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Comparison of yield and panicle productivity of hulled (*Avena sativa* L.) and naked (*Avena nuda* L.) oats*

Porównanie plonu i produktywności wiechy u owsa oplewionego (*Avena sativa* L.) i nagiego (*Avena nuda* L.)

To evaluate oat yield and determine grain yield components, three cultivars of hulled oat and three cultivars of naked oat were tested in field trials in the years 1999–2001. The experiments were carried out at four locations. The yield of naked oats reached 74% of that of hulled oats, but the production of nude grains was higher by 23% in naked oats. The productivity of panicles is the crucial trait affecting oat yield. Hulled cultivars, as compared with naked oats, produced a greater number of spikelets and a greater number of grains per panicle, respectively by 4.2 and 6.2 on average. The weight of 1000 grains produced by hulled cultivars was higher by 14%, but the percentage of the husks covered about 25% of the whole grain mass. The percentage of nude grains in the naked cultivars was higher (85%) than that in the hulled cultivars (50%).

Key words: hulled oats, naked oats, yield, panicle, productivity

W latach 1999–2001 przeprowadzono polowe doświadczenia, w których porównano plon 3 odmian owsa oplewionego i 3 odmian owsa nieoplewionego oraz określono rolę poszczególnych elementów plonotwórczych. Ocenę prowadzono w czterech miejscowościach. Owies nieoplewiony plonował średnio na poziomie 74% plonu owsa oplewionego, jednakże plon czystego ziarna owsa nieoplewionego był wyższy o 23% od plonu ziarna owsa oplewionego po obłuszczeniu. Zasadniczy wpływ na plon ziarna miała wydajność wiech. Owies oplewiony charakteryzował się większą liczbą kłosków i większą liczbą ziaren w wiesze niż owies nieoplewiony, średnio — odpowiednio — o 4,2 i 6,2. Ciężar 1000 ziaren owsa oplewionego był większy o 14%, jednakże zawartość łuski wynosiła w nich ok. 25% ogólnej masy ziarna. Stąd procentowy udział czystego ziarna był wyższy w plonie owsa nieoplewionego (85%) niż w plonie owsa oplewionego (50%).

Słowa kluczowe: owies oplewiony, owies nieoplewiony, plon, wiecha, wydajność

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INTRODUCTION

The main difference between naked and hulled oats is that in the separation of grains and hulls during threshing. Moreover, naked oats may be used in monogastric feeding without the necessity of grain husking. In the Czech Republic, the main areas of utilization of naked oats are food industry and feeding (feed mixtures for breeding and young animals).

The absence of husks, which in hulled cultivars cover about 25% of the whole grain weight, is the reason for the lower yields of naked oats. The net yield of naked grain obtained with both kinds of oat is rather similar. The absence of husks is the feature that is linked with the oat ability to produce a higher number of florets, which makes possible to assume a higher potential yield. However, oat grains are limited in their development in a panicle, which is due to the considerable reduction of florets. The effect of a great number of florets upon the grain uniformity is undesirable. Insufficiently developed grains are more readily infested by fungal diseases, and the infection results in the appearance of „black“ or „rotten“ grains. The presence of such grains decreases both the sensory and hygienic/medicinal quality of oat food. On the other hand, characteristic of hulled oats is a considerable microbial activity among the loosed hulls. The fungi representing the genus *Fusarium* produce a wide range of toxic metabolites. They are the most harmful microorganisms among those occurring on the grains.

The studies on the oat panicle productivity have so far been conducted, among others, by Peltonen and Sainio (1991), Moudrý and Nýdl (1992) and Chapko and Brienkmann (1991). In this work, the yields of naked oats and hulled oats grown at two locations in Austria and in two locations in the Czech Republic are compared. Moreover, the yield components have been determined.

MATERIALS AND METHODS

Three cultivars of hulled oat (*Avena sativa* L. — Auron, Edmund, Expander) and three cultivars of naked oat (*Avena nuda* L. — Abel, Izak, Salomon) were tested in field trials in the years 1999–2001 at two experimental locations in Austria (Lambach and Freistadt) and at two locations in the Czech Republic (Humpolec and České Budějovice). After harvest, the yield of grain and three yield elements (panicle structure, occurrence of black and rotten grains) were evaluated. The methods of evaluation were as reported by Moudrý (2002).

RESULTS AND DISCUSSION

The yield of grain of naked oat cultivars (4.3 t/ha on average) reached 74% of that of hulled cultivars. However, the net production of oat grain (after removing the hulls to obtain “oat rice”) was higher with naked oat cultivars by approx. 23%. This was because of the higher rate of yield recovery (85% in naked oats vs. 50% in hulled oats). Thus, as regards the yield of oat rice, the naked oat cultivars were found to be more suitable than the hulled cultivars for cultivation under growing conditions of Austria and the Czech Republic.

The higher grain yields of hulled cultivars, as compared with those of naked cultivars, were found to be determined by all the three yield components. The density of hulled oat growth (15 panicles/m^2) was higher by 6% than that of naked oats. The coefficient of productive tillering in oats was, in general, very low (1.18 panicles per plant), and there were only slight differences between cultivars. The lower density of naked oats was due to the low rate of field germination and a relatively high sensitivity to damage. In the process of differentiation of shoot apex, the naked oat plants constituted longer panicles than did hulled oat plants, whereas the differentiation of levels, branches and spikelets was more intensive in hulled oats. The number of spikelets per panicle was in naked oats lower than in hulled oats by 4.2 on average. The low number of differentiated spikelets was compensated by a higher level of their productivity. The number of spikelets was found to be the most important component of the panicle structure, of those influencing the yield of grains. A number of grains per panicle produced by hulled cultivars (6.2) was greater (by 10%) than that produced by naked oats. Among the evaluated cultivars, a hulled cv. Expander was the most productive one (73.8 grains per panicle), whereas a naked cv. Salomon produced the smallest number of grains (54.7). However, a high number of grains per panicle resulted in the decreasing of their weight. The lowest TGW factor (a thousand grains weight) was recorded with cv. Expander, i.e. with the cultivar that produced the greatest number of grains per panicle. On the contrary, the TGW for cv. Salomon had the highest value. In general, the TGW for hulled cultivars (3.8 g) was by 14% higher than that for naked cultivars. However, after taking into account the share of the hulls (25%) in the hulled oat grain, the net production was assessed to be higher in naked oats.

Table 1

Correlation matrix between yield parameters in a husked oat panicle
Macierz korelacji między parametrami plonu wiechy owsa oplewionego

	DL	PP	PV	PKL	PZ	PPK	HZ	PZ/PKL
DL		0,156**	0,332**	0,209**	0,359**	0,278 **	0,083**	0,062
PP	0,156**		0,166**	0,421**	0,319**	-0,238**	0,011	-0,035
PV	0,332**	0,167**		0,565**	0,487**	0,046	0,095**	0,007
PKL	0,209**	0,421**	0,565**		0,758**	-0,197**	0,082**	-0,116**
PZ	0,359**	0,320**	0,487**	0,758**		-0,036	0,112**	0,130**
PPK	0,278**	-0,238**	0,046	-0,197**	-0,036		0,022	0,049
HZ	0,083**	0,011	0,095**	0,082**	0,112**	0,0223		0,018
PZ/PKL	0,062*	-0,035	0,0068	-0,116**	0,130**	0,049	0,018	

DL — Length of panicle, PP — Number of whorls, PV — Number of branches
DL — Długość wiechy, PP — liczba baldaszków, PV — Liczba rozgałęzień
PKL — Number of spikelets, PZ — Number of grains, PPK — Number of dry spikelets
PKL — Liczba kłosków, PZ — liczba ziaren, PPK — Liczba kłosków suchych
HZ — Weight of grains per panicle
HZ — Ciężar ziaren z jednej wiechy

The development of particular yield-affecting elements and their compensation were significantly influenced by climatic conditions. During the initial differentiation of oat panicles, a sufficient amount of rainfall and lower temperatures in April and May were recorded. The crucial element affecting the panicle productivity, i.e. a number of spikelets, was mainly influenced by the year of cultivation, but also by oat cultivar and the trial

location. The hulled cultivars, as compared with the naked ones, showed a lower variation in panicle productivity.

The main factor affecting the occurrence of black grains were climatic conditions. The influence of both the trial location and cultivar was also significant. The higher number of black grains was recorded with cv. Izak (7.1%), whereas the lowest one with cv. Abel. A relatively weak positive correlation ($r = 0.341^{***}$) between the number of grains per panicle and the occurrence of black grains was found.

Table 2

Correlation matrix between yield parameters in a naked oat panicle
Macierz korelacji między parametrami wiechy owasa nagiego

	DL	PP	PV	PKL	PZ	PCZ	HZ	PZ/PKL
DL		0,467**	0,583**	0,675**	0,474**	0,323**	0,048	-0,100**
PP	0,467**		0,448**	0,461**	0,490**	0,248**	0,074**	0,198**
PV	0,583**	0,448**		0,735**	0,565**	0,363**	0,051	-0,034
PKL	0,675**	0,461**	0,735**		0,724**	0,336**	0,067*	-0,116**
PZ	0,474**	0,490**	0,565**	0,724**		0,341**	0,094**	0,577**
PPK + PCZ	0,323**	0,248**	0,363**	0,336**	0,341**		0,008	0,116**
HZ	0,048	0,074**	0,051	0,067*	0,094**	0,008		0,057*
PZ/PKL	-0,100**	0,198**	-0,034	-0,116	0,577**	0,116**	0,057*	

DL — Length of panicle, PP — Number of whorls, PV — Number of branches
DL — Długość wiechy, PP — Liczba baldaszków, PV — Liczba rozgałęzień
PKL — Number of spikelets, PZ — Number of grains, PCZ — Number of black grains
PKL — Liczba kłosków, PZ — Liczba ziaren, PCZ – Liczba sczerniałych ziaren
HZ — Weight of grains per panicle; HZ — Ciężar ziaren z jednej wiechy

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