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EXAMINATION OF AGROPHYSICAL PROPERTIES OF RAPE

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Krotochvil, Nicolaisen, and Fiedziuszko [1—3] tried to show that the mechanical stability of rape pods might be the measure of their resistance to cracking. The cracking rate of pods is the cause of high losses at, and before, harvest. When estimating the cracking resistance of different varieties in selecting and breeding work, the determination of the strength of valve connection in a representative sample of pods proves to be a verv prolific approach. Fiedziuszko [1] determined the cracking resistance subjectively by twisting the pod with fingers. Kratochvíl [2] constructed a piece of equipment where a force, perpendicular to the partition of the pod, acts on the suppored pod. The magnitude of the force was measured by using a mechanical lever dynamometer. The value of the force at which the pod breaks and cracks is here considered as the measure of resistance to the cracking. The error of this method is in taing no account of different bending rigidity of the valves themselves of different pods, which seems to influence the results that should express the strength of valve connection.

METHOD

To break the connection of the pod valves in the suture it is necessary to induce a sufficiently high stress in the suture. A spontaneous induction of suture stress required for the cracking of the pod may be the result of stress and deformation due to alterations in structure, the cause of which may be the ripening, change of temperature and humidity, pest attack, application of chemicals, etc. This stress, however, may be induced by pod deformation due to an extraneous action. The magnitude of this action needed for breaking the coherence of the suture can be considered as a measure of suture strength. As regards the mechanical effects, the pod can be strained by compression torsion (Fig. 1), bending

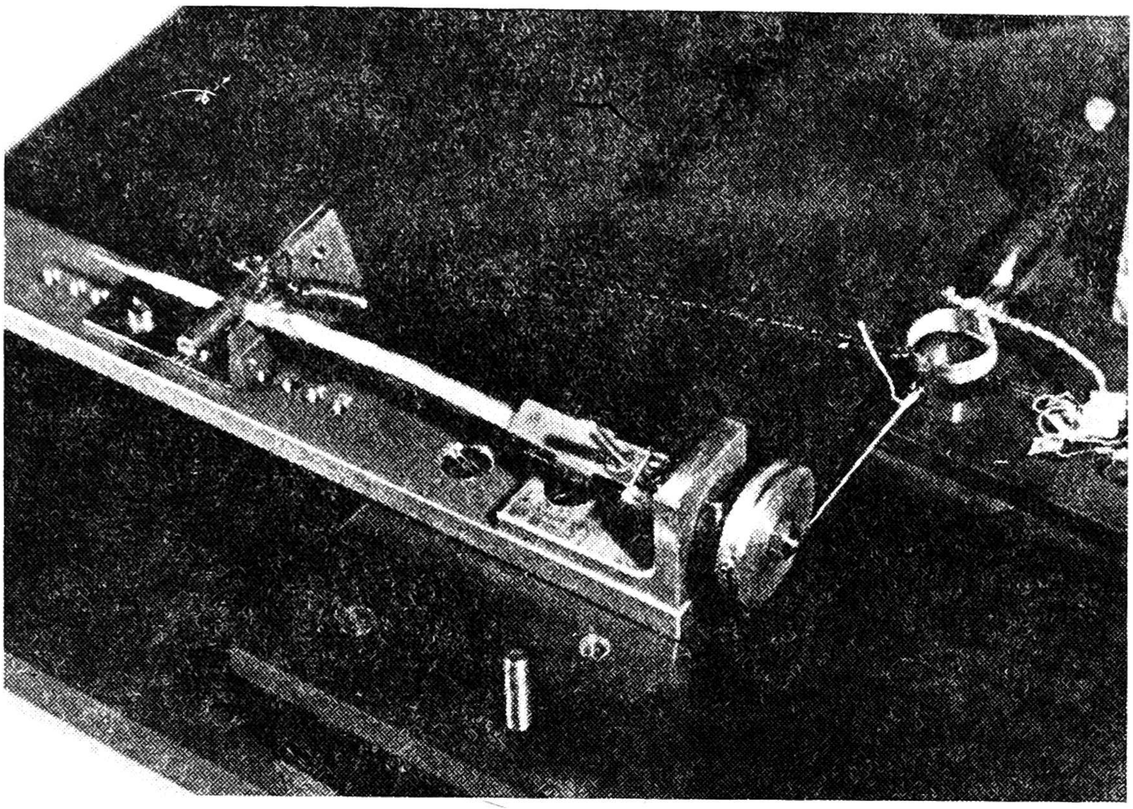

Fig. 1. Straining of the pod by torsion

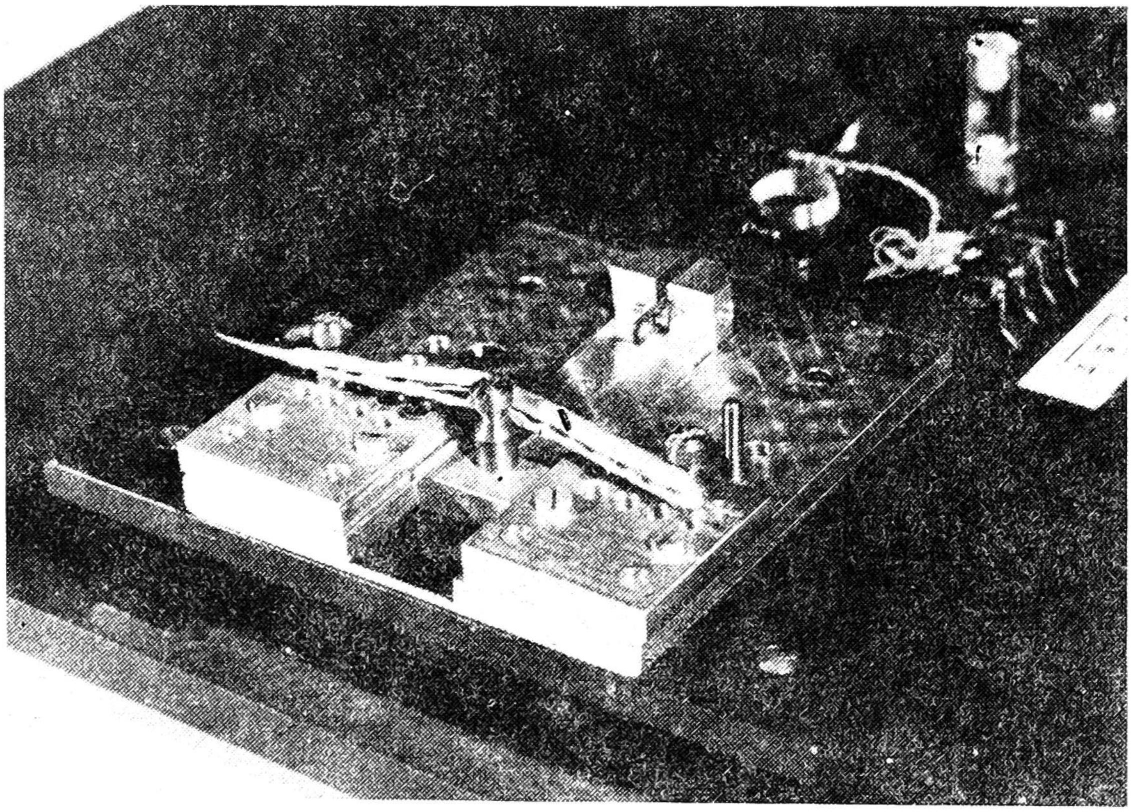

Fig. 2. Straining of the pod by bending

(Fig. 2) or by a combination of these stresses. The valves can be separated by tensile or shear force. It is possible to realize all these kinds of strainig. It is also possible to realize a special bending stress, when the pedicel is tightly clasped and a force perpendicular to the partition acts on the pod. (Fig. 3). This way of straining imitates very well the conditions of mu-

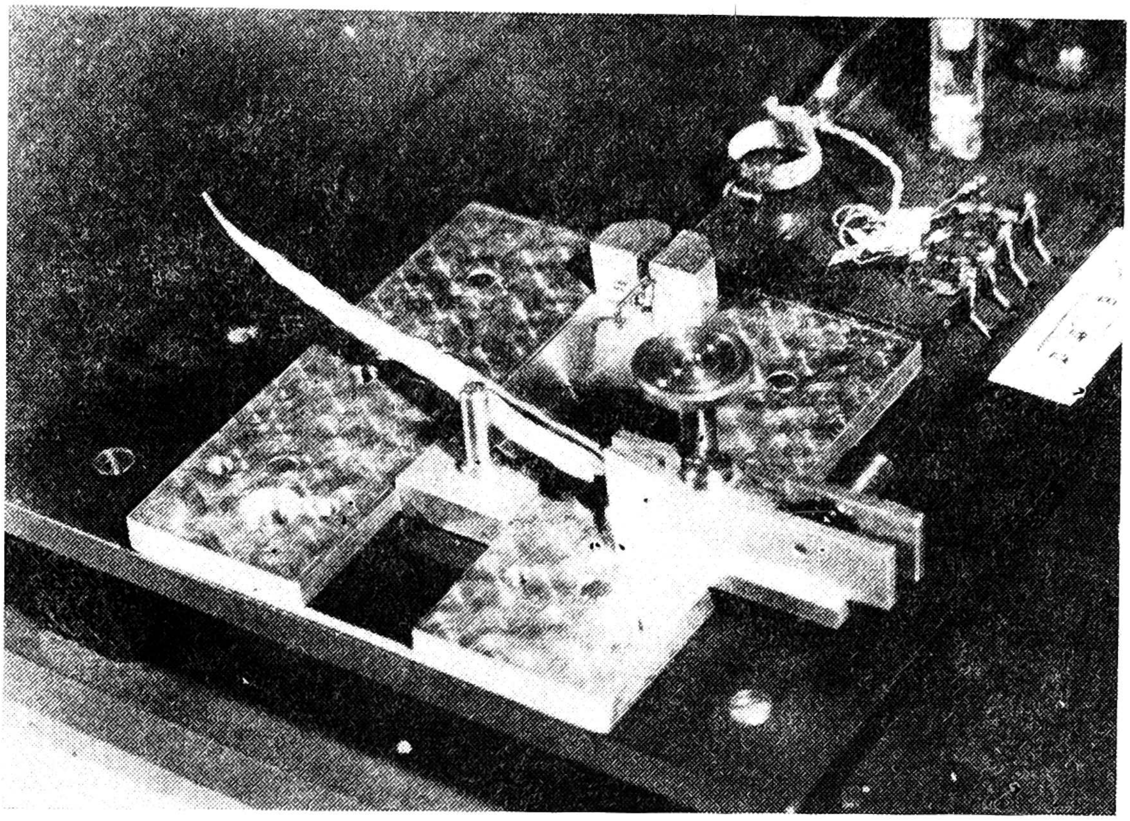

Fig. 3. Action of the force perpendicular to the partition

tually touching plants in the field and at harvest. In view of the fact that the pod cracks very easily as result of this stress, this mechanism is to be considered — apart from spontaneous cracking — as the major cause of losses.

Thus the kind of extraneous mechanical effect can be various. It is necessary to agree on it and define it, in order that a method might be developed, whose results would be comparable, no matter what equipment used.

The most convenient, of course, would be to exert such an effect on the pod as to induce a stress in the suture, esay to estimate, and this stress at which the suture connection breaks — i.e. the limit of the suture strength — should be considered as suture strength. This approach, however, does not appear to be a real one, the material and form of the suture and pod being very complicated.

On the basis of verifying experiments on various kinds of stress and with regard to good prospects of interpreting the measured values, it is the torsion stress that appears most suitable; first of all because the critical section of the suture is stressed by the same stress and the torsion required for breaking the valve connection does not damage the valves themselves, neither induce any essential plastic deformation to them. In addition, the course of a necessary moment of torsional force exhibits an outstanding maximum, which may be advantageous in evaluating measurements.

During uniformly proceeding distortion of the pod, the moment of torsional force M increases almost linearly in dependence on the torsional angle φ, until the stress due to this straining reaches the value at which the valves separate — crack — most often first on one side of the pod — in one suture. At this instant the torsional angle is φ_1 and the moment of torsional force reaches the value M_1; after cracking it drops very rapidly to the value M_2 (Fig. 4). During further distortion the necessary

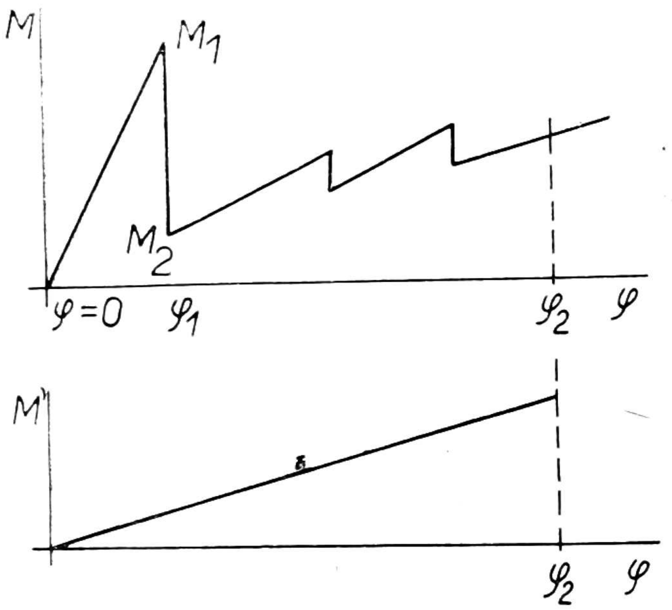

Fig. 4. Graph of the course of the moment of torsional force during uniformly proceeding distortion of the pod

moment of torsional force increases again and one or two rapid falls occur, in response to the separation of the valves on the other side of the pod. Thereafter, the moment of torsional force increases approximately linearly without essential breaks and this increase during further distortion reflects the rigidity of the pod with valves completely separated. The torsional angle at which both sutures are separated already shall be designated φ_2. If we further observe, beginning from $\varphi = 0$, the dependence of the torsional moment M' on the torsional angle φ during the distorting of the same pod, but with completely separated valves, we shall find an approximately linear dependence.

For distorting an initially intact pod in torsional angle φ_2 the work $A = \int_0^{\varphi_2} M \, d\varphi$ is to be expended. For distorting the pod with completely separated valves in the same torsional angle φ_2 the work $A' = \int_0^{\varphi_2} M' d\varphi$ is to be expended. The difference of the works $\Delta A = A - A'$ shall be the measure of effort required for breaking the valve connection — for valve separation — and thus for falling out of the seeds, so that it is also the measure of the resistance to the falling out of seeds as result of cracking due to extraneous mechanical effect.

Irrespective of the connection with the losses caused by the falling out, the measure of the resistance to cracking due to extraneous effects may be expressed as the work ΔA_1 required for induction of the first cracking — in one suture, i.e. at the instant the necessary moment of torsional force reaches the value M_1 and the torsional angle is φ_1. If we designate the required torsional moment for distorting the pod with one suture cracked as M'', then $\Delta A_1 = A_1 - A''_1$, where $A_1 = \int_0^{\varphi_2} M\,d\varphi$ and $A''_1 = \int_0^{\varphi_2} M''d\varphi$. M'' at $\varphi = \varphi_1$ apparently equals M_2 and $M = M_1$. Considering the fact that M and M'' are dependent, until the value $\varphi = \varphi_1$, on φ approximately linearly, we can write $\Delta A_1 = {}^1/_2\varphi_1(M_1 - M_2)$. From the measurements made until now it may be concluded that $M_2 = K \cdot M_1$, where the coefficient K reaches the values round 0.4. Then $\Delta A_1 = {}^1/_2\varphi_1(1-K)M_1$.

In case it should be confirmed by further more extensive measurements that K is approximately the same for various pods of different varieties, the method could be simplified to measuring φ_1 and M_1 only. It would be also possible to develop a very simple apparatus for this purpose.

EXPERIMENTAL EQUIPMENT

When realizing the methods mentioned above it is necessary, therefore, to obtain the values A, A', or A_1 and A''_1. The most simple, but also the most laborious and time-consuming is the method which provides graphic records of $M = f_1(\varphi)$ and $M' = f_2(\varphi)$. The values of A, A', A_1, A''_1 are to be determined by the planimetric method. It is possible, of course, in case we use electric converters in measuring M, M' and eventually φ, to utilize an analog electric circuit — integrator — for determining A and A', so as to gain the necessary data immediately after termination of measurement. It is also possible to record the course of M and M' on a punched tape and to let the computer evaluate ΔA and ΔA_1, as well as further statistical analysis. Nevertheless, the simultaneous graphic record of the courses of M and M' is of importance, as their forms make it possible to obtain further knowledge on the properties of pods.

To obtain records of the courses of the moments of torsional forces a tensile testing micromachine described by Řezníček [4] can be used. The jaws are modified for straining the sample by torsion (Fig. 1). The moment of torsional force is realized by the force induce by the motion screw. This force acts with regard to the rotation axis of the rotatable clamp on the arm equal to radius of the roller attached to the axis (Fig. 1). The equipment consists of a frame *a* (Fig. 5a), a slat *B* which mova--ble clamp *C* which may be set to various distance according to the pod

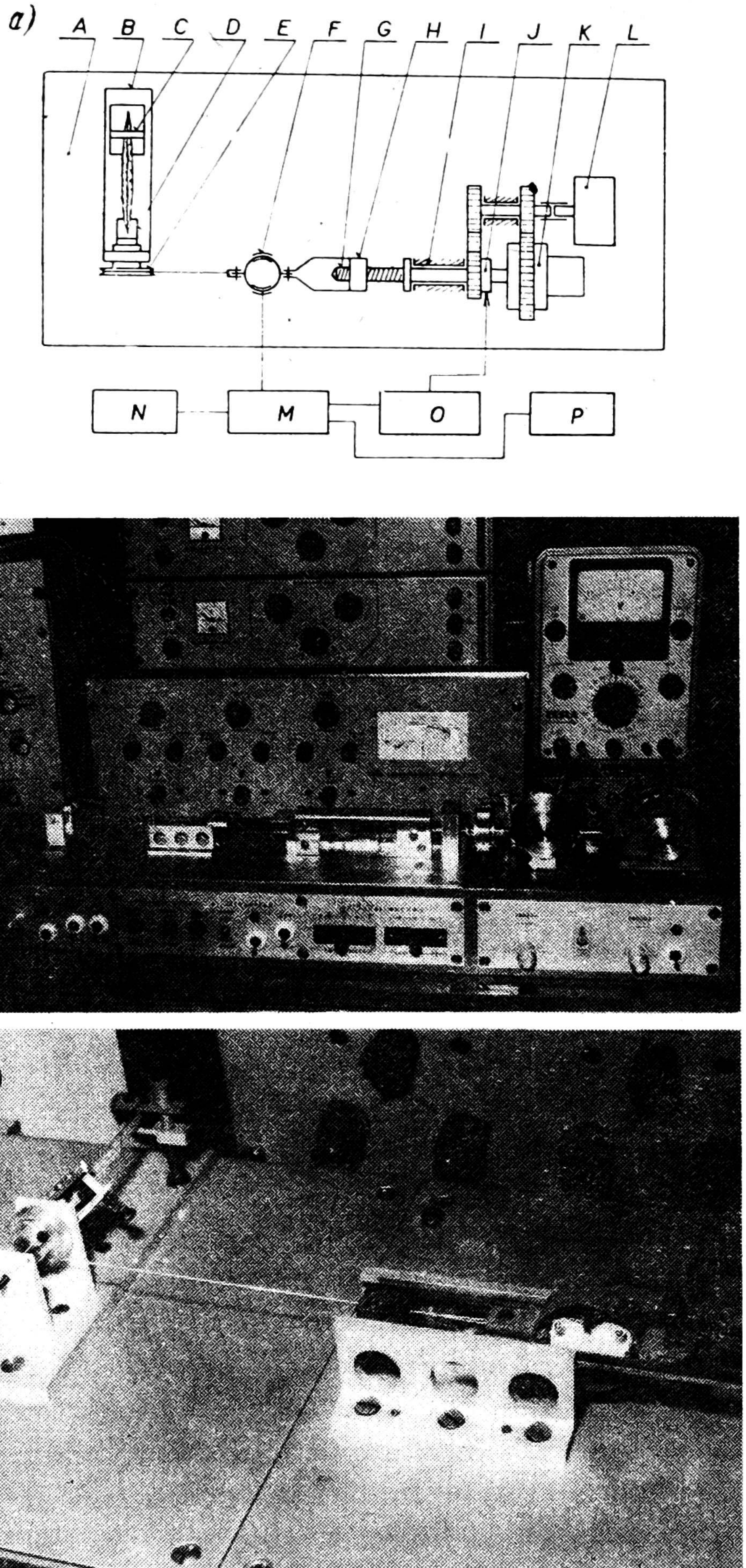

Fig. 5a, b, c. The tensile testing micromachine length. The slat *B* carries a rotatable clamp *D* mounted on a shaft with necessary axis clearance where a roller *E* is fastened, too. The roller is connected with the dynamometer ring *F* by means of a fibre. There is here further the motion screw *G*, nut *H*, bearing I, switch *J* for recording the rotation of the motion screw, coupling *K*, electromotor *L*. The dynamometer ring *F* is circular with a diameter of 13 mm, thickness 0.15 mm, and height 4 mm. It is made of a bronze thin-walled tube. To the ring are attached 4 resistor tensometers of 120 Ω which form a complete bridge. To this a tensometric apparatus *M* is attached. The output from the apparatus goes to the oscilloscope *N* with a long afterglow of the tracing (for visual examination), to a loop oscillograph *O*, (for permanent record), and to the integrator *P* (for determining *A*, *A'*, event. A_1, A''_1). The loop oscilograph receives also pulses produced by the switch *J* in the marker circuit. The examples of record of *M* and *M'* are shown in Fig. 6.

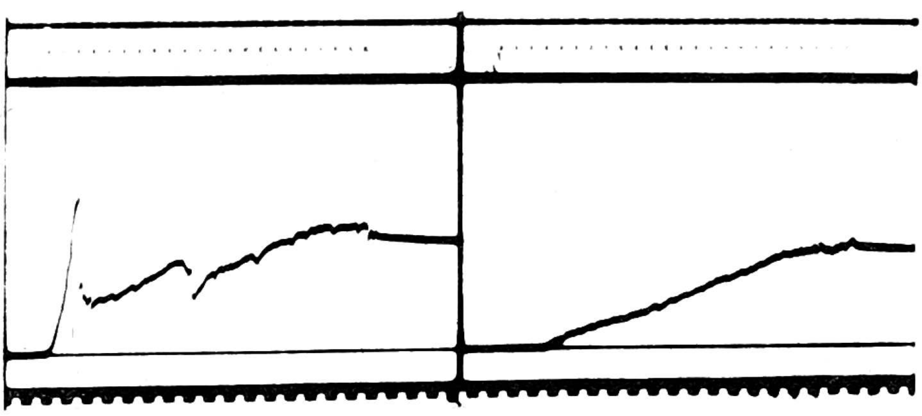

Fig. 6. Graphic record of the courses of M and M'

The torsion length, i.e. the distance between the clamps *C* and *D* was estimated, on the basis of tests, on 50 mm, which meets best the requirements of realizing the method.

A more perfect type of the tensile testing machine has been designed and constructed in the Department of Physics of the University of Agriculture in Prague.

CONCLUSION

1. The methods for examining the cracking rate of rape pods are lacking. The cracking rate depends on the strength of valve connection. Objective information concerning this property can be obtained during torsional stress of the pod.

2. The equipment was designed and constructed to carry out quan-

titative examination and to record the courses of the moment of torsional force, required for distorting the pod until complete cracking.

3. On the basis of a great number (hundreds by order) of examined courses of the moments of torsional force, causing the cracking of pods of several different rape varieties, the definitions of two agrophysical quantities, characterizing the pod properties and methods of their estimation, were proposed:

a. Resistance to falling out of the seeds as result of pod cracking is equal to the work ΔA expended during the distortion of the pod till complete separation of both valves.

b. Resistance to cracking is equal to the work ΔA_1 expended during the distortion of the pod for breaking one suture.

4. According to preliminary measurements in various varieties at full maturity the values of ΔA are units of mJ and those of ΔA_1 are decimals of mJ. From the results of more extensive measurements from the year 1974 [5] the following average values of ΔA and ΔA_1 in mJ are derived for the varieties: Třebíčská: 13.16, 1.20; Norde: 11.61, 0.83; Rapol: 14.94, 1.42; Gorczanski (Brillant): 17.28, 1.68.

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METODA OZNACZANIA SIŁY PĘKANIA ŁUSZCZYN RZEPAKU

Streszczenie

W artykule omówiono problematykę określenia odporności łuszczyn rzepaku na pękanie pod wpływem działania mechanicznego.

Praca zawiera definicje tej wielkości fizycznej, metodykę pomiaru oraz opis aparatury pomiarowej.

Р. Жезничек

ИССЛЕДОВАНИЯ АГРОФИЗИЧЕСКИЕ СВОЙСТВ РАПСА

Резюме

В статье рассматривается проблематика определения устойчивости стручка рапса против растрескивания под влиянием механического действия. Приводятся в ней также определение этой агрофизической величины, метод и приборы, необходимые для ее исследования.

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