi šķirnei 'CDC Freedom' 2005. gadā, kad to veicināja graudu sadīgšana vārpās. Kuļspraugas samazināšana būtiski uzlaboja plēkšņu atdalīšanu no graudiem tikai vienā gadījumā, bet vairākos gadījumos tās ietekme uz sašķelto graudu daudzumu bija būtiska, īpaši gadījumā, ja kulti graudi ar zemāku mitrumu. Sēklas materiāla iegūšanai atbilstošāks bija kulšanas režīms ar zemāku kuļtrumuļa apgriezienu skaitu (900 apgriezieni min) un 4 mm kuļspraugu. Kuļot ar šādu režīmu, sēklas dīgtspēja pārsniedza minimālo pieļaujamo visiem genotipiem, izņemot

‘CDC Freedom’ 2005.gadā. Pret traumām jutīgiem genotipiem (‘CDC Freedom’), kuļot graudus ar nelielu mitruma saturu (2003.gadā), pozitīvs efekts var tikt iegūts, samazinot apgriezienu skaitu līdz 800 un palielinot kuļspraugu līdz 5 mm. Apgriezienu palielināšana būtiski palielināja graudu daudzumu ar traumētiem dīgļiem un samazināja dīgtspēju. Samazinot apgriezienu skaitu minūtē no 1250 uz 900, ‘CDC Freedom’ un KM-2084 divos izmēģinājumu gados izdevās paaugstināt dīgtspēju virs 85%. Attiecīgā gada meteoroloģisko apstākļu ietekme uz visiem pētītajiem rādītājiem bija būtiska un pārsniedza genotipa un kulšanas režīma ietekmes īpatsvaru uz graudu tilpummasu un sēklas dīgtspēju. Visaugstākais kulšanas režīma ietekmes īpatsvars (28%) bija uz sašķelto graudu daudzumu.

Abstract

Requirements for harvesting hulless and covered barley are significantly different. Hulless barley for consumption and for seed has to be harvested differently. For consumption it is more necessary to separate hulls from the grain and to increase volume weight, but for seed production retention of germination is essential. In our experiment we analyzed the yield of three hulless barley varieties harvested by using five different harvester settings during four growing seasons. The harvester drum speed and distance between threshing drum and concave was varied. Quality features essential for for feed and food production (volume weight, amount of kernels with undetached hulls and broken kernels) and for seed production (germination ability and amount of kernels with germ damage) were determined. Our results indicate that meteorological conditions during harvesting influenced all tested features significantly ($p<0.05$). The variety features also influenced the investigated parameters significantly ($p<0.05$). Grain volume weight correlated significantly less with the amount of kernels with undetached hulls. The increase of the harvester drum speed had a significant positive effect on grain parameters important for consumption in more cases, than the reduction of the distance between the threshing drum and concave. The best results for consumption were reached mainly by using harvester settings recommended for covered spring barley. More appropriate for harvesting hulless barley grain for seed production were harvester settings with lower drum speeds.

Key words

Hulless barley, threshing, volume weight, germination

Introduction

Hulless barley (HB) is a non-traditional cereal in Europe, which is attractive because of its nutritional value for feed and healthy food purposes. Breeding for HB is carried out in several EU countries including Latvia. HB for consumption and for seed has to be harvested differently. For feed and food use it is more necessary to separate hulls from grain and to increase the volume weight, but for seed production retention of germination is essential.

Quality standards for HB grain for human food and animal feed are distinctive. Canadian requirements for food grain are: maximum 5% of grains with hulls, volume weight 773 g L^{-1}, cracked and broken kernels maximum 4%, grain should be fully mature, bright, clean and free of diseased and sprouted kernels. Feed grain standards are easier to reach: hull content less that 15%, volume weight 742 g L^{-1}, sprouted kernels maximum 10% and broken kernels maximum 15%. (McLelland, 1999) Requirements for HB seed quality are currently the same for hulless and covered barley in EU countries. Recommendation to lower minimum acceptable germination for HB seed from 85 to 75 % was given according to research results (Legzdina, 2003).

Harvester settings for hulless and covered barley are significantly different. According to the experience of Australian researchers, harvester drum speed may be up to 250 rounds per minute slower while threshing HB. It will reduce kernel cracking and embryo damage. They recommend decreasing the distance between threshing drum and concave to improve hull separation from grain. To reduce the amount of separated hulls and prevent the grain loss at the same time the rear blower fan speed and the rear cleaning sieve angle have to be increased. (Box, Barr, 1997) Similarly, Canadian recommendations for HB harvesting are to use “tight concave setting and as slow a cylinder speed as possible” (McLelland, 1999). HB grain must be dry to remove hulls successfully. Secondary buffing process can be used if hull removal is not satisfactory.

Threshability is a trait showing hull removal during threshing and it varies between HB genotypes. HB varieties have to be with good threshability, otherwise there is no advantage in comparison to covered barley. Selection for better threshability is done by selecting genotypes with higher volume weight because there is a positive relationship between both traits. (Rossnagel, 1999; Rossnagel, 2000)

The aim of our experiment was to find the optimum harvester settings for HB in Latvian growing conditions, to state the differences between the genotypes and the influence of meteorological conditions. The need for such investigations was pointed out in previous research (Legzdina, 2001; Legzdina, 2003).

Materials and Methods

We analyzed the yield of three hulless barley genotypes harvested by using five different harvester settings during four growing seasons (2003-2006). Genotypes with good yield potential in Latvian growing conditions were selected: the Canadian HB variety 'CDC Freedom', the Czech breeding line KM-2084 and the Swedish breeding line SW-1291. Field trials were carried out in the Research and Study farm "Vecauce" of the Latvia University of Agriculture. Trial was arranged in 4 replication blocks, plot size 5 m^2. Soil (mainly sod-calcareous leached soil) characteristics: loam with pH_{KCl} = 6.2-7.1; content of available for plants P = 76–114 mg kg^{-1} and K = 68-130 mg kg^{-1}; humus content 21-29 g kg^{-1}. Plot combine Hege-140 was used; harvesting was done in time as close as possible to full maturity. The harvester drum speed and the distance between the threshing drum and the concave was varied during harvesting (Table 1). The standard threshing mode was the one recommended for covered barley (drum speed 1250 rounds per min (hereafter - rpm), distance between threshing drum and concave 4 mm) and was the same each year. Other threshing modes were changed according to the results obtained. The data were analyzed in three combinations: the influence of the increase of the threshing drum speed (threshing modes 2, 3 and 4), the influence of the reduction of distance between threshing drum and concave at high drum speeds (threshing modes 4 and 5) and low drum speeds (threshing modes 1 and 2).

Table 1 Harvester settings applied and grain moisture content during threshing

Threshing mode	2003		2004		2005		2006	
	Drum speed, rpm	Distance*, mm	Drum speed, rpm	Distance*, mm	Drum speed, rpm	Distance*, mm	Drum speed, rpm	Distance*, mm
1	800	5	800	4	900	3	900	3
2	900	4	900	3	900	4	900	4
3	1100	4	1100	3	1100	4	1100	4
4 (stand.)	1250	4	1250	4	1250	4	1250	4
5	1250	3	1250	3	1250	2	1250	2
Moisture range, %	12.1-16.0		14.5-25.5		11.8-17.2		13.3-15.5	
Mean moisture, %	13.7		17.4		14.7		14.6	

* distance between threshing drum and concave

Meteorological conditions before and during harvesting varied between the years. It influenced grain moisture content during threshing (Table 1). In 2003 and 2006 grain moisture content was close to optimum, but in 2004 grain moisture content was too high because of frequent rainfall around harvesting time. In 2005 the grain moisture content was satisfactory during threshing, but there was one week long period of heavy rain when plants were close to maturity and it caused sprouting. The variety 'CDC Freedom' was particularly susceptible to sprouting.

Quality features essential for consumption for feed and food (volume weight, amount of kernels with undetached hulls and broken kernels) and for seed production (germination ability and the amount of kernels with germ damage) were determined. One sample per plot was analyzed after cleaning with an air separator. The amount of kernels with undetached hulls, broken kernels and kernels with germ damage was determined in 100 g samples and calculated in percent by weight. Feed and food grain quality was compared to the requirements existing in Canada (McLelland, 1999). Germination tests were done for 100 seeds in Petri dishes between moist filter paper layers for 7 days in 20 °C. ANOVA and correlation analysis was used for data processing.

Results and Discussion

Important quality indices for food and feed grain, which can be influenced by the threshing process, are the amount of kernels with undetached hulls, volume weight and the amount of broken kernels. Grain volume weight correlated negatively with the amount of kernels with undetached hulls and the correlation was significant in three growing seasons (r_{2003} = -0.79; r_{2005} = -0.88; r_{2006} = -0.77; $r_{0.05}$ = 0.51). In general, grain quality was closest to the optimum for food and feed requirements by using the standard threshing mode (Table 2).

Table 2 Grain and seed quality obtained with the standard threshing mode (2003-2006)

Variety / line	Values	Yield, t ha^{-1}	Volume weight, g L^{-1}	Kernels with undetached hulls, %	Broken kernels, %	Germination, %	Kernels with damaged germ, %
KM-2084	Mean	4.8	752	5.6	2.0	88.6	7.7
	Min-max	4.3-5.3	741-785	4.4-8.5	0.7-2.8	80.5-94.3	3.1-12.0
SW1291	Mean	5.7	768	9.0	1.8	90.2	7.9
	Min-max	3.9-7.6	744-792	7.0-17.2	1.0-1.4	88.0-98.8	1.7-7.8
CDC Freedom	Mean	5.2	747	2.6	3.3	77.9	14.2
	Min-max	3.9-6.3	689-797	1.6-4.1	1.2-6.2	51.8-97.0	5.4-19.5
$LSD_{0.05}$ (variety)			7.4	1.68	0.18	1.7	0.61

Grain volume weight was acceptable for food requirements (>773 g L^{-1}) using this harvester setting for all genotypes only in 2003, when the driest grain was harvested. The variety ‘CDC Freedom’ was the only one, for which it was possible to reach the amount of kernels with undetached hulls under the 4% level, but only by threshing grain with low moisture content in 2003 and 2006. Grain of ‘CDC Freedom’ did not correspond to feed grain requirements in 2004 and 2005 due to very low volume weight. Reason for this was high grain moisture content and severe sprouting. Grain volume weight and the amount of kernels with undetached hulls for lines KM-2084 and SW-1291 was satisfactory for feed requirements in all years except for 17.2 % grain with hulls for SW-1291 in 2005. Differences between the amounts of kernels with undetached hulls among the genotypes were significant; it certifies that threshability is a genetically determined trait. The amount of broken kernels was below 4% in all cases except ‘CDC Freedom’ with 6.2% in 2005. This variety was more susceptible to kernel breaking in general, and sprouting in 2005 promoted it. The negative correlation between the amount of kernels with undetached hulls and broken kernels was found, but it was significant only in 2003 (r_{2003} = -0.57; $r_{0.05}$ = 0.51). It means that in dry conditions the improvement of hull separation may go along with high level of broken kernels.

The increase of drum speed influenced significantly the amount of kernels with undetached hulls in 2003, 2004 and 2006 and volume weight in 2003 and 2004 (Fig.1, Table 3). The influence of variety was significant on both traits in all cases ($p<0.01$). The difference between the amount of kernels with undetached hulls at a drum speed of 900 and 1250 rpm was significant for SW-1291 (2003, 2006) and KM-2084 (2003, 2004). Hull separation was not significantly improved for the comparatively better threshing variety ‘CDC Freedom’, but it helped to obtain grain with the corresponding hull content requirements for food in years with unfavorable threshing conditions (2004 and 2005). Increase of drum speed improved volume weight significantly for KM-2084 (2003, 2004) and SW-1291 (2006). It elevated volume weight to acceptable levels for food requirements (KM-2084, 2003) and for feed requirements (KM-2084, 2004 and 2006, SW-1291, 2005 and 2006). The amount of broken kernels was influenced by drum speed increase significantly in all years (Table 3). Differences between grain threshed with 1250 and 900 rpm drum speed was significant for ‘CDC Freedom’ in all years (0.9-5.2%), but the amount of broken kernels was raised to unacceptable levels for food (6.2%) only in 2005, when sprouting made grain more easily breakable. For both breeding lines differences were significant in 2004 and 2006.

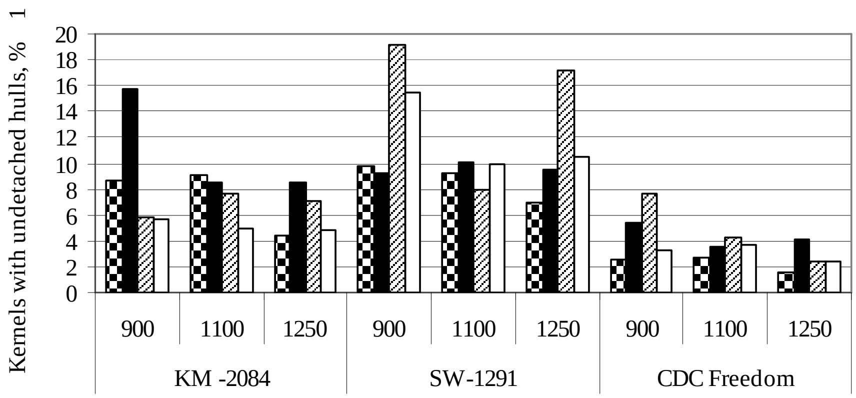

Figure 1. Influence of drum speed increase (rpm) on hull separation:

2003 2004 2005 2006

The reduction of the distance between drum and concave at 1250 rpm drum speed had a significant effect on the amount of broken kernels in dry threshing conditions (2003 and 2006, Table 3, Fig. 2). In both years a significant increase of broken kernels was found for 'CDC Freedom', and the amount exceeded the 4% level showing that one should be careful with the reduction of distance between the drum and concave for sensitive varieties. If grain with high moisture content was harvested (2004), the differences in the amount of broken kernels were minor. In most cases this reduction improved hull separation and volume weight, but the effect was significant only for SW-1291 in 2006 (differences 4.3% and 21 g L^{-1} respectively). It did not advance grain quality for food requirements.

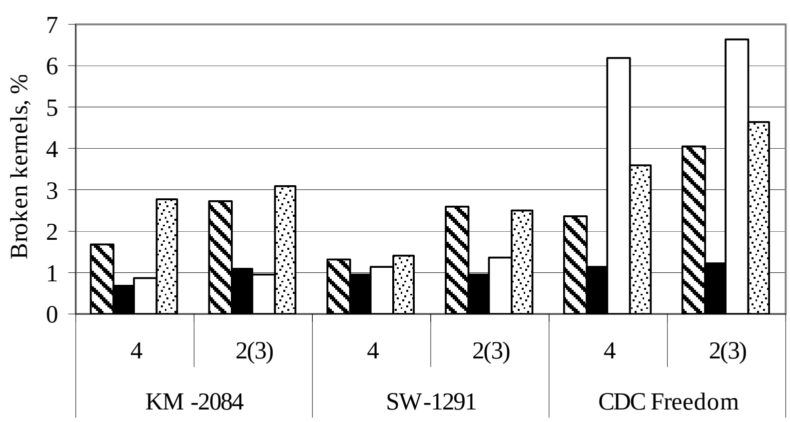

Figure 2. Effect of reduction of distance between threshing drum and concave (mm) on amount of broken kernels using 1250 rpm drum speed:

2003 2004 2005 2006

Table 3 The Influence of drum speed increase and the reduction of distance between the threshing drum and concave on quality parameters

Threshing modes analysed	Year	Kernels with undetached hulls	Volume weight	Broken kernels	Kernels with germ damage	Germination
Increase of drum speed						
Nr. 2, 3, 4	2003	p<0.01	P<0.01	p<0.01	p<0.01	p<0.01
	2004	p<0.01	P<0.01	p<0.01	p<0.01	n.s.
	2005	n.s	n.s.	p<0.01	p<0.01	p=0.04
	2006	p=0.03	n.s.	p<0.01	p<0.01	p<0.01
The reduction of the distance between the threshing drum and concave at high and low drum speed						
Nr. 4, 5	2003	n.s	n.s.	p<0.01	p<0.01	n.s.
Nr. 1, 2		n.s	n.s.	p<0.01	p<0.01	n.s.
Nr. 4, 5	2004	n.s	P=0.02	n.s.	n.s.	n.s.
Nr. 1, 2		n.s	n.s.	p=0.02	p=0.03	n.s.
Nr. 4, 5	2005	n.s	n.s.	n.s.	n.s.	n.s.
Nr. 1, 2		n.s	n.s.	p=0.04	n.s.	n.s.
Nr. 4, 5	2006	n.s	P=0.03	p<0.01	p<0.01	p<0.01
Nr. 1, 2		n.s	n.s.	n.s.	n.s.	p<0.01

If grain is harvested for seed production purposes it is most important to retain germination ability, which can be significantly influenced by germ damage. Significant correlation between germination ability and the amount of kernels with visible germ damage was found in three years (r_{2004} = -0.59; r_{2005} = -0.78; r_{2006} = -0.96; $r_{0.05}$ = 0.51). Previous studies stated, that visible germ damage explained 50.3% of all changes of germination ability (Legzdina, 2003). Higher germination ability and more rapid coleoptiles growth of HB kernels with undetached hulls in comparison to kernels without hulls were found (Box et al., 1999). In our study a correlation between germination ability and the amount of kernels with undetached hulls was positive, but it was significant in 2006 only (r_{2006} = 0.71; $r_{0.05}$ = 0.51). The amount of broken kernels can also influence seed quality and although parts of grain are able to germinate, the seedlings are weaker than those from normal seeds (Box et al., 1999). The correlation between germination ability and the amount of broken kernels was negative and significant in two years (r_{2004} = -0.55; r_{2006} = -0.79; $r_{0.05}$ = 0.51). Seed quality was overall the best, if threshing was done with lower drum speeds (900 rpm) and a 4 mm distance between the threshing drum and concave. Germination ability using this setting corresponded to seed quality requirements for all genotypes in all years except 'CDC Freedom' in 2005 (Table 4) because of sprouting. Highest germination ability was reached in 2004, when grain was harvested with high moisture contents. The amount of kernels with damaged germ was lowest for SW-1291 and highest for 'CDC Freedom', differences between genotypes were significant (p<0.05).

Table 4 Parameters influencing seed quality (threshing mode Nr.2, 2003-2006)

Variety / line	Values	Germination, %	Kernels with damaged germ, %	Broken kernels, %
KM-2084	Mean	94.7	2.7	0.4
	Min-max	90.5-97.5	1.8-3.2	0.1-0.6
SW-1291	Mean	95.3	1.4	0.4
	Min-max	91.5-98.8	0.3-2.4	0.2-0.8
CDC Freedom	Mean	83.3	6.7	0.7
	Min-max	55.3-97.3	1.9-9.6	0.3-1.0
$LSD_{0.05}$ (variety)		1.7	0.61	0.18

The decrease of drum speed influenced the amount of kernels with damaged germs and germinating ability significantly (Table 3). The influence of the genotype was also significant on both traits ($p<0.01$). Differences between germination of grain harvested with 1250 and 900 rpm drum speed was significant for KM-2084 in all years, 'CDC Freedom' in 2003 and 2006 and SW-1291 in 2006. The effect was more promounced if the grain was harvested with lower moisture contents (2003 and 2006). It was possible to surpass 85% germination by lowering drum speed for KM-2084 (2003 and 2005) and 'CDC Freedom' (2003 and 2006). The decrease of drum speed reduced significantly germ damage for all genotypes in all years except SW-1291 in 2006 (Fig. 3).

The reduction of the distance between the threshing drum and concave (threshing modes Nr. 1 and 2) influenced significantly the germination ability in 2006 and the amount of kernels with damaged germs in 2003 and 2004 (Table 3), but did not cause a decrease of germination under 85%. The increase of distance between threshing drum and concave from 4 to 5 mm in 2003 had a significant effect on germ damage for 'CDC Freedom'. This setting might be useful for sensitive genotypes in dry harvesting conditions.

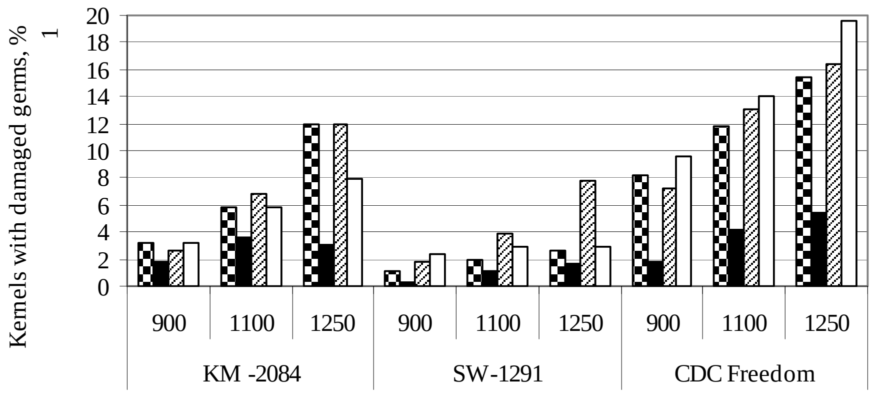

Figure 3. Influence of drum speed increase (rpm) on amount of kernels with damaged germs:

2003 ■ 2004 2005 □ 2006

Data analyses showed that the influence of specific meteorological conditions on the investigated traits was significant in all cases ($p<0.05$) and it surpassed in influence the proportion of genotype and threshing mode for volume weight (30.9-46.3%) and germination ability (35.8-40.3%). The influence proportion of yearly conditions on hull separation was lowest (3.9-9.6%). Threshing mode had the highest influence proportion on the amount of broken kernels when the drum speed was increased (28%). Genotype had the highest influence proportion on the amount of kernels with undetached hulls (29.6-36.8%).

Conclusions

Changes of harvester drum speed influenced the grain quality for food and feed, and seed production to a larger extent than changes of distance between the threshing drum and concave.

Grain quality was more appropriate for food and feed, if higher a drum speed (1250 rpm) and 4 mm distance between the threshing drum and concave was used. The reduction of the distance between the threshing drum and concave improved hull separation only in one case, but also had a negative effect on amount of broken kernels. It can be effective if grain moisture is low and the genotype is resistant to kernel breakage.

For seed production a threshing mode with a lower drum speed (900 rpm) and 4 mm distance between the threshing drum and concave can be recommended.

The new HB varieties have to be tested before release to find out the most appropriate harvester settings. In the HB breeding process attention has to be paid to the improvement of threshability, volume weight and resistance to grain germ damage.

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AGROEKOLOĢISKO APSTĀKĻU IETEKME UZ ZIEMAS KVIEŠU GRAUDU LIPEKĻA SATURU UN TĀ KVALITĀTES RĀDĪTĀJIEM
INFLUENCE OF AGROECOLOGICAL CONDITIONS ON WINTER WHEAT GRAIN GLUTEN QUANTITY AND QUALITY INDICES

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Abstract

Wheat is the major field crop grown in Latvia. High quality wheat grains are required for the milling and baking industries. Gluten quantity and quality are important qualities indices for technological processing of wheat.

Our objectives were to determine the relative influence of variety (V), year (Y), nitrogen fertilizer (N) on the variation of winter wheat (*Triticum aestivum. L*) gluten quantity and quality indices.

Field experiments with 9 winter wheat varieties of different origin were conducted on brown lessive soils of the Study and Research farm "Peterlauki" of the Latvia University of Agriculture in 2000, 2001, 2002 and 2004.

Split nitrogen fertilization was applied in the following way: early in spring at the beginning of the vegetation period, at the end of tillering and at the end of shooting into stems. The N fertilizer amount applied was four nitrogen fertilizer (90, 90+30, 90+30+30 and 90+30+60 N kg ha^{-1}) treatments for all the studied winter wheat varieties. Wet gluten content (WG), gluten index (GI), dry gluten (DG), water binding capacity in wet gluten (WBC) were measured at the Latvia University of Agriculture, Institute of Agrobiotehnology, Grain and Seed Research Laboratory by ICC No. 155 and. No. 137 /1 (LV ST-275).

Highly significant differences were detected among the environments and varieties for each of the quality variables. Variety and environment and nitrogen fertilizer had a significant effect on wet gluten quality indices. Results showed, that gluten quantity and quality indices were mostly influenced by the genetic peculiarities of a crop variety, to a lesser extent by meteorological conditions in the growing season and by the rate of split N fertilizer.

Close positive correlations were determined between the wet gluten and dry gluten, water binding capacity and dry gluten, water binding capacity and wet gluten.