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MAIZE SEED RESIDUES AND LOSSES DURING DRYING AND PROCESSING

OTPAD I GUBICI SEMENA KUKURUZA U PROCESU SUŠENJA I DORADE

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ABSTRACT

The ZP hybrid maize seed (Maize Research Institute, "Zemun Polje", Serbia) production is organised each year by 10-20 seed growers. Maize seed drying and processing is preformed in seven processing plants. The following factors affect the volume of seed residues and losses: moisture content of seed, genetic traits of hybrids, quality of a dryer's equipment, technological norms in the course of seed drying and processing. Residues occur due to seed shelling during unloading, on conveyors, loading into bins, transport to shellers and seed spilling during processing and packing. Drying is performed down to 13% seed moisture. If the kernel comes off the ear and mixes with kernels of other hybrids such kernel is considered the residue. The ZP technology requires seed calibration into fractions of 6.5 to 11.0 mm. The amount of seed moisture and cob weight cannot be treated as a residue, as it is a biological property of the seed. The following amounts of hybrid ears were processed at the Maize Research Institute, Zemun Polje, during 2008: 491 t - ZP 341; 2433 t - ZP 434; 1263 t - ZP 704 and 4472 t - ZP 677 (total of 8659 t). The weight of ear, admixtures, shelled kernels and silk was measured. Based on obtained values, their participation in the total weight was determined.

***Key words**: hybrid maize, yield, drying and processing, residue, seed losses.*

REZIME

Proizvodnja ZP semena hibridnog kukuruza (Institut za kukuruz „Zemun Polje") organizuje se svake godine kod 10-20 proizvođača. Sušenje i dorada semena obavlja se na sedam doradnih centara. Na obim otpada i gubitaka semena u procesu sušenja i dorade utiču sledeći faktori: vlažnost zrna, genetička svojstva hibrida, kvalitet opreme na sušari, tehnološke norme u procesu sušenja i dorade semena. Otpad nastaje zbog krunjenja semena u postupku istovara, na transportnim trakama, utovara u binove, transporta do krunjača i prosipanja zrna prilikom dorade i pakovanja. Sušenje se obavlja do 13% vlage zrna. Kada zrno otpadne sa klipa i dođe do mešanja sa semenom drugih hibrida tada se tretira kao otpad. Pored ovoga, ZP tehnologija zahteva da se seme doradi na kalibratoru dimenzije od 6,5-11,0 mm.

Cilj rada je da se utvrdi količina i procentualno ušešće: primesa, mase vlage zrna i kočanke u ukupnoj masi ubranog klipa kukuruza, i količina semena koja otpadne u procesu sušenja i dorade, kao i uzroci i mesta gde do toga dolazi. Institut za kukuruz „Zemun Polje" je u 2008. godini doradio sledeće količine klipa hibrida: ZP 341 – 491 t; ZP 434 – 2433 t; ZP 704 – 1263 t i ZP 677 – 4472 t, što je ukupno 8659 t. Merena je mase klipa, primesa, okrunjenog zrno i svilice. Na osnovu toga utvrđenao je njihovo učešće u ukupnoj masi. Rezultati su pokazali da od ukupne mase klipa: ZP 341, ZP 434, ZP 704 i ZP 677 od 8659t, bilo je primesa 1045 t (12,1%) i čistog klipa 7614 t (87,9%). U procesu sušenja isparilo je 1174 t vlage (15,4%), kočanke je bilo 1523 t (20,0%), otpalo je 668 t (8,8%) zrna i ostvareno je 4249 t (55,8%) semena 6,5-11,0 mm.

***Ključne reči**: hibridni kukuruz, prinos, sušenje i dorada, otpad, gubici semena.*

INTRODUCTION

The production of ZP hybrid maize seed is organised each year on the area of 3,000 to 5,000 hectares. It is a very voluminous, responsible and risky operation that requires great financial means. Approximately 10-20 seed growers perform this production. Seed drying and processing is done in seven processing plants. As neither of processing plants have the same equipment and the uniform processing system, seed losses during drying and processing are different in these plants. Losses are in some plants greater and in some plants lower. The following factors affect losses: percent of seed moisture, genetic traits of hybrids, quality of the equipment of a dryer, technological norms in the course of seed drying and processing. Greater amounts of residues occur due to seed shelling during unloading, on conveyors, loading into bins, transport to shellers and uncontrolled seed spilling during processing and packing. If ears bump less into hard surfaces during transport to the dryer, then the shelling is lower and residues are smaller. Drying is performed down to 13% moisture content of grain and the loss will be greater if seeds are over-dried. If the kernel comes off the ear and mixes with kernels of other hybrids such kernel is considered the residue. Namely, in order to keep seed genetically pure, mixing of seed of different hybrids is not allowed during drying and processing. Genetic purity control is done by reliable laboratory methods (*Zlokolica et al., 2000*). Therefore, if it is not possible to determine without any doubt that any spilt seed belongs to the same hybrid it is a residue.

Furthermore, the ZP technology requires seed calibration into fractions of 6.5 to 11.0 mm. Due to this factor, each seed larger or smaller than the stated fractions are considered the residue, only because of its physical properties, while its genetic traits can equal those of the stated fractions. The seed that comes off without control during drying and processing is a loss that directly affects the reduction of cost-effectiveness of this production.

Different types of admixtures are eliminated prior to the beginning of seed drying. Their amount varies, and it is mostly affected by the maize harvest method and technical properties of a combine to remove husk. The amount of seed moisture that evaporate in the process of drying, and the cob weight, cannot be treated as residues, because it is a seed biological trait. These are actually biological traits of the ear, hence moisture and cobs have to be removed in order to store seeds in a proper way. They are always present to a greater or a smaller extent, which depends on several factors.

Bearing in mind all stated facts, the aim of this study was to determine the amounts and percents of: admixtures, moisture of

seed and cob in the total weight of harvested maize ear and the amount of seeds that come off during drying and processing, as well as, to determine causes and places of their occurrences. These facts could point to procedures to be applied in order to remove deficiencies that result in unjustifiable seed losses during drying and processing.

MATERIAL AND METHOD

The following amounts of hybrid ears were processed at the Maize Research Institute, Zemun Polje, during 2008: 491 t - ZP 341; 2433 t - ZP 434; 1263 t - ZP 704 and 4472 t - ZP 677 (total of 8659 t). Masses of ears and admixtures that include husk, off-type ear, ear with visible diseased kernels, doubtful ears according to their size and appearance, shelled kernels and silk, were measured. Based on these parameters the amount and percent participation of admixtures and pure ears in the total ear weights were calculated.

Prior to drying, ear samples were drawn to determine seed moisture. The estimation of moisture mass was done in a way that the percent over 13%, as seed is dried to that moisture, is deducted from the total amount of pure ear. The cob of all hybrids was estimated with 20%. Seed processing and calibration was done to the fractions of 6.5 to 11.0 mm. At the end, the amount of come off seeds during processing was determined.

RESULTS AND DISCUSSION

Obtained results and estimation of weight and the percent participation of admixtures, seed moisture, cob, come off kernels during drying and processing of ZP maize seed are presented in Tables 1-5.

The total ear mass (Tab. 1.) of the hybrid ZP 341 in three seed growers amounted to 491 t. There were 29 t (6.0%) of admixtures and 462 t (94.0%) of pure ears. A total of 80 t (17.3%) of moisture evaporated in the process of drying. There were 93 t (20.0%) of cobs, while 61 t (13.2%) of kernels came off during processing. After fractioning seeds on the 6.5-11.0 mm sieves there were 228 t (49.5%) of seeds.

The total ear mass (Tab. 2.) of the hybrid ZP 434 in four seed growers amounted to 2433 t. There were 302 t (12.4%) of admixtures and 2131 t (87.6%) of pure ears. A total of 406 t (19.0%) of moisture evaporated in the process of drying. There were 426 t (20.0%) of cobs, while 162 t (7.6%) of kernels came off during processing. After fractioning seeds on the 6.5-11.0-mm sieves there were 1137 t (53.4%) of seeds.

The total ear mass (Tab. 3.) of the hybrid ZP 704 in three seed growers amounted to 1263 t. There were 281 t (22.0%) of admixtures and 982 t (78.0%) of pure ears. A total of 141 t (14.3%) of moisture evaporated in the process of drying. There were 196 t (20.0%) of cobs, while 87 t (8.9%) of kernels came off during processing. After fractioning seeds on the 6.5-11.0-mm sieves there were 558 t (56.8%) of seeds.

The total ear mass (Tab. 4.) of the hybrid ZP 677 in six seed growers amounted to 4472 t. There were 433 t (9.7%) of admixtures and 4039 t (90.3%) of pure ears. A total of 547 t (13.5%) of moisture evaporated in the process of drying. There were 808 t (20.0%) of cobs, while 358 t (8.9%) of kernels came off during processing. After fractioning seeds on the 6.5-11.0-mm sieves there were 2326 t (57.6%) of seeds.

Table 1. Residues and losses during seed drying and processing of maize hybrid ZP 341 in 2008 (in t)

Seed grower		Ear mass	Admixtures	Pure ear	Moisture		Residue		Processed 6.5-11 mm
					Content >13%	Mass (t)	Cob	Kernels	
Plavna		142	11	131	19.0	25	26	19	61
VSD		203	10	193	17.4	36	39	40	78
Hrastovača		146	8	138	13.6	19	28	2	89
Total	t	491	29	462	16.7	80	93	61	228
	%	1000	6.0	94.0	-	-	-	-	-
Content (%)				100.0	-	17.3	20.0	13.2	49.5

Table 2. Residues and losses during seed drying and processing of maize hybrid ZP 434 in 2008 (in t)

Seed grower		Ear mass	Admixtures	Pureear	Moisture		Residue (t)		Processed 6.5-11 mm
					Content >13%	Mass (t)	Cob	Kernels	
S.Kovačević		624	72	552	14.5	80	110	23	339
Turija		638	102	536	17.3	93	107	33	303
Orahovo		668	68	600	24.5	147	120	65	268
Panonija BG		503	60	434	19.5	86	89	41	227
Total	t	2433	302	2131	18.9	406	426	162	1137
	%	100.0	12.4	87.6	-	-	-	-	-
Content (%)				100.0	-	19.0	20.0	7.6	53.4

Table 3. Residues and losses during seed drying and processing of maize hybrid ZP 704 in 2008 (in t)

Seed grower		Ear mass	Admixtures	Pureear	Moisture		Residue (t)		Processed 6.5-11 mm
					Content >13%	Mass (t)	Cob	Kernels	
Petefi		717	215	502	13.7	69	100	21	312
Nadalj		239	38	201	13.1	26	40	14	121
Hrastovača		307	28	279	16.5	46	56	52	125
Total	t	1263	281	982	14.4	141	196	87	558
	%	100.0	22.0	78.0	-	-	-	-	-
Content (%)				100.0	-	14.3	20.0	8.9	56.8

Table 4. Residues and losses during seed drying and processing of maize hybrid ZP 677 in 2008 (in 000 t)

Seed grower		Ear mass	Admixtures	Pureear	Moisture		Residue (t)		Processed 6.5-11 mm
					Content >13%	Mass (t)	Cob	Kernels	
S.Kovačević		2269	134	2135	13.2	182	427	258	1268
Sirig		704	106	598	21.4	128	120	25	325
Institut ZP		580	110	470	21.9	103	94	3	270
TurijaZP dor.		371	56	315	13.9	44	63	10	198
Slan		38	3	35	10.6	4	7	1	23
Zrenjanin		510	24	486	17.7	86	97	61	242
Total	t	4472	433	4039	16.4	547	808	358	2326
	%	100.0	9.7	90.3	-	-	-	-	-
Content (%)				100.0	-	13.5	20.0	8.9	57.6

Table 5. Residues and losses during seed drying and processing of ZP maize hybrids in 2008 (in t)

Seed grower		Ear mass	Admixtures	Pure ear	Moisture		Residue (t)		Processed 6.5-11 mm
					Content >13%	Mass (t)	Cob	Kernels	
ZP 341		491	29	462	16.6	80	93	61	228
ZP 434		2433	302	2131	18.9	406	426	162	1137
ZP 704		1263	281	982	14.4	141	196	87	558
ZP 677		4472	433	4039	16.4	547	808	358	2326
Total	t	8659	1045	7614	16.6	1174	1523	668	4249
	%	100.0	12.1	87.9	-	-	-	-	-
Content (%)				100.0	-	15.4	20.0	8.8	55.8

The total ear mass (Tab. 5.) of all hybrids amounted to 8659 t. There were 1045t (12.1%) of admixtures and 7614 t (87.9%) of pure ears. A total of 1174 t (15.4%) of moisture evaporated in the process of drying. There were 1523 t (20.0%) of cobs, while 668 t (8.8%) of kernels came off during processing. After fractioning seeds on the 6.5-11.0-mm sieves there were 4249 t (55.8%) of seeds.

The admixture mass and the moisture content of seeds and cobs can to a certain extent be affected by maize growing practices and during crop harvest (*Pavlov et al., 2005*). Almost all these elements, if in a greater scope, unnecessarily "burden" the operation of maize seed drying and processing. However, some kind of an "optimal" volume of moisture content of cob has to exist. The volume of these admixtures can be reduced in the following way: the application of contemporary maize growing practices (*Videnović et al., 2007*), weed-free crop (*Simić Milena and Lidija Stefanović, 2003*), the existence of off-type and diseased ears to the lowest extent and the utilisation of combines that well husk ears. Moreover, it should not be forgotten that the modern technological operation leaves several husks on the ear in order to alleviate kernels damage in the process of transport and unloading. Therefore, ears are additinaly husked in the processing plants. These residues can be used as feedstuff.

Maize can be harvested when kernel moisture content amounts to 40%. The lower moisture content is the less energy for drying is necessary. Sometimes, harvest starts even with higher moisture content in order to prolong drying period (*Pavlov et al., 2009*). If weather conditions in the field are favourable, moisture content of grain faster reduces. Maize seeds can be dry with natural air or with the combination of warm and cold air. The rational use of energy for these purposes is established in each processing plant.

The cob mass mainly a genetic trait of maize inbred lines (*Ivanović et al., 2002*). However, its percent increases in the period of poor pollination due to unfavourable natural condtions or if pollination of male and female components does not concur. Therefore, a correct sowing, irrigation and complete maize growing practices reduce the cob participation, and thereby unnecessary costs for its manipulation. Moreover, the applied type of sterility affects the amount of the cob (*Urs et al., 2002*). The cob can be used as a fuel, then in metal manufacturing industry, chemical industry, cosmetic industry and for removal of spilt oil (*Radosavljević et al., 2003 ; Božović et al., 2004*).

The seed mass lost during drying and processing amounted to 13.2%, i.e. 7.6% in the hybrid ZP 341, i.e. ZP 434, respectively. The ZP technology requires the seed calibration to the fractions of 6.5 mm to 11.0 mm (*Pavlov and Videnović, 2007*). This is one of methods to improve maize production (*Duvik, 2005*). It has been noticed in the practice that the least seeds come off the ear when the seed moisture is 20-25%, when it is carefully manipulated, when rubber shock absorbers for falling kernels are used (*Dragica Ivanović et al., 2005*). Losses are also smaller when correct and complete computer control of graders, conveyers, packing and storage up to the optimal height are applied during processing. Loses are sometimes great due to incorrect storage of seed stoks that are attacked by rodents (*Stanković Slavica et al., 2007; Lević Jelena et al., 2008*). The modern storage rooms reduce such losses to the smallest degree (*Lončarević et al., 2009*). Such seed losses can be further lessen and thereby cost-effectiveness of the seed production can be increased.

Seed genetic purity provided by correct growing practices is of a particular importance. It is very important to avoid mixture of seeds of different maize hybrids during drying and processing. Seed quality is tested and confirmed by laboratory analyses (*Drinić Mladenović Snežana and Konstantinov Kosana, 2002*).

According to obtained results on ZP hybrid maize seed drying and processing in 2008, the following can be concluded:

– The total ear mass of the hybrid ZP 341 amounted to 491 t. There were 29 t (6,0%) of admixtures and 462 t (94.0%) of pure ears. A total of 80 t (17.3%) of moisture evaporated in the process of drying. There were 93 t (20.0%) of cobs, while 61 t (13.2%) of kernels came off during processing. After fractioning seeds on the 6.5-11.0 mm sieves there were 228 t (49.5%) of seeds.

– The total ear mass of the hybrid ZP 434 amounted to 2433 t. There were 302 t (12.4%) of admixtures and 2131 t (87.6%) of pure ears. A total of 406 t (19.0%) of moisture evaporated in the process of drying. There were 426 t (20.0%) of cobs, while 162 t (7.6%) of kernels came off during processing. After fractioning seeds on the 6.5-11.0 mm sieves there were 1137 t (53.4%) of seeds.
– The total ear mass of the hybrid ZP 704 amounted to 1263 t. There were 281 t (22,0%) of admixtures and 982 t (78.0%) of pure ears. A total of 141 t (14.3%) of moisture evaporated in the process of drying. There were 196 t (20.0%) of cobs, while 87t (8.9%) of kernels came off during processing. After fractioning seeds on the 6.5-11.0 mm sieves there were 558 t (56.8%) of seeds.
– The total ear mass of the hybrid ZP 677 amounted to 4472 t. There were 433 t (9.7%) of admixtures and 4039 t (90.3%) of pure ears. A total of 547 t (13.5%) of moisture evaporated in the process of drying. There were 808 t (20.0%) of cobs, while 358 t (8.9%) of kernels came off during processing. After fractioning seeds on the 6.5-11.0 mm sieves there were 2326 t (57.6%) of seeds.
– The total ear mass t of hybrids ZP 341, ZP 434, ZP 704 and ZP 677 amounted to 8659 t. There were 1045 t (12.1%) of admixtures and 7614 t (87.9%) of pure ears. A total of 1174 t (15.4%) of moisture evaporated in the process of drying. There were 1523t (20.0%) of cobs, while 668 t (8.8%) of kernels came off during processing. After fractioning seeds on the 6.5-11.0-mm sieves there were 4249 t (55.8%) of seeds.

CONCLUSION

The application of correct maize growing practices can reduce admixture and cob %. In order to perform harvest with lower grain moisture, a prices plan of drying has to be designed. If computer control is provided in the operations of drying and processing, seed losses will be smaller.

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