Evaluation of work quality of the green peas harvester Ploeger EPD 490

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Abstract

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Machines for harvesting vegetable must reliably collect the given type of vegetables at various climatic conditions, and with adequate performance, quality and low losses. Machines for harvesting of green peas must be sufficiently reliable and handling must be simple. The criteria of their work are based on harvested product quality, and the size of losses incurred depends on the rate of release of pods from the plants and on the release of grains from pods. The size of loss of grain and pods in the field and grain damages in the storage tank is directly proportional to the appropriately selected operating mode of the machine. Resistance to the damage of grain can be partly affected by selecting varieties with appropriate physical and mechanical properties and by choosing appropriate operating speed of the collector of green peas. Experimental measurements were carried out in the cooperative farm Zemné, Slovak Republic, within a conventional tillage technology, which has suitable conditions for the cultivation of this commodity. The subject of research was green peas Ploeger EPD 490.

Keywords: *Pisum sativum* L.; quality of the harvest; damage of grain; seed properties

Vegetable is an essential component of human nutrition. It contains valuable vitamins active in its natural form, an important fibre, minerals and other components that have a positive and favourable impact on the immune system and protect it from dangerous civilization diseases. However, the consumption of vegetable per capita has decreased considerably in the last years. This is reflected in the reduction of floricultural areas, including areas on which green peas is cultivated.

The determination of the beginning of green peas harvesting and its realization is one of the key work activities of those employees who are involved in organizing, coordinating and realization of harvesting of various types of vegetables. This activity is directly reflected in continuity of harvesting, the quality of harvested fruits and in the economic effects of the growing effort of employees of the cooperative farm. The improper alignment of workflow technology within the harvesting is mainly reflected in higher harvest losses (30–50%) and in reduced quality of the final product.

When planning the harvest, it is necessary to keep in mind the requirements of processors of green peas. Damaged and contaminated grains of green peas require higher demands on cleaning and sorting in the premises of processors. The period from harvesting till the transport of grains to the processing location should not exceed 4–6 hours. As it is the biological material easily succumbed to

deterioration, this period of time is particularly important in relation to maintaining the highest possible volume of nutrients (Poničan 2001; Rédl, Kučera 2008).

The intensity of threshing should be regulated according to the characteristics of the stand, variety and according to the ripeness and moisture of mass in threshing (Mekinda 1977; Gorzelany 1997). The rate of grain release depends on the used release system. Brkič (1970), and Brkič and Dujmovič (1978) found out that the rate of release increases with the number of release and separation drums. Dedenko et al. (1977) confirmed this finding and also indicated the widespread adoption of higher performance for systems with more drums.

In our conditions, we require 98% purity in the storage tank of the collector. These criteria are quite high and it is sometimes difficult to keep them. There is a demand to keep required technological discipline – the stand should be cleared of weed, height-balanced and regularly distributed on a given area. Another aspect is harvest ripeness. The peas are not harvested to be put to the stock, but they are directly transported to canneries, which set up the harvest period. Therefore, we often have to make compromise between the period and quality of harvest.

The paper deals with the assessment of work quality of the collector Ploeger EPD 490 (Ploeger Machines BV, Oud Gastel, Netherlands) at different operating speeds within the harvest of green peas by a machine.

MATERIAL AND METHODS

The reduction of harvest losses within the harvest of green peas by direct manner makes demands not only on complying with the technological discipline within the harvest but also on the harvest technique itself. The selection of operating speed within the harvest of green peas is a parameter that significantly affects the damage of harvested product and the content of impurities in the storage tank. In addition to operating speed, the physical and mechanical properties of the stand, the rotations of hackling and releasing drum affect the harvest quality.

The individual parameters were monitored at selected points. Field experiments were carried out in the cooperative farm Zemné, district Nové Zámky, Slovak Republic. The total area of the monitored land was 48.2 hectares. Measurement methodology could be divided into the following steps:

(a) Characteristics of farming technology, targeting of land, establishment of monitoring sites.
(b) Monitoring of productivity elements of green peas stand.
(c) Characteristics of the object of the research.
(d) Monitoring of qualitative and exploitation properties of green peas collector.

Description of operations, targeting of land and establishment of monitoring points. The soil preparation for growing of green peas corresponded to conventional technologies. Winter wheat was a forecrop. After the harvest of forecrop, the stubble ploughed under by the Lemken Smaragd Subsoiler (LEMKEN GmbH & Co. KG, Alpen, Germany) was performed (0.1 m in depth). Then a ploughing by a rotary plough Lemken EuroOpal (LEMKEN GmbH & Co. KG) followed (depth of 0.3 m with partial settlement of the surface). The "before seeding" soil treatment took place in spring. We used the compactor Commodore 6000 (LEMKEN GmbH & Co. KG) to a depth of 0.08 to 0.1 m and then the seeding by the John Deere 750 A seeder (Deere & Company, Moline, USA) followed. The handheld satellite navigation system GPS navigator EMAP (Garmin Ltd., Kansas City, USA) as well as the handheld satellite navigation Leica GS20 (Leica Geosystems Inc., Norcross, USA) were used for mapping of land borders. The spatial location of monitoring points was performed according to coordinates of the layout of points in the PCB program Agrogeometric (Slovak University of Agriculture in Nitra, Nitra, Slovak Republic).

Monitoring of productivity elements of green peas stand. Parameters were monitored after the technological ripeness of the stand. The suitability of green peas for harvesting is determined by their hardness with the use of tenderometer TU 12 (Food Technology Corporation, Sterling, USA), which was owned by the canning factory to which green pea was delivered. The following are selected characteristics of green peas stands:

– weight of stand harvested from m^2,
– height of stand (stage of lodged stand),
– length of stalk,
– deployment of fruits (pods) from the ground,
– density of stand per m^2,
– actual harvest,
– ageing process,
– change in humidity,
– splitting of fruits (pods), cracking and the shedding fruits or grains.

Characteristics of the research object. The picker Ploeger EPD 490 (Fig. 1) was used for har-

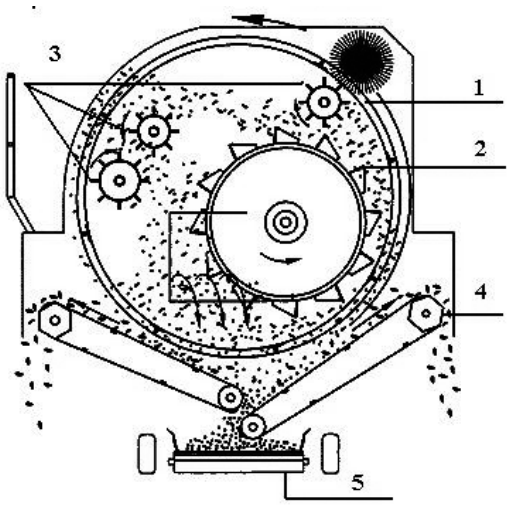

Fig. 1. (A) – Technological description of the release system: (1) main separator drum, (2) main release drum, (3) auxiliary release cylinders, (4) round side strips, (5) carry grain conveyor, (B) – view of the machine within work activities

vesting. The machine uses a motor with the power of 157 kW for the hydrostatic drive (Table 1). This allows the rolling of the releasing drum along the length and in the transverse direction. It eliminates the "flooding" of the drum.

RESULTS AND DISCUSSION

Evaluation results of productive elements of the stand on the monitoring sites

In practice, the most common way to determine the degree of ripeness of green grains suitable for harvesting is based on the physical principle. It is carried out by means of tenderometer or texture meter. In most of the cases the suitability of green grains for harvest is determined in field conditions by portable devices. It should be noted that increasing ripeness of grains of green peas reduces their quality. The evaluation measurements of productive elements were carried out on 16 monitoring points, which were equally distributed on the plot (Fig. 2).

Table 1. Technical parameters of the machine

Indicator	Ploeger EPD 490
Measurements (mm)	
Length	10,990
Height	3,995
Width	3,590
Width of the releasing drum (mm)	3,350
Weight (kg)	16,336
Balancing (%)	
Longitudinal	12.5
Side	16.5

Concerning the measured physical properties of the stand we came to the following conclusions: the average number of plants of variety Konto was 105 plants/m^2 and stand height reached 228 mm. The average stalk length was 885 mm and the average height of pod deployment was 464 mm (Table 2).

Grain yield of harvested product reached 6.28 t/ha. We monitored the straw yield as well (20.33 t/ha; Table 3).

Results evaluation of qualitative parameters of the machine Ploeger EPD 490

Measurements were carried out on the collector Ploeger EPD 490. The following values were investigated:

(a) Working speed of the machine.
(b) Work quality of the release system was evaluated by:
(1) percentage of whole dropped grains,
(2) percentage of visibly damaged grains,
(3) percentage of pressed grains,
(4) percentage of pods and impurities in the storage tank.

The work quality of the release system was evaluated by sampling from the storage tank and by the following analysis of samples (Table 4). Concerning the obtained data, we reached the following values at particular speeds: Concerning the evaluation of quality, we compared different operating speeds. The evaluation of quality was based on the possi-

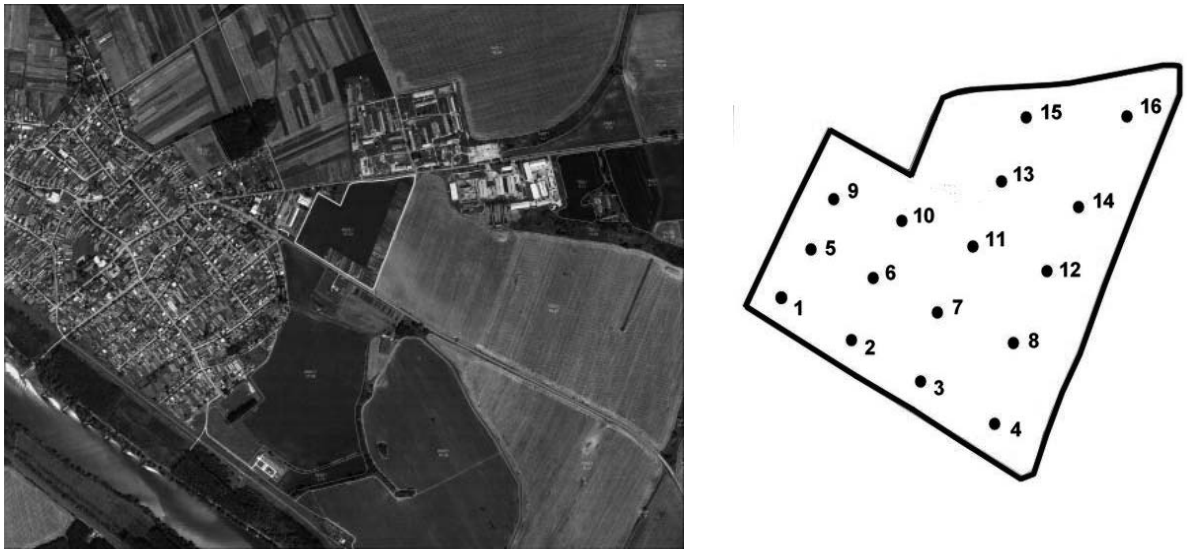

Fig. 2. Detail of monitoring points where the experiment was carried out

Table 2. Characteristics of green peas stand

Type	Number of plants (pc/m^2)	Height (mm)	Length of stalk (mm)	Pod deployment height (mm)
Konto	105	228	885	464
CM 550	90–120	143–320	540–1300	250–720

Table 3. Results of monitored productive elements

Grain (t/ha)	6.28
Humidity of grain (%)	17.85
Pod (t/ha)	7.35
Stalk (t/ha)	20.33
Humidity of the crop (%)	51.58

bilities of energy means. Based on these results we can conclude that when working at a lower speed (2.2 km/h), a higher percentage of whole grains was achieved. The increase of operating speed (v_p) to 2.9 km/h caused an increased presence of damaged grains by 1.2%, compressed grains by 1.22% and the content of impurities was increased by 1.88% (Fig. 3).

When analysing the results of the losses on defined area after hackling drum, we found out that the highest % of losses was caused by torn pods (4.87% at v_p = 2.2 km/h and 4.76% at v_p = 2.9 km/h), which fell to the ground and the conveyor was not able to collect them. Regarding the percentage of losses in pods not plucked (2.32% at v_p = 2.2 km/h and 3.15% at 2.9 km/h) it was determined by the variety and stage of ripeness of a given green peas stand (Fig. 4). Therefore, the mentioned factors cannot be always affected by the technique.

Damaged and contaminated grains of green peas present higher requirements for cleaning and sorting in the premises of processors as it increases the production costs. This is reflected in the price of the final product.

CONCLUSION

The evaluation of the quality of green peas collector is especially useful because of the following fact: the agro-technical term for harvesting is rela-

Table 4. Quality of grain in the storage tank of the collector (n = 230/min)

Variant	Whole grains (%)	Damaged grains (%)	Pressed beans (%)	Pods and additives, soil (%)
v = 2.2 km/h	84.6	10.2	2.98	2.22
v = 2.9 km/h	80.3	11.4	4.2	4.1

n –rotations of hackling drum of the collector

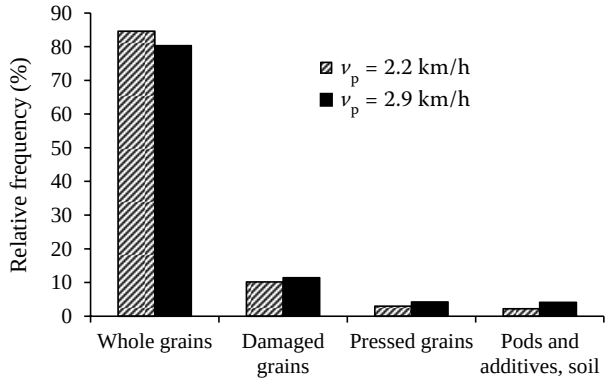

Fig. 3. Percentage of individually monitored fractions in the storage tank of the collector at different operating speeds

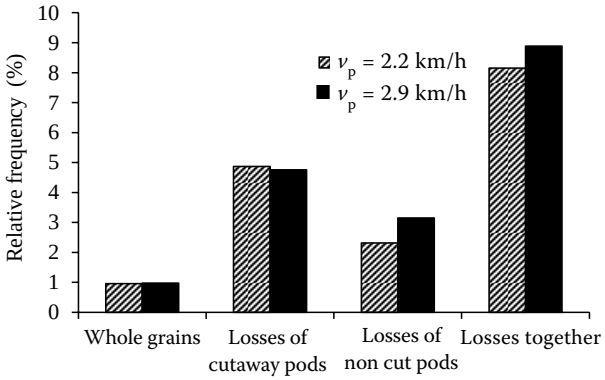

Fig. 4. Percentage of individually monitored losses after hackling system of the collector at different operating speeds

tively short and flat performance of these machines is small. This forces us to use the upper limit of operating speed, which is often done at the expense of quality of harvested product. The above described problems motivated us to solve the issue introduced in this paper. Based on the obtained results, we can present the following conclusions:

– when assessing the physical properties of the stand, we can conclude that the average number of plants of the variety Konto was 105 plants/m^2 and the stand height reached 228 mm. The average stalk length was 885 mm and the average height of pod deployment was 464 mm,
– the grain yield reached 6.28 t/ha and straw yield was 20.33 t/ha,
– the quality of work of the release system was evaluated by sampling from the storage tank and by the following analysis of samples. Based on the observed data, we found out that the increase of operating speed from 2.2 to 2.9 km/h increased the damage of the grain from 13 to 15.6%. The same rising trend was presented in the content of impurities in the storage tank of the collector,
– the increase of ground speed from 2.2 km/h to 2.9 km/h caused an increase of harvest losses after the hackling system by 0.74%.

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