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EVALUATION OF HARVEST LOSSES WITHIN A FULL MECHANISED GRAPE HARVEST

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Abstract

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A contribution deals with an evaluation of harvest losses within a full mechanised berries harvest using two self-propelled harvesters GREGOIRE G 152 and NEW HOLLAND VL 6060 differing in kinds of harvesting and catching mechanisms. Observation was done in vineyards of ZVOS Hustopeče joint–stock company at harvest of Müller Thurgau and Lemberger varieties in a period 2009–2010. Results gained under operating conditions showed that both self-propelled harvesters reached a comparable quality of a harvested product. There were observed losses by a slump in a case of using GREGOIRE G 152 harvester 0.8–1.45%. By using NEW HOLLAND VL 6060 the losses were 0.86–1.52% and data were gained with a respect to vine condition, the variety and the vintage. Next to losses by the slump also losses as non-harvested product were observed. Using GREGOIRE G 152 were reached 1.08–2.56% of non-harvested product losses and in a case of NEW HOLLAND VL 6060 similarly 1.17–2.22%. However a value of the non-harvested product losses cannot be perceived absolutely because in a practice the non-harvested grapes are consequently picked up manually. Total losses perceived as a sum of losses by the slump and non-harvested losses values were at GREGOIRE G 152 harvester 2–4% and at NEW HOLLAND VL 6060 harvester 2–3.7% of total hectare yield.

viticulture, mechanical harvesting process, self–propelled harvester, berries lost

A current economic environment of the Czech Republic forces vineyard companies (especially larger ones, of more than 40 ha) to look for new effective production ways. A solution can be found in a replacement of handmade operations by mechanized operations and a use of machines with modern constructions for a multi–row application or merging the operations and etc. An usage of harvesters significantly leads to a decrease of a labour intensity of technological processes in viticulture (RŮHLING, 1995; SCHÖDL, 2005).

The full mechanised harvest and its possibilities were already explored in the 1970s years of the last century in conditions of Czech large cooperatives (FIC *et al.*, 1980). As the first machines Bulgarian and German harvesters were used. However harvest losses observed with the first harvesters using as well as a harm of vine and a damage of a supporting construction in vineyard led to a low spread of their use. Other factors like an inconsistent basic agro-technical operation and low machines' handlers training also intervened (OTÁHAL, 1990).

Since 1990 growers have focused on using harvesters with modern construction offered by world leader manufacturer like PELLENC, GREGOIRE, NEW HOLLAND etc. Higher technical standards of the machines have brought more friendly approach to a harvest product as well as vine (PFAFF, 1997). Current types of harvesters dispose of a fast operating mode adjustment, a column detection, an accurate setting of operating speed and other accessories.

In countries like France (1200 pieces), Germany (800 pieces), Australia (600 pieces), Austria (185 pieces), Italy (150 pieces), South Africa and Spain 50–90% of a whole grape production is reaped by the aid of harvesters. Actually in the area of South Moravia 50 pieces of self–propelled or trailer type of grape harvesters can be found (ZEMÁNEK, BURG, 2010).

Full mechanised grapes harvest in a current Czech conditions have to face main problems like are an acquisition price, an efficiency as well as a value of harvest losses.

The aim of this work was an assessment of harvest losses within the full mechanised harvest of grapes using two kinds of self-propelled harvesters with modern construction. Data were gained on self–propelled harvesters currently used in viticultural conditions of the South Moravia regions.

MATERIAL AND METHODS

Experimental measurements were done in vineyards ZVOS Hustopeče joint–stock company (catastral area Hustopeče) at harvest of Müller Thurgau and Lemberger varieties in a period 2008–2010. A sugar content of variety Müller Thurgau reached in time of harvest 20⁰ČNM (Czech Standardized Grape Must Scale) in 2009 and 18⁰ČNM in 2010. In a case of Lemberger variety the sugar content was 21⁰ČNM in 2009 and 18⁰ČNM in 2010. A vineyard with Müller Thurgau variety was maintained in a shape of high trunk with one shoot, on supporting construction with 1.8 m high concrete columns, with a site slope up to 3% (flat) and plantation 3.0 × 1.0 m. Lemberger variety was maintained in a shape of high trunk with one shoot, supporting construction had 2.0 m high steel columns, a site slope was 0% (flat) and plantation 2.4 × 1.0 m.

Harvesters used for the experiment

Self–propelled harvester GREGOIRE type G 152 (G 152) with an engine power 120 kW, prolonged banana shaped shakers, a catching area consisting of catcher trays pivoting by the integrated stiffeners and with a bin capacity 2 700 l.

Self–propelled harvester NEW HOLLAND model VL 6060 (NH VL 6060) with an engine power 107 kW. The harvesting mechanism consists of arched shaking rods with both side fixation and rods are cambered in a direction to row axis. Two pocket conveyors perform a catching mechanism as well as a transport of the product. A bin's capacity is 3 200 l.

Techno-economic parameters

An efficiency of both harvesters was evaluated under operating conditions in vineyard. The evaluation was done by chronological snaps (ČSN 470120 "Time structure within machinery use"), a fuel consumption was detected by a method of refilling a petrol to a tank. An operating speed was evaluated by measuring a time to pass 2000 m between the rows. Data about an acquisition price and the other parameters were gained from actual vendor's pricelists.

Observation of the harvest losses

The measurement was done in three repetitions (marked 1, 2 and 3). There were marked 10 meters long sections in rows of harvested vineyards. The sections were covered with 3 m long polyethylene foil before a harvester passing. The foil was suited well to touch a vine trunks and supporting construction columns. Then the foil served to catch non–harvested berries which were not captured in catching area of a harvester and would fall down on a land surface.

The evaluation of losses by a slump (berries felt down on the foil) and losses as non–harvested product were measured independently. Grapes or their parts which were not harvested at all were subsequently picked up manually by the aid of scissors. Then harvest losses were quantified from obtained data and hectares yields (in producer's evidence) and expressed in $kg.ha^{-1}$ or percentage.

UNISTAT software was used for a statistical assessment of data. Homogeneity of a basic data variance was proved by Cochran's test then data were evaluated by an analysis of variance and a multiple comparison.

RESULTS AND DISCUSSION

Obtained techno–economic data of the monitored harvesters are shown in Tab. I.

Tab. II–Tab. V show results from experimental measurements done in years 2009 and 2010 at varieties Lemberger and Müller Thurgau. Values of losses by a slump and losses as non-harvested product are shown separately for both harvesters.

Gained data show that losses caused by a slump in 2009 at Müller Thurgau were laying between 0.92–1.36%. Values of losses as non-harvested product were between 1.08–1.17%.

As shown in Tab. III losses by a slump in 2010 at Müller Thurgau variety were similar to previous year data and laid in the interval 1.42–1.45%. A more significant increase was observed in data of losses as non-harvested grapes or their parts. The values moved from 1.98 to 2.56%. Such data could be

I: *Techno-economic parameters of the harvesters*

Parameter	G 152	NH VL 6060
Acquisition price (€)	170 000 €	195 000 €
Engine power (kW)	120 kW	107 kW
Bin capacity (l)	2 700	3 200
Average operating speed ($km.h^{-1}$)	3.5	3.2
Fuel consumption ($l.h^{-1}$)/($l.ha^{-1}$)	18/36	20/40
Inning efficiency W_{07} ($ha.inning^{-1}$)	3.9	3.7

II: *Harvest of Müller Thurgau variety (20°ČNM), year 2009*

Experiment repetition–section	Losses in the marked section (10 bushes)			
	G 152		NH VL 6060	
	Losses by a slump (kg)	Non–harvested (kg)	Losses by a slump (kg)	Non–harvested (kg)
1	0.207	0.280	0.228	0.138
2	0.157	0.350	0.377	0.284
3	0.235	0.076	0.285	0.345
Average	0.200	0.235	0.297	0.256
Losses ($kg.ha^{-1}$) for 3 300 $bushes.ha^{-1}$	65.89	77.66	97.90	84.37
Losses (%) for hectare yield 7.2 $t.ha^{-1}$	0.92	1.08	1.36	1.17
Total losses ($kg.ha^{-1}$) for hectare yield 7.2 $t.ha^{-1}$	143.55		182.27	

Reference: average yield for 1 bush 2.18 kg

III: *Harvest of Müller Thurgau variety (18°ČNM), year 2010*

Experiment repetition–section	Losses in the marked section (10 bushes)			
	G 152		NH VL 6060	
	Losses by a slump (kg)	Non–harvested (kg)	Losses by a slump (kg)	Non–harvested (kg)
1	0.323	0.395	0.282	0.279
2	0.255	0.560	0.254	0.475
3	0.160	0.346	0.185	0.256
Average	0.246	0.434	0.240	0.337
Losses ($kg.ha^{-1}$) for 3 300 $bushes.ha^{-1}$	81.18	143.11	79.31	111.1
Losses (%) for hectare yield 5.6 $t.ha^{-1}$	1.45	2.56	1.42	1.98
Total losses ($kg.ha^{-1}$) for hectare yield 5.6 $t.ha^{-1}$	224.29		190.41	

Reference: average yield for 1 bush 1.70 kg

IV: *Harvest of Lemberger variety (21°ČNM), year 2009*

Experiment repetition–section	Losses in the marked section (10 bushes)			
	G 152		NH VL 6060	
	Losses by a slump (kg)	Non–harvested (kg)	Losses by a slump (kg)	Non–harvested (kg)
1	0.154	0.304	0.178	0.162
2	0.163	0.153	0.153	0.275
3	0.105	0.187	0.125	0.185
Average	0.141	0.215	0.152	0.207
Losses ($kg.ha^{-1}$) for 4 200 $bushes.ha^{-1}$	59.08	90.16	63.84	87.08
Losses (%) for hectare yield 7.4 $t.ha^{-1}$	0.80	1.22	0.86	1.18
Total losses ($kg.ha^{-1}$) for hectare yield 7.4 $t.ha^{-1}$	149.24		150.92	

Reference: average yield for 1 bush 1.76 kg

a result of lower berries maturation so their stronger cohesive forces with a stem were not overreached by an operating force of the harvesting mechanism. Thus some berries were left on the grapes.

Similar results of the harvest losses were observed at Lemberger variety in years 2009 and 2010. Data are shown in Tab. IV and Tab V. A slightly lower value of losses by a slump probably reflected better condition of a vine bush for the mechanised harvest. Each vine plants were straight with well–shaped old wood trunks so positively afforded a proper function of catching mechanisms of both harvesters. Thus losses by a slump in both years laid in the interval 0.8–1.52%.

A level of berry maturation at harvest had probably had an effect on a total value of losses caused by non-harvesting in both years of the experiment. The losses were 1.18–2.22%.

V: *Harvest of Lemberger variety (18°ČNM), year 2010*

Experiment repetition–section	Losses in the marked section (10 bushes)			
	G 152		NH VL 6060	
	Losses by a slump (kg)	Non–harvested (kg)	Losses by a slump (kg)	Non–harvested (kg)
1	0.125	0.212	0.198	0.198
2	0.175	0.353	0.179	0.424
3	0.098	0.143	0.123	0.109
Average	0.133	0.236	0.167	0.244
Losses (kg.ha^{-1}) for 4 200 bushes.ha^{-1}	55.72	99.12	70.00	102.34
Losses (%) for hectare yield 4.6 t.ha^{-1}	1.21	2.15	1.52	2.22
Total losses (kg.ha^{-1}) for hectare yield 4.6 t.ha^{-1}	154.84		172.34	

Reference: average yield for 1 bush 1.10 kg

VI: *Analysis of variance – losses by a slump*

Source of variation	Sum of squares	Degrees of freedom	The average square	F stat.	Importance
The main effects	0.064	3	0.021	8.327	0.0009
Harvester	0.007	1	0.007	2.708	0.1155
Variety	0.057	1	0.057	22.273	0.0001*
Year	0.000	1	0.000	0.001	0.9715
Explained	0.064	3	0.021	8.327	0.0009
Error	0.051	20	0.003		
Total	0.116	23	0.005		

Reference: * mark statistically significant difference

VII: *Analysis of variance–losses as non–harvested product*

Source of variation	Sum of squares	Degrees of freedom	The average square	F stat.	Importance
The main effects	0.093	3	0.031	2.551	0.0845
Harvester	0.002	1	0.002	0.179	0.6765
Variety	0.049	1	0.049	3.980	0.0598
Year	0.043	1	0.043	3.494	0.0763
Explained	0.093	3	0.031	2.551	0.0845
Error	0.244	20	0.012		
Total	0.337	23	0.015		

Reference: * mark statistically significant difference

Multifactorial variance analysis of data of losses by a slump found a statistically significant difference among vine varieties (shown in Tab. VI). Neither effect of the harvester nor vintage was found.

No statistically significant differences were found within factors in the evaluation of non–harvested losses data. Analysis of variance of the data is shown in Tab. VII.

A range of authors is interested in the evaluation of a full mechanised harvest process under local conditions. HOLEČKOVÁ (1987) explored berries' maturation in connection with a cohesive force of berries with a stem. Her results showed that a wrong timing of the harvest as well as an adjustment of an operating mode of harvesting mechanism could affect non–harvested losses value.

ŽUFÁNEK, ZEMÁNEK (1992) published 2.74% losses by a slump Müller Thurgau variety using LABECO harvester. SKOKANITSCHOVÁ (2006) dealt with harvest losses evaluation in a region of South Moravia. According her results at Saint Laurent, Müller Thurgau, Chardonnay and Lemberger varieties gained with self-propelled harvester ERO (SF 190) losses by a slump amounted 2.8–9.2%. Results gained with self–propelled harvester GREGOIRE G 152 at Cabernet Sauvignon and Riesling varieties showed 1.7–3.0% the lowest values of losses by a slump. COOMBE *et al.* (1991) presented as an acceptable value of harvest losses caused by a slump of berries to a ground 10% from a total losses value. KÄDISCH, MÜLLER (1999) considered as an acceptable value of harvest losses by a slump up to 3% and WALG (2007) published up to 2–4%. Within the experiment there were revealed losses by a slump 0.8–1.45% in a case of using harvester GREGOIRE G 152 and 0.86–1.52%

using NEW HOLLAND VL 6060 harvester, data were evaluated with a respect to vine condition, variety and vintage. It was found that a main reason for such results was an inconvenient shape of vine old wood trunks of Müller Thurgau variety which affected a reliable function of catching mechanisms. Therefore found differences within values of losses by a slump could not be attributed to structural designs of catching mechanisms. The idea was also proved by statistical analysis.

There were found no statistically significant differences within the analysis of data of lose as non–harvested product. In a case of harvester GREGOIRE G 152 values of non-harvested product losses laid in the interval 1.08–2.56% and using NEW HOLLAND VL 6060 harvester were 1.17–2.22%. ZEMÁNEK, BURG (2005) evaluated two harvesters with different kinds of constructions and observed 1.7–2.5% losses of a total hectare yield. BACCARINI *et al.* (2008) considers as an acceptable value of losses 2%. It seems to that an irregular placement of grapes within a vine bush, a berries maturation and a density of a foliage are more significant for a creation of losses as a non–harvested product than a construction design or an operating mode of a harvesting mechanism. Columns of supporting construction also could significantly affect the amount of losses. Steel columns presented in vineyard with Lemberger variety enabled a better transport of vibrations to berries within the shaking off so the berries harvest could be affected in a positive sense. Anyway the harvest losses cannot be perceived absolutely. In a practice the rests of non–harvested (non–shook off) grapes are subsequently picked up manually–obviously two persons are needed (ZEMÁNEK, BURG, 2010). Growers interested in a usage of harvesters should take into account those facts.

CONCLUSION

The aim of this work was an assessment of harvest losses using two self–propelled harvesters with modern construction GREGOIRE G 152 and NEW HOLLAND VL 6060 currently used in viticultural conditions of the South Moravia regions. Two approaches were applied for a harvest losses measurement. There were assessed losses by a slump caused by berries felt down onto a land surface and losses as a non–harvested product presented by a portion of berries which stayed on a stem of vine. The evaluation was realised in a period of years 2009–2010 at Müller Thurgau and Lemberger varieties. Total losses as a sum of losses by the slump and non–harvested losses values were at GREGOIRE G 152 harvester 2–4% and at NEW HOLLAND VL 6060 harvester 2–3.7% of a total hectare yield. In both cases reached values of total losses are acceptable with a respect to a modern viticultural practice. Reached results also confirm the fact that a condition of a vine bush and a kind of columns used for a supporting construction of vineyard are the main factor affecting the amount of losses.

SUMMARY

A contribution deals with an evaluation of harvest losses within a full mechanised berries harvest using two self–propelled harvesters GREGOIRE G 152 and NEW HOLLAND VL 6060 differing in kinds of harvesting and catching mechanisms. Observation was done in vineyards of ZVOS Hustopeče joint–stock company at harvest of Müller Thurgau and Lemberger varieties in a period 2008–2010. Results gained under operating conditions showed that both self-propelled harvesters reached a comparable quality of a harvested product. There were observed losses by a slump in a case of using GREGOIRE G 152 harvester 0.8–1.45%, using NEW HOLLAND VL 6060 losses were 0.86–1.52% and data were gained with a respect to vine condition, the variety and the vintage. Next to losses by the slump also losses as non–harvested product were observed. Using GREGOIRE G 152 were reached 1.08–2.56 non–harvested product losses and in a case of NEW HOLLAND VL 6060 similarly 1.17–2.22%. Total losses perceived as a sum of losses by the slump and non–harvested losses values were at GREGOIRE G 152 harvester 2–4% and at NEW HOLLAND VL 6060 harvester 2–3.7% of total hectare yield.

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