RESULTS OF INVESTIGATIONS ON THE DETERMINATION ON THE PHYSICAL PROPERTIES OF SUGAR BEET

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Works on the determination of plant properties connected with the work of machines (mainly the physical properties) were begun by us from the working out of the literature of the subject [8]. Then in the period 1968—1971 on the basis of a large team of specialists a four--ligual catalogue of the discussed plant properties [9] was prepared for printing. In the period 1971—1975 a new varsion of this cataloque (againg multilingual) was worked out [4], in which the properties of sugar beet were prepared by a team of specialists from Poland and the GDR. Basing on these materials in 1974 systematic investigations of the physical properties of sugar beet were started within the frames of problem coordinated by the Institute of Agrophysics of Polish Academy of Sciences. The works were begun by determining the range of investigations, determining the most important properties of sugar beet, and the sequence of investigating them. In order to grasp the soil-climate variability the investigations were set up in four localities: on the experimental field of the Institute of Plant Genetics and Breeding in Wilanów near Warsaw, in the Regional Experimental Station of the Agricultural Academy in Lublin (in Felin), in the SHR Więcławice near Inowrocław, and in the SHR Radziemice in the region of Cracow. Four varieties were considered: AJ Poly 2, AJ3, AJ-Polycama, and Trimono. Two levels of mineral fertilization were used: 100 kg/ha N, 120 kg/ha P_2O_5 and 130 kg/ha K_2O, and a level 50% higher. In order to create the possibility of investigating the corelation between the investigated properties and the usable value the following were determined: the crop of roots and leaves, the content of sugar and ash, the content of dry mass in beet root, the weight of root.

The investigations were carried out on the level of single plants and greater populations, which allowed in the first case to solve some methodological quastions, while the investigations of populations allowed to determine the individual variability, and the interaction of varieties, localities, and years. In the first place the physical properties of the root were determined, though at the same time such introductory investigations were carried out as those of the force of breaking the side roots the resistance to breaking and compressing, the properties of elasticity and plasticity, the limit resistances overcome by the roots and the sprout during germination. As to the leaves the investigations were limited to measurements of the geometrical properties. As to the root, apart from the geometrical features and the anatomical features, the following properties should be investigated: the distribution of values concerning the weight, the specific weight, the bilging, the permeability, the resistance to breaking, compressing and cutting, elasticity, plasticity, the elasticity and plasticity modulus, the histological build up, the cuttability of roots, the force necessary to remove root from soil, the thermo-physical properties, etc. As to plants in the second year of development the root system and leaves are expected to be investigated in the same range as industrial beets. Moreover it seems to the point to get to know the geometrical and the morphological properties of stem and the cutting resistance of stems in relation to the variety and the type of seedling, and the properties connected with lodging. Another large and important group of problems are the physical properties of glomuses, both single and in the form of prismed or bagged mass. This concerns the geometrical, and anatomical properties, as well as the force of compressing, friction, etc. The presented scheme is the maximum program, which, depending on the possibilities, will be gradually realized. On the present stage of investigations we can present our attitude to same of the obtained results, the more so that the making of a synthesis will be possible after the completion the three-year cycle of investigations. Analysis of the results concerning the usability features (crop yield of roots and leaves, sugar, the content of sugar and ash) indicates that the planned differentiation of plant material which will to a considerable degree representative for the determination of relationships between them and the investigated mechanical properties, was achieved. Moreover, our investigations confirmed the existence of high individual variability among the particular roots, which clearly influences the number of plants in the investigated sample [2]. This number is surely different for different properties, but we can assume that in the majority of cases the making of determinations on a number of beets lower than 50 is pointless. Also the influence of agro-ecological conditions on the geometrical features of roots and leaves, the height of beets growing above ground, the force necessary to remove beets from soil, the hardness of roots, etc. proved to be considerable. It is usually much greater than that of the heritable properties of varieties. Moreover the influence of the developmental variability is very clear. And thus for instance roots dug out at a term delayed by one month in relation to that usually applied in the region showed an increase of the weight of roots and leaves, a changed shape index, greater compactness of dry mass, and an increase of hardness. Thus, depending on the term of investigations, it is possible to obtain different parameters of the investigated physical properties of roots. Also the place of measurement on plant is very important. The determination of some mechanical properties requires the consideration of the shape of root, and so for instance the permeability of roots or their breakability or crumbliness are directly connected with the dimentions of roots. The shape of sugar beet root is usually determined with the help of two parameters. It was proved that it is better to use three parameters: width, length and thickness. These parameters are subject to considerable modification under the influence of the compactness and moisture of soil, and the content in if of the more important fertilizing components. The diploidal varieties are generally characterized by a higher shape index. Moreover bigger roots are usually characterized by higher shape index.

The value of force necessary to pull out a root increases within one variety with roots of greater diameter and longer ones (1, 3, 4). Also the occurence of forked roots is of considerable influence. Because these properties are strongly connected with variety properties, in further concequence also the force necessary to pull roots out from soil is a variety property. However, no variety has roots of one type only, and at the same time the influence of soil conditions is in this case so great, that practically the influence of environment is greater than that of variety properties. Thedeeper a beet root is grown into soil, and the more divided it is, the greater force is necessary to pull it out from soil. It was established that greater forces are necessary they were subjected to plants in a row are growing more sparsely, when they were subjected to raining during vegetation, and they are less fertilized with nitrogen. This means that all the factors causing a deeper positioning of roots in soil cooperate with their stronger bond with soil. And conversely, when they grow higher above soil surface, the lower the force necessary to pull them out. The force necessary to pull sugar beets out from soil is measured with a lever fitted with a dynamometer. The measurements can be made without ony prior measures taken, or after excavating the beets. In the latter case when we soften the soil in the inter-rows, we eliminate the variability resulting from soil conditions. The measurements in question should made by pulling the root vertically. The more important physical properties of beet roots include their woodening and hardness. The voodening of the fiber-wood bundles results from a higher content of cellulose and lignin. The woodening of root makes the work of the cutter and the course of diffusion more difficult. It is a heritable property considerably susceptible to environmental modification. For the determination of the degree of woodening chamical and microscopic methods are used, but the breeders determine it by calculating the number of holes in Wolski's press (0.7 mm in diameter) used for the pressing through of 100 root sections from a given field. Rierberg used additionally the organoleptic evaluation of root intersections. Hardness is the resistance which a material gives to bodies pushed into its surface. This property of roots is connected with the course of heading beets during harvesting and with the cuttability of beets in factory processes. It is measured by the depth to which a blade can be pushed in. The hardness of root to a high degree depends on the turgor of tissues. After the carrying out of plasmolysis the hardness of roots decreases to about 30% of the initial value. Hence the measurements are comparable when they are made in such conditions that the roots do not have time to dry. At first we made the measurements of hardness with the help of Höppler's consistometer with a blade 3.8 mm in width. Although this apparatus determines hardness, in final effect with the property of hardness cooperates the phenomenon of cracking of root tissues, and therefore the measurement is not very precise. Moreover the masurements are made on a small section of root, which cannot represent the value of whole root. Considering at that that the measurements depend considerably on the turgor of root, in effect they are loaded with large error. Hence in further investigations we used Vukov's apparatus in which the wire of the pendulum (0.4 mm in diameter) cuts a candle of the surface area of 2 cm^2. This apparatus is not free from all the above mentioned faults, but it gives more representative results. This was checked by comparing the results with investigations carried out with the help of Bieluga's penetrometer and the dynamic penetrometer. Investigations of the hardness of beet roots showed that it is a property heitable to a degree, but there are considerable differences among plants within the variety. Moreover all the environmental factors influencing the turgor modify the property in question, since it is assumed that about 50% of the cutting resistance is constituted by the turgor of roots. Apart from that elasticity and resistance are other important properties of beet roots. Elasticity is a property of solid body consisting in the ability to return to the initial size and shape after the cesation of acetion of the deformation causing forces. The measurements of elasticity, always carried out at the height of 0.75 of the hright of beet, are made with Schob's elastometer by letting the pendulum fall from a point where the potential energy of the pendulum with the weight is 2.5 kg. Intervariety differences were found. Generally a higher level of mineral fertilization caused an increase of the elasticity of roots. Resistance is the resistance to damage caused by exterial factors, made by a material because of the inner interparticle build-up. In the case of beets it is connected among others with cracking, i.e. the breaking of the tissues of root, which can have different character (for instance cracking can be caused by drying, frost, growth etc.). To a considerable degree it results from the anatomical build-up of beets. Cracking from drying is usually the result of the contraction of root consisting in the decrease of the dimentions of root during drying. The phenomenon in question is contrary to swelling, i.e. the increase of the dimentions of root during the sorption of water absorbed in the submicroscopic pores of cell walls. Permability is the ability to take in water or other liquids by a root submarged in liquid. The measuresof permeability are:

— the maximum moisture a root can assume as a result of moiste-ning,

— the rate of imbibition,

— the degree of saturation of root, that is the relation of moisture content assumed to the maximum moisture content.

The initiated investigations of this group of properties of beet roots allowed to choose the following course of action: the permeability was investigated in two terms of harvesting at one month intervals; the roots were placed in water of the temperature of 14 and 16°C for the periods of 15.40 and 75 hours. The displacement of water by beet roots of four varieties coming from different levels of fertilization was measured by placing them in a water container determining the weight of water displaced by the roots. The measurements were made after 15 hours of saturation and after 5 days.

Penetrability consists in the penetration of water or another liquid through the tissue of beet roots. It is connected with the heritable properties of a given variety, the initial moisture of the investigated roots, the pressure of the liquid, and the conditions of growth of the beets. From each beet two samples were randomly taken. A iccm section of the pulp of beet taken on the outer side was put in a glass pipe of the inner diameter of 1 cm. The pipe was 60 cm in height. It was filled with water of the temperature of 19°C. The height of the column of water was 50 cm. The penetrability of the root tissue was determined after 15 hours and after 40 hours. The force of binding between the glomus and seed sprout varies strongly depending on the weater conditions, the position of the glomus on the sprout. For these measurements a micropicker was used. In the course of work the following difficulties were met: there is a high developmental variability, hence the measurements should be made in possibly the same ripness stage, which is difficult to unify. The investigated force is different depending on the position of the glomus on the sprout. The apparatus does not allow to make measurements on a growing plant, and apart from that it is necessary to wait long for the reading.

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W. Byszewski

WYNIKI BADAŃ NAD OKREŚLENIEM FIZYCZNYCH WŁAŚCIWOŚCI BURAKÓW CUKROWYCH

Streszczenie

1. Burak przemysłowy

Badania trzyletnie prowadzono zespołowo, wykorzystując materiał uzyskany ze specjalnie w tym celu założonych doświadczeń w 4 miejscowościach przy dwóch poziomach nawożenia. Wstępne pomiary wykonano na pojedynczych osobnikach, a następnie określano zakres zmienności badanych cech w obrębie różnych populacji. W pierwszym przypadku skoncentrowano się na porównaniu różnej aparatury pomiarowej oraz określenia sposobu pobierania i reprezentatywności prób w zależ ności od ich wielkości i miejsca pobrania z korzenia. Następnie w obrębie populacji określano rozkład i wartości graniczne fizycznych cech na tle różnych warunków agroekologicznych. Omawiane badania dotyczyły następujących cech: system korzeniowy, siła zrywania korzeni bocznych, opory graniczne pokonywane przez korzeń podczas kiełkowania, wytrzymałość na zrywanie i ścinanie. Korzeń spichrzowy: cechy geometryczne, morfologiczne i mechaniczne. Liście — cechy geometryczne.

2. Burak nasienny

Badania prowadzono na niewielkiej liczbie osobników, analizy populacji są dopiero zapoczątkowane. Określano następujące cechy: cechy geometryczne i ważniejsze cechy mechaniczne liści i pędów oraz cechy geometryczne, anatomiczne i mechaniczne kłąbków.

В. Бышевский

ИТОГИ ИССЛЕДОВАНИЙ ПО ОПРЕДЕЛЕНИЮ ФИЗИЧЕСКИХ СВОЙСТВ САХАРНОЙ СВЕКЛЫ

Резюме

1. Промышленная свекла.

Трехлетние опыты проводились коллективно в четырех местностях на двух уровнях удобрения. Начальные измерения проводились на отдельных растениях, затем определялись пределы изменчивости исследуемых свойств в пределах различных популяций. В первом случае сосредоточились на сравнении различной измерительной аппаратуры и определении способа взятия и репрезентативности проб в зависимости от их величины и места на корне, из которого были взяты. Затем в пределах популяции определялись распределение и крайние величины физических свойств на фоне различных агроэкологических условий. Обсуждаемые условия касались следующих свойств: корневой системы, силы срывания боковых корней, предельных сопротивлений, преодолеваемых во время прорастания, устойчивости против срывания и среза. У хранилищных корней определялись геометрические, морфологические и механические свойства, у листьев — геометрические.

2. Семенная свекла.

Исследования велись на небольшом числе особей, анализы популяций лишь начинаются. Определялись геометрические свойства и более важные из механических свойств листьев и побегов, а также геометрические, анатомические и механические свойства клубочков.

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