DEVELOPMENT OF METHODS FOR THE INVESTIGATION THE PHYSICAL PROPERTIES OF CROPS WITHIN THE PROGRAMME OF MECHANIZATION

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The investigating of the products by way of narrow physico-mechanical tests offers very useful information in the case of many fruits and vegetables and these are extraordinarily worthy from the aspect of science — but they can be taken into practice only after a while. Therefore in the recent stage of machines development, the methods less attractive but more purposeful should also be applied at any rate, selecting those fundamental elements of the tasks in technology — the resolution of which is decisive in a given case to obtain success in the whole of production. The effort is to collect the most important data of products. The urging resolution of task arises concretely when it is about a well developed growing technology, and the design engineer has began his work to solve stages by means of machines.

The Institute of Farm Machine Development in Budapest has been dealing with the investigation of interactions between horticultural crops and machines for ten years. Our investigations usually centre around particular mechanization objectives. Accordingly, the nature and depth of our measurements are determined by the problems to be solved. Therefore, when research is planned and methods are developed, great attention is paid to the practical applicability of the data obtained. Our primary concern is to gain in sights into the physical and mechanical properties of crops and in addition to this we also make studies of the morphological and biological properties of plants.

In recent years the Institute has had the task to develop complex machine systems covering the entire production technology for vegetable crops. Efforts made in this direction have resulted in the development of machine systems for tomatoes, paprika for spice, French beans and onions. We have also studied the crops in their complex production tech-

nologies observing the development of the plant from the time of sowing to the time of harvesting.

Crop investigations relating to sowing were designed to clarify the question whether it is the machine or the technology employed, or the seed itself that is responsible for possible deficiencies in emergence. Investigations along such lines showed that certain seeds contained as much as 5 to 20% of foreign material and shrunken seeds. The latter are also sown by the machine with no plant emerging afterwards. A tangible result of such observations was that in some cases, another operation had to be added to production processes, e.g. a sorting machine had to be inserted into the range of equipment used for sowing. All these investigations serve the more distant purpose of obtaining a contiguous uniform stand for harvesting machines by improving the work of seeding machines.

In the period of cultivations our task was to study the growth of shoots and leaves, their position in space and the development of roots. Measurements of this kind have shown differences between crop varieties that may by utilized in power farming. By giving crop sizes we have been able to render assistance to those designing cultivation machinery sizes.

Naturally it is the determination of crop parameters for harvesting that constitutes the greatest task and gives most work.

E.g., the position of the crop in front of the harvesting implement was studied in several harvesting operations. Thus, in the case of tomatoes grown in beds the position of fruits was examined on the surface of the beds, both along the rows and in respect of height above ground. With these data known the cutting mechanism of the harvester was designed so as to ensure the cutting of tomato stalks below ground level, careful picking up of fruits from the ground, and uniform spreading of tomatoes on the separating mechanism.

Preliminary surveys of crop position and adjustments of the cutting mechanism for depth make it possible to calculate in advance the losses arising from the leaving behind of tomatoes hanging down into furrows and located on the edges of beds.

Similarly, the position of the crop before harvesting was investigated for different onion varieties with a view to assisting in the adjustment of the lifting mechanism for depth. Onion roots can be cut without damage, consequently for mechanical lifting it is the depth of the onion tuber in the ground that is of importance.

Studying the weight proportions between crops and other plant materials is essential for designing conveying and separating mechanisms,

especially on machines lifting the whole plant (as with tomatoes) or those lifting the crop by its leaves (as with carrots).

A point of departure in designing machines is the geometrical size of the crop. Size distribution and size holding are properties characteristic of a given variety. They determine wether variety is suitable for cultivating and harvesting by machine or not. With some crops size also

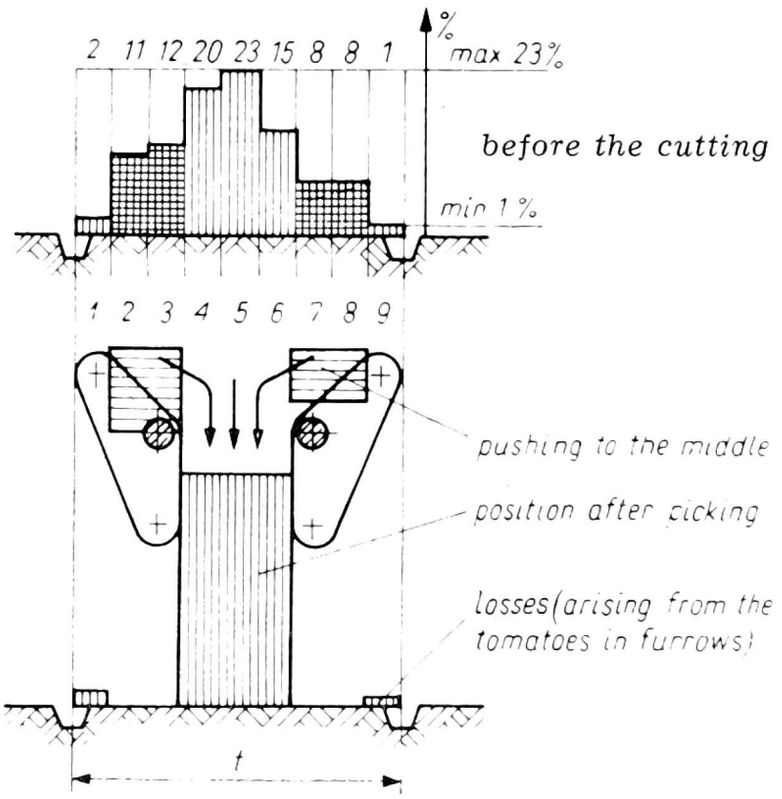

Fig. 1. Position of the tomatoes on the beds and after the cutting

means a quality grade. For such crops the investigation of size distribution is indispensable.

Knowledge of the conditions of ripeness, under which the crop must be detached from the plant will be necessary with any mechanical harvesting procedure. From the mechanical point of view the crop should be ideally harvested when most resistant to injuries. In selecting ripeness, however, there are other factors to be reckoned with besides strength, such as colour, shape, size, facility of detachment, sugar and acid content etc. All of these properties reach their respective optimum values at a different date. It is just for this reason that in determining what is termed harvesting maturity the effects of several of these properties have to be considered.

Among technical problems related to mechanical harvesting a prominent part is played by those referring to the determination of the detachment force. With tomatoes, for instance, the magnitude of the force required for the static detachment of fruits was investigated and plotted

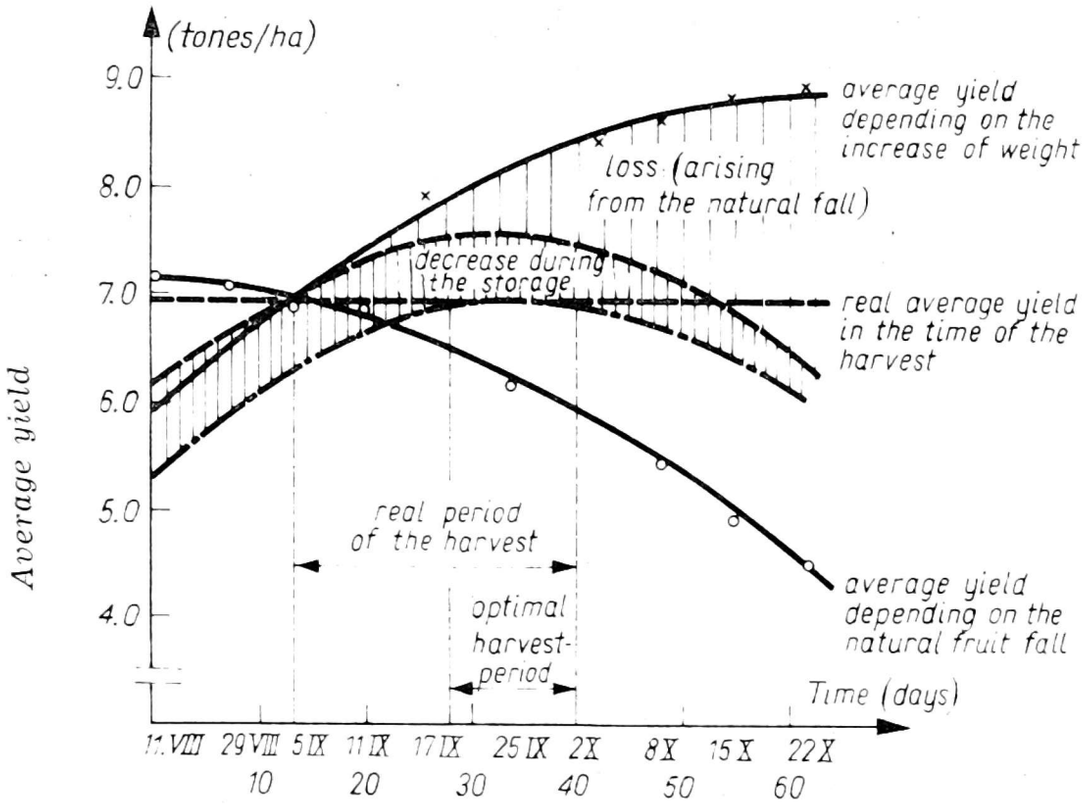

Fig. 2. Changing of the quantity of the product depending on the harvest time (Jonathan apple)

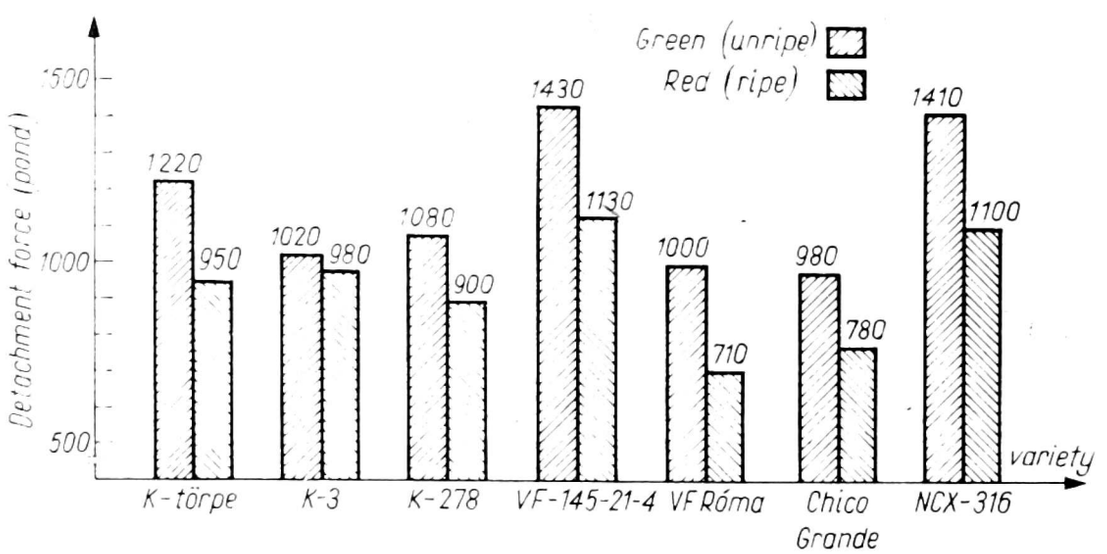

Fig. 3. Changing of the detachment force depending on the ripeness of the tomato

against ripeness. Detachment of ripe tomatoes requiered 25 to 40 per cent less force than that of unripe ones.

It was also examined to what extent the force necessary to detach the fruits is reduced when ripe tomatoes are left on the stem for 5 to 7 days. It was found that the force required for the detachment of such tomatoes is reduced by 4 to 35 per cent on an average of the varieties studied. The latter data drew attention to the fact that waiting for a higher rate

of ripeness also increases the danger of dropping which is undesirable if the machines are to do a good job.

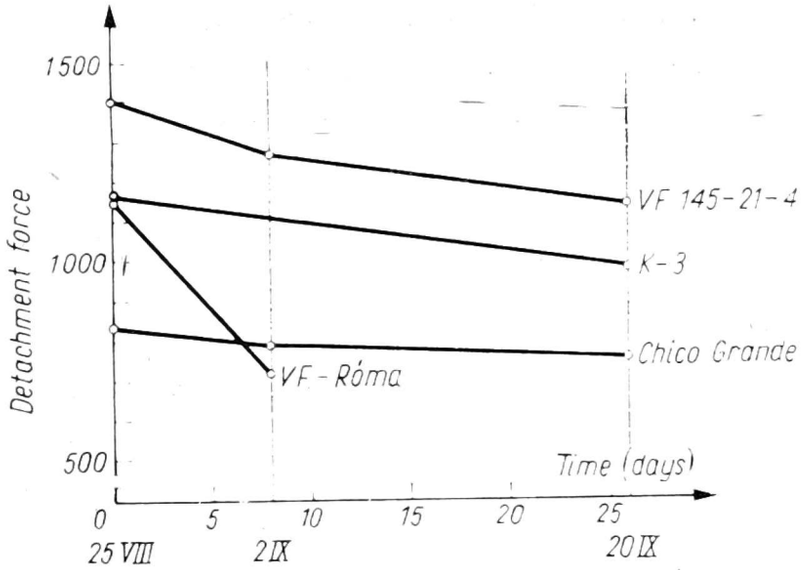

Fig. 4. Changing of the detachment force (in pond) of the ripe tomatoes

The mechanical operations involved in crop harvesting may in some cases necessitate special investigations. A case in point is the immersion testing of the tomatoes. This test was designed to decide the question, whether it is feasible to separate i.e. sort out red, yellow and green fruits in water on the basis of specific weigth differences, which are related to ripeness. Our measurements have proved that specific weight differences are slight and cannot serve as a basis for sorting.

In the course of harvesting, gathering, transporting and manipulating, the crop is exposed to a great number of strains of various types. The primary objective being the protection of the good value of the crop which can be loaded without damage. For determinning damage from fall, which is still acceptable, we introduced studying the critical height of fall. For these investigations it is necessary to specify and determine respectively the category of failure and damage. With the apple — for instance — mirror flattening (slight flattening) is also classed as failure, thus the critical height of fall for the apple is 8 to 10 cm; with the tomato it is the cracking of skin that is considered to be a failure and in this case the critical height of fall is 30 to 35 cm for spherical fruits and 60 to 80 for elongated type tomatoes.

Most suitable for measuring crop resistance to failure are tests of strength of various types. All over the world the majority of instruments and methods have been developed in this field. Various pressure gauges and penetrometers have been developed for the purpose of studying the flesh strength of crops and the conditions of loading and deformation.

For studying the effects of dynamic and static stresses we have de-

veloped some instruments and measuring devices, which help in determining particular physico-mechanical crop characteristics considered to be important. An instrument of this type is an equipment for measuring the force and deformation resistance of the products. On the force-deformation curve there are several characteristic points on which, if known, can be used to characterize crop failure. From the characteristics

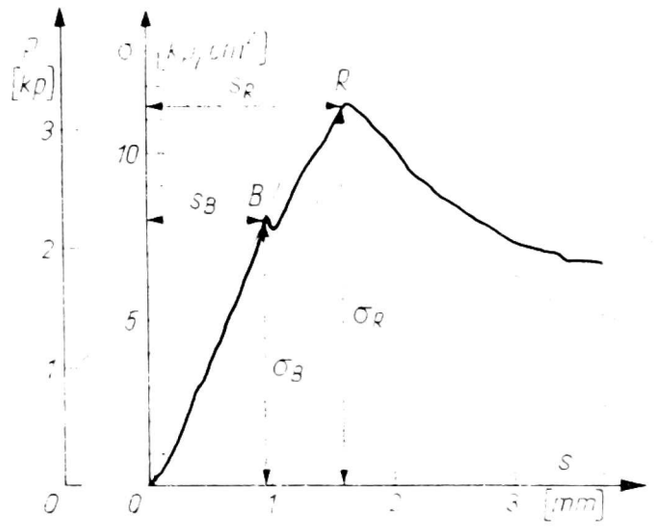

Fig. 5. Force-deformation curve of the apple (Jonathan). B — bio-yeild point, R — rupture point

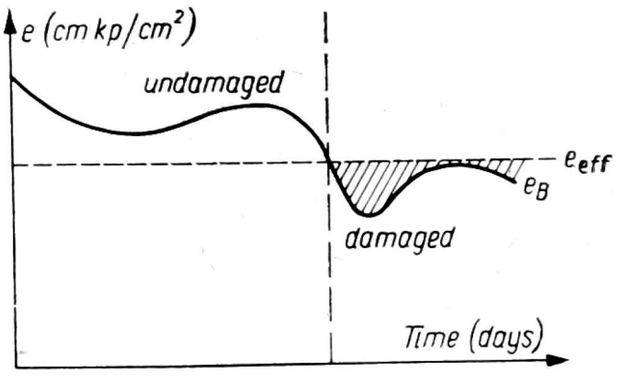

Fig. 6. Determination of the energy-limit causing the damage of the fruit. e_B — energy to the bio-yield point, e_{eff} — effective energy

of loading force and deformation — on the basis of the area below the curve — the magnitude of the energy transmitted can also be calculated. In certain cases if the relationship between loading force and deformation can be accepted to be linear, the modulus of elasticity for the material can also be determined.

Measurements of dynamic stresses — resistance to impact — were used e.g. for measurements of tenderness in French beans and for studying the effect of dynamic stresses in onions, paprika for spices etc.

These investigations, although conducted in modest circumstances and on a modest scale, have already yielded a number of useful data for designing our machines. It is regarded as an achievement that now the recording of crop parameters precedes machinery design, while a few years ago investigations were usually conducted parallel to mechanization. Today we are able to supply our designers with some basic data at the start already. It is our aim to further broaden the field of investigations in this direction by including other crops and by extending crop investigations to individual stages of storing, drying and processing.

The investigations on the physical properties of plants and products,

made purposely for reactions both in the field of improving and in the field of growing and mechanization, those stimulating one another make it possible to obtain more and more new results. We could take it as useful if periodically the representatives of all the branche of science released a report on their results, the methods applied and the processes of measurements.

I. Komándi

METODY BADAŃ CECH FIZYCZNYCH PRODUKTÓW W PROGRAMIE MECHANIZACJI

Streszczenie

Instytut Rozwoju Maszyn Rolniczych przez około 10 lat badał zależności pomiędzy zastosowaniem a produkcją rolną.

Ponieważ za podstawowe zadanie Instytutu przyjęto mechanizację technologii upraw kompleksowych, badania zbiorów następowały bezpośrednio po prostych fazach technologii, odpowiednio od siewu do zbioru i składowania. Działalność badawcza Instytutu była skierowana na badanie właściwości fizycznych i mechanicznych oraz morfologicznych i biologicznych warzyw i owoców.

Rezultaty osiągnięte podczas wspomnianej pracy badawczej są streszczone według wniosków ogólnych. Wyniki badań plonów omawiane w aspekcie siewu, ochrony roślin, zbioru i dalszych operacji. Podano również metody pomiaru i opis aparatów, wraz z krótką analizą uzyskanych wyników i możliwości ich zastosowania w pracach konstrukcyjnych.

И. Команди

МЕТОДЫ ИССЛЕДОВАНИЙ ФИЗИЧЕСКИХ СВОЙСТВ ПРОДУКТОВ В ПРОГРАММЕ ПО МЕХАНИЗАЦИИ

Резюме

Институт по проектированию сельскохозяйственных машин (MEFI Будапешт) уже десять лет занимается изучением взаимодействия сельскохозяйственных продуктов и машин.

Основной задачей института является разработка комплексных агрегатов для технологий возделывания, поэтому изучение продукции, начиная с простейших технологических фаз вплоть до уборки и хранения, последовательно прослеживает эти технологические процессы.

Исследовательская деятельность института в первую очередь направлена на изучение физико-механических свойств овощей и фруктов, однако, в случае

необходимости, занимаемся рассмотрением некоторых морфологических и биологических свойств.

Результаты данной исследовательской работы представлены по фазом возделывания. В резюме даются результаты анализов продуктоз во взаимосвязи с посевом, уходом за растениями, уборкой и следующими за ними процессами, а также методы измерения и приборы, анализируется воздействие полученных результатов на конструкторскую работу.

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