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SELECTED PHYSICAL PROPERTIES OF BUCKWHEAT IN DETERMINATE FORM

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Summary. Buckwheat is a species prone to lodging which is one of the reasons of lowering the size of buckwheat seeds yield; the other is never-ending vegetation, which favours uneven seeds maturation and seeds shattering before harvesting. At one-stage harvesting, canopy dessication of the presently cultivated buckwheat varieties is necessary. Determinate form is characterised by a shorter vegetation period than other cultivated varieties, it loses leaves and dries earlier. Height, diameter, stiffness and energy of cutting stalks of Determinate from was assessed. It was found that the higher is an internode of a stalk the lower is its stiffness. The height of a stalk and its thickness are features which are positively correlated with stiffness and energy of cutting stalks. Energy necessary for cutting stalks decreases along with the plant height and is rather low.

Key words: buckwheat, stalk, stiffness, energy of cutting, lodging

Introduction

Buckwheat is a variety valued in organic farming. It is resistant to pathogens and can use nutrients which are hardly available. Nowadays, interest in its cultivation increases due to its dietary and taste qualities. Uneven cropping is one of the features which significantly limit the acreage of buckwheat cultivation in Poland 0.5–2.5 t·ha^{-1}. The reason for this is susceptibility to lodging, never finishing vegetation, unevenness of flowering and maturation of seeds and their self-shattering. Never-finishing vegetation causes that at one-phase harvesting dessication should be applied, which may cause loses in seeds as a result of self-shattering [Woliński 2012]. Plants lodging hinders combine harvesting; causes decrease of efficiency of harvesting machines [Gieroba 1968; Szot, Kolemba 1973; Woliński et al. 2002]. Susceptibility to lodging is highly related to stalks stiffness. Research on stalks stiffness of buckwheat has been started recently [Woliński et al. 2002, 2005, 2008; Woliński 2012], although there are results of research on stiffness of various plant varieties in literature [Szot, Skubisz 1979; Szpryngiel 1981; Skubisz 2001; Skubisz 2002; Kolowca,

Knapik 2008]. Determinate form is a new form of buckwheat, which loses leaves during vegetation season and some plants finish their vegetation spontaneously. This form is characterised by a shorter vegetation period, a quite flobby stalk susceptible to lodging. It was formed as a result of irradiation of buckwheat seeds of Hruszowska variety with radioactive caesium C^{137} [Wolińska et al. 2007] and is a genetically unstable form, therefore it requires further cultivation works.

Purpose, scope and methodology of research

The purpose of the study was to assess physical properties of buckwheat stalks of new Determinate form and to determine the scope of further works on obtaining a new buckwheat variety adjusted to one-phase harvesting without dessication. Tests on physical properties were carried out in 2010-2011. The obtained results were compared with the results obtained in 2006-2011 for Kora variety (main buckwheat variety in Poland).

50 plants of each form were selected for the research. The height of plants was later measured. Measurements of the stalk diameter were taken in three measuring points - I and II internodes and in an internode under I inflorescence on a stalk (beginning of fructification sphere). 100 mm long sections of internodes were collected for research and a diameter was measured in the middle of the examined internode section. A diameter of stalks was measured with a digital caliper with an electronic digital monitor VICHENG 8628.

Measurements of stiffness and static cutting energy were carried out in the Institute of Agrophysics PAN in Lublin at INSTRON 6022 apparatus with a part adjusted for this type of tests (photo 1).

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Photo 1. Measurements of physical properties of buckwheat on Intron 60221 device
Fot. 1. Pomiary właściwości fizycznych gryki na urządzeniu Intron 60221

Measured sections of stalk were placed on two suspensions located 60 mm from each other and then bent in the point where a diameter was measured (and in the middle between suspensions) with the speed of 50 mm/min. Courses of the force growth at bending a stalk obtained from Instron 6022 recording instrument enabled determination of the maximum value of force concerning elasticity of the stalk section and respective deflection. A modified method used for grain stalks was applied for calculating stiffness of internodes [Alhgrimm 1978; Skubisz 1989]. Theory of bending an elastic beam of circle cross-section, suspended on two suspensions and bent with force concentrated in the middle of the distance between suspensions was applied.

Deflection of a beam is expressed with the following formula:

$$y = Pl^{3} \cdot (48EJ^{-1}) \quad (1)$$

after transformation, stiffness values (EJ) were obtained

$$EJ = Pl^{3} \cdot (48y^{-1}) \ [Nmm^2] \quad (2)$$

where:

P – stalk bending force [N]
l – length of the bent piece of a stalk [mm],
y – deflection [mm],
EJ – stalk stiffness [Nmm^2].

Calculated values of stiffness were referred to the outside diameter of the researched internode of buckwheat.

Review of the research results

The research which was carried out enabled comparison of height, diameters and stiffness of stalks and cutting energy of the researched buckwheat forms. The results were presented in table 1.

The average height of stalks of the Determinate form was 101.4 cm and was characterised by quite high coefficient of variation V=39.53%. It was found that values of this property differed significantly from the values obtained for Kora variety, where average height was 120.8 cm and was characterised with the lowest variability of all the researched properties (V=18.53%).

Both forms differed significantly with a diameter of stalks at all internodes. In both researched forms at the I internode, a stalk was the widest. Kora variety formed a thicker stalk (7.13 mm) than Determinate form (5.82 mm). The smallest diameter (Determinate form 4.02 mm, Kora variety 4.40 mm) produced III in the researched internode (under I inflorescence). Similar results for Kora variety were obtained by Woliński [2012], Woliński et al. [2002, 2006]. This feature for Kora variety is characterised by relatively low variability, for Determinate form; considerably higher coefficients of variation were obtained. Earlier drying of Determinate form plants caused decrease of the stalk diameter.

Table 1. Values of physical proeprties of stalks of the researched buckwheat forms
Tabela 1. Wartości cech fizycznych łodyg badanych form gryki

Number	Property	Unit of measure	Determinate				Kora				Significant differences between properties
			average	minimum	maximum	coefficient of variation [%]	average	minimum	maximum	coefficient of variation [%]	
1.	Height	[cm]	101.4	65.5	149.5	39.53	128.08	105.3	145.8	18.53	α =0.01
	I internod										
2.1.	Stalk diameter	[mm]	5.82	3.02	9.75	31.66	7.13	3.41	10.71	22.30	α =0.01
2.2.	Stalk stiffness	[10^4Nm^2]	3.54	0.33	20.45	79.92	3.96	0.54	22.76	77.32	α =0.01
2.3.	Energy	[J]	0.212	0.019	1.254	124.62	0.244	0.026	1.395	113.67	α =0.05
	I internod										
3.1.	Stalk diameter	[mm]	5.36	3.27	9.43	30.15	6.53	3.75	9.59	21.59	α =0.01
3.2.	Stalk stiffness	[10^4Nm^2]	3.45	0.28	19.95	97.5	3.72	0.34	22.13	99.90	α =0.01
3.3.	Energy	[J]	0.185	0.019	1.903	119.81	0.211	0.022	1.206	99.79	insignificant
	I internod										
4.1.	Stalk diameter	[mm]	4.02	2.15	6.86	34.0	4.40	3.13	7.71	18.60	α =0.01
4.2.	Stalk stiffness	[10^4Nm^2]	2.51	0.20	19.81	104.5	2.86	0.26	20.23	99.99	α =0.01
4.3.	Energy	[J]	0.156	0.011	0.743	108.72	0.171	0.019	0.915	101.30	insignificant

Source: author's own study

Similar tendencies were reported at testing the stalks stiffness. Both forms differed significantly at all internodes on account of this feature. Determinate form was characterised with lower stiffness of a stalk than Kora variety. I internode in the Determinate form was characterised by the highest stiffness ($3.54x10^4$ Nmm^2), high variability (V=79.92%). Similarly, in Kora variety, the highest stiffness occurred in the I internode ($3.96x10^4$ Nmm^2). This property was highly variable (V=77.32%). The lowest stiffness and the highest coefficient of variation was reported in the III internode ($2.86x10^4$ Nmm^2 and V=99.99% in Kora variety and $2.51x10^4$ Nmm^2 and V=104.5% in Determinate form). At the II internode, stiffness of stalks as well as their variability had average values.

Both forms differ with stalks cutting energy while significant differences in the value of this property were obtained for cutting energy in the I internode. Between II internode and an internode under the I blossom no significant differences in the value of this property were determined. Kora variety had a higher cutting energy of stalks in each internode, where the highest cutting energy of stalks was obtained in the I internode (0.244 J), and the lowest in the III (0.171 J). Determinate form had lower values of this property. In the first internode, cutting energy of a stalk amounted to 0.212 J and in the III it was 1.156 J. It was found that the higher was the internode the lower was the cutting energy of a stalk. This property is variable, value of coefficients of variation exceeds 100%.

Correlation between the researched properties was calculated (tab. 2). Significant dependence between the height of a stalk and its diameter (r=0.64) was reported. Lower coefficients of correlation within 0.5 were obtained for the remaining features.

Table 2. Values of coefficients of correlation between the height, a stem diameter and the energy of its cutting

Tabela 2. Wartości współczynników korelacji pomiędzy wysokością, średnicą łodygi a energią jej cięcia

Property	Stalk diameter	Cutting energy
Height of a stalk	0.64	0.51
Cutting energy	0.53	X

Source: author's own study

Conclusions

1. Determinate form produced a lower and flabbier stalk in comparison to Kora variety. High values of the coefficient of variation in both tested forms and slight differences in the value of this property make it impossible to find stiffness as a variety property.
2. High variability of stalk stiffness and cutting energy of a stalk indicated the possibility of obtaining a variety of higher stiffness and lower susceptibility to lodging through selection.
3. The height of a stalk and its thickness are features which are positively correlated with stiffness and energy of cutting stalks. Energy necessary for cutting stalks decreases along with the plant height and is rather low.

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WYBRANE WŁAŚCIWOŚCI FIZYCZNE ŁODYG GRYKI FORMY SAMOKOŃCZĄCA

Streszczenie. Gryka jest gatunkiem podatnym na wyleganie, co jest jedną z przyczyn obniżenia wysokości plonu nasion gryki; inną jest niekończąca się wegetacja, co sprzyja nierównomiernemu dojrzewaniu nasion, osypywaniu się części z nich przed zbiorem. Przy jednoetapowym zbiorze zachodzi konieczność desykacji łanu obecnie uprawianych odmian gryki. Forma Samokończąca charakteryzuje się krótszym okresem wegetacji niż inne uprawiane odmiany, wcześnie traci liście i zasycha. Oceniano wysokość, średnicę sztywność i energię cięcia łodyg formy Samokończąca. Stwierdzono, że im wyższe międzywęźle łodygi, tym mniejsza jest jej sztywność. Wysokość łodygi oraz jej grubość to cechy dodatnio skorelowane ze sztywnością i energią cięcia łodygi. Energia potrzebna do cięcia łodygi maleje wraz z wysokością rośliny i jest niezbyt wysoka.

Słowa kluczowe: gryka, łodyga, sztywność, energia cięcia, wyleganie

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