Dependence of the legume seeds vigour on their maturity and method of harvest

STANISŁAW GRZESIUŁ, RYSZARD GÓRECKI

Department of Plant Physiology and Biochemistry, Agricultural-Technical University, 10-957
Olsztyn-Kortowo bl. 40, Poland

(Received: October 19, 1988. Accepted: December 2, 1988)

Abstract

Several methods were used to study the vigour and viability of legume seeds (*Pisum sativum* L. cv. Hamil, *Pisum arvense* L. cv. Mazurska and *Lupinus luteus* L. cv. Tomik) harvested at three main stages of seed ripening (green, wax and full). The seeds were tested immediately after harvest (series A) and after two weeks of storage in pods (series B). It was found that: 1) the vigour of ripening legume seeds increases with maturation; 2) post-harvest storage in pods increases the degree of ripeness and, consequently, vigour; 3) seeds attain full vigour later than full viability; 4) seed leachate conductivity method gives erroneous results in assessing the vigour of immature seeds; 5) full vigour of maturing seeds of various degrees of ripeness can be determined by simultaneous application of both biological (eg. seedling growth analysis, VI) and biochemical (e.g. total dehydrogenase activity) methods.

Key words: vigour, viability, seeds of various degrees of ripeness, legumes

INTRODUCTION

The sowing quality of seeds can best be determined by a preliminary assay of their vigour (Grzesiuk and Górecki 1981, Górecki 1986), that is, of those potential physiological properties of seeds which determine rapid and uniform germination, sprouting and the normal development of seedlings under various environmental conditions (Anonym 1983). The vigour of a given species and variety (and a seed batch) is, however, dependent on many factors such as environmental conditions, health, ageing (age) etc. (Pollock and Roos 1972, Grzesiuk and Górecki 1981). The biochemical basis of vigour

variability (Abdul-Baki 1980) also points to its significant dependence on maturity, degree of development, density, manner of harvest and storage and other similar properties of seeds (Górecki 1982, 1986, Górecki and Grzesiuk 1983).

Due to topophysical, genetic and ecologic variability, marked differences in the physiological quality of ripening seeds occur in crop species of legumes (*Pisum sativum*, *P. arvense* and *Lupinus luteus*) (Górecki and Grzesiuk 1982, 1983, Górecki 1983). Consequently, each harvested batch of seeds is a complex biological population whose sowing quality may be best expressed by the vigour criterion (Górecki and Grzesiuk 1983).

The objective of this study was to determine the optimal methods for testing the vigour of *Pisum sativum*, *P. arvense* and *Lupinus luteus* seeds harvested at various stages of ripeness.

MATERIAL AND METHODS

Ripening *Pisum sativum* L. cv. Hamil, *Pisum arvense* L. cv. Mazurska and *Lupinus luteus* L. cv. Tomik seeds came from the University plantation at Tomaszkowo near Olsztyn. They were harvested at the green, green-wax (only pea), wax and full ripeness stages (Table 1).

Each seed batch was divided into two parts: Series A — seeds were removed from the pods immediately after harvest, Series B — the pods were stored in a laboratory with good air circulation for two weeks, after which seeds were removed. Fresh weight and water contents were determined just after removing the seed from the pods and their viability and vigour tested. The protein content of air-dry seeds was also determined.

Viability of seeds was determined on the basis of their capacity and rate of germination (Grzesiuk and Kulka 1981), while vigour was determined using three methods: total dehydrogenase activity, seed leachate conductivity (Knypl 1979b, Grzesiuk and Tłuczkiewicz 1982) and growth analysis of sprouts and seedlings (Górecki 1986). Total protein content of the partially dried seeds was determined using the method of Lowry et al. (1951).

RESULTS

WEIGHT AND HYDRATION OF SEEDS OF VARIOUS MATURITY

The tested seeds of three legume species (*Pisum sativum*, *P. arvense* and *Lupinus luteus*) had different initial fresh weights and contained no equal amounts of water (Table 2). The hydration of the seeds decreased as ripening progressed, while their fresh weight (with the exception of *P. sativum*) steadily increased. The seeds from series B (stored two weeks in pods) had, as a rule,

Table 1

Harvest of legume seeds at different stages of ripeness (Tomaszkowo, 1982 r.)

Species cultivar	Green ripeness		Green-wax ripeness		Wax ripeness		Full ripeness	
	date of harvest	number of days after flowering	date of harvest	number of days after flowering	date of harvest	number of days after flowering	date of harvest	number of days after flowering
<i>Pisum sativum</i> L. cv. Hamil	07.08	20	07.14	26	07.20	32	07.26	38
<i>Pisum arvense</i> L. cv. Mazurska	07.21	29	—	—	07.27	35	08.02	41
<i>Lupinus luteus</i> L. cv. Tomik	08.03	44	—	—	08.09	50	08.14	55

Table 2

The weight of 1000 seeds and the water content in legume seeds harvested at different stages of ripeness

Ripeness	Number of days after flowering	Water content on harvest in %	Weight of 1000 seeds (in g)	
			series A	series B
	<i>Pisum sativum</i>			
Green	20	77.0	66.5	93.0
Green-wax	26	70.6	152.2	165.2
Wax	32	53.4	206.1	200.2
Full	38	14.4	187.1	179.1
LSD p = 0.05		0.02	0.14	0.12
	<i>Pisum arvense</i>			
Green	29	64.4	103.9	96.6
Wax	35	24.6	123.0	127.3
Full	41	13.9	126.1	130.6
LSD p = 0.05		0.04	0.13	0.11
	<i>Lupinus luteus</i>			
Green	44	65.8	81.5	80.1
Wax	50	22.4	88.1	94.5
Full	55	18.1	101.5	97.6
LSD p = 0.05		0.03	0.11	0.12

a lower weight than seeds of the same degree of ripeness from series A. This was, however, not true for the youngest pea seeds (Table 2). The increase in hydration of the seeds in the pods occurred most likely as the result of biopolymerization of the reserve substances as well as of drying out (Sobolev and Zhdanova 1983).

VIABILITY OF SEEDS OF VARIOUS DEGREES OF RIPENESS

The rate of germination and germination capacity of seeds not in the state of dormancy are good parameters of seed viability (Grzesiuk and Kulka 1981). The legume seeds of various degrees of ripeness attained higher and higher germination capacity and germination rate with maturation (Table 3). However, the manner of harvest influenced their viability. The seeds harvested by a two-step method (series B), that is, removed from the pod after 14 days of

Table 3

Germination (in %) of legume seeds harvested of different maturity

Ripeness	Number of days after flowering	Series A			Series B		
		rate of germination, %	germination capacity, %	average germination time, days	rate of germination, %	germination capacity, %	average germination time, days
		<i>Pisum sativum</i>					
Green	20	0.0	0.4	7.3	53.6	53.6	2.8
Green-wax	26	25.6	32.4	5.0	48.0	48.0	2.6
Wax	32	40.0	82.0	6.1	67.6	67.6	2.4
Full	38	83.6	93.2	3.7	97.2	99.6	2.6
LSD $p = 0.05$		4.62	5.99	2.80	7.42	7.29	0.33
		<i>Pisum arvense</i>					
Green	29	6.4	34.4	8.7	84.4	98.4	3.7
Wax	35	90.4	92.0	3.6	100.0	100.0	2.1
Full	41	99.2	99.0	2.4	99.6	100.0	2.4
LSD $p = 0.05$		7.74	7.20	1.19	12.96	2.07	0.82
		<i>Lupinus luteus</i>					
Green	44	56.0	66.4	3.4	32.0	34.8	2.6
Wax	50	97.6	100.0	2.9	100.0	100.0	2.1
Full	55	99.6	100.0	2.7	100.0	100.0	2.1
LSD $p = 0.05$		6.91	4.82	0.53	5.27	2.88	0.58

storage, showed as a rule a greater rate of germination (germination capacity and average time), than the seeds removed from their pods just after harvest (series A); this in itself was an evidence of their greater vigour.

THE VIGOUR OF SEEDS OF VARIOUS RIPENESS

The vigour of legume seeds was assessed using four methods: a) growth analysis of sprouts and seedlings, b) seed leachate conductivity, c) vigour index (coefficient), d) total dehydrogenase activity.

a. In the growth analysis of sprouts and seedlings the lengths of the epicotyl (stem) and root, and dry weight of the sprout or seedling were measured. These measurements (Table 4) showed that two-week storage of *P. sativum* and *P. arvense* seeds in pods (series B) noticeably increased and improved their vigour; this was not observed in *L. luteus*. The largest sprouts and seedlings were produced by *P. arvense* seeds at wax ripeness. Pea seeds which were removed from their pods just after harvest (series A) at green ripeness did not germinate at all, at green-wax stage they germinated very poorly with their sprouts often dying, and those at wax ripeness germinated poorly. The *P. arvense* seeds harvested at the initial ripeness stages produced small and weak sprouts and only *L. luteus* seeds formed relatively large sprouts with a high fresh weight starting from the first stages of ripeness (green, wax).

b. Seed leachate conductivity according to Knypl (1979a) is considered to be one of the best methods of testing the vigour of mature legume seeds (Knypl 1979a, b, Perry 1981, Górecki and Grzesiuk 1983, Powell 1986). It is believed that a relatively lower value of seed leachate conductivity indicates a greater seed vigour (Anonym 1983). Measurements of seed leachate conductivity of legume seeds of various ripeness did not confirm that belief and showed a high variability and irregularity of results (Table 5). Although the leachate conductivity exhibited a decreasing tendency as maturation progressed, but the phenomenon was irregular. Noteworthy is a much higher conductivity of leached from more mature seeds (series B) than from the less mature seeds (series A).

Comparison of the conductivity of leachates from the mature seeds (Fig. 1) indicates that *P. arvense* seeds had a higher vigour than *L. luteus* seeds and particularly *P. sativus* seeds, which, however, does not agree with the results of growth analysis of these species (see point a). These results indicate that the seed leachate conductivity method cannot be used to compare the vigour of seeds from various species. Figure 1 shows, however, that seed leachate conductivity can be well measured as early as 6, 9 and 12 hours after submersion in water.

c. The vigour index (VI) is a combination of the seedling growth analysis method and viability testing through germination (Knypl 1979b). In this study the VI was calculated in three ways:

Table 4
Growth analyses of legume sprouts from seeds of various ripeness

Ripeness	Number of days after flowering	Series A			Series B		
		stem length, mm	root length, mm	sprout dry weight, mg	stem length, mm	root length, mm	sprout dry weight, mg
		<i>Pisum sativum</i>					
Green	20	0.0	0.0	0.00	1.1	4.7	1.05
Green-wax	26	0.0	0.0	0.00	1.8	6.0	1.40
Wax	32	0.3	1.3	1.23	2.3	12.7	3.28
Full	38	1.1	4.8	1.65	4.2	20.6	4.52
LSD $p = 0.05$		0.08	0.75	0.11	0.70	2.57	0.33
		<i>Pisum arvense</i>					
Green	29	0.1	0.4	0.05	1.7	6.7	1.50
Wax	35	2.1	11.4	2.34	10.2	38.1	6.80
Full	41	7.7	30.2	5.36	7.7	26.5	5.51
LSD $p = 0.05$		0.53	4.57	0.26	0.79	3.58	0.42
		<i>Lupinus luteus</i>					
Green	44	6.8	11.7	4.40	2.3	3.7	1.40
Wax	50	8.7	16.1	6.29	9.0	16.4	6.84
Full	55	8.9	17.2	7.23	8.7	16.6	7.08
LSD $p = 0.05$		0.94	2.16	8.50	0.99	2.03	0.44

Table 5

Seed leachate conductivity of ripening legume seeds (in $\mu\text{S} \times \text{cm}^{-1} \times \text{l g}^{-1}$ seeds)

Ripeness	Number of days after flowering	Series A			Series B		
		measurement after (hr)					
		6	12	24	6	12	24
		Pisum sativum					
Green	20	18.4	37.3	82.4	30.0	41.0	53.6
Green-wax	26	12.0	24.7	33.6	22.0	32.7	41.8
Wax	32	11.7	17.2	21.2	12.3	22.5	35.8
Full	38	5.2	10.6	16.6	9.1	19.1	33.9
LSD p = 0.05		1.29	2.15	1.48	2.29	2.72	3.78
		Pisum arvense					
Green	29	7.4	16.3	29.9	2.4	5.4	9.8
Wax	35	4.5	7.4	11.4	5.6	21.4	16.9
Full	41	3.0	6.1	10.4	2.5	7.7	12.0
LSD p = 0.05		0.21	0.22	0.37	0.2	0.37	0.46
		Lupinus luteus					
Green	44	24.6	35.1	42.5	115.9	135.6	166.6
Wax	50	5.9	8.4	12.2	11.7	20.4	29.7
Full	55	6.7	11.0	16.8	12.8	25.0	38.4
LSD p = 0.05		0.39	0.54	0.38	0.63	1.7	1.68

Fig. 1. The seed leachate conductivity of legume seeds picked at full ripeness, series A and B. The dashed lines show the probable general dependence of conductivity on time

1. VI = sprout length (in mm) $\times$ % of germinated seeds on the day of measurement of germination capacity.
2. VI = sprout length (in mm) $\times$ % of germinated seeds on the day determination of germination rate.
3. VI = sprout (seedling) length (in mm) $\times$ % of germinated seeds after 10 days of germination.

The vigour index (VI) of seeds harvested at different stages of ripeness increased as the seeds attained higher degrees of maturity (Table 6). This was true for the seeds of all three studied species harvested in one or two steps; and only the seeds of *P. arvense* in series B had a maximal VI by wax ripeness.

d. The total dehydrogenase activity in seeds is considered to be a good and positively correlated parameter of seed vigour (Grzesiuk and Tłuczkiewicz 1982). In the studied legume seeds, the total dehydrogenase activity systematically increased as the seeds, harvested at various ripeness stages, matured (Table 7). In addition, it was always greater in the seeds stored for two weeks in pods than in the corresponding seeds removed from the pods immediately after harvest. Similar relationship with the vigour of maturing seeds was shown previously by rate of germination, growth analysis of sprouts and the vigour index.

Table 6

Vigour index (length of sprout (in mm) x % germinated seeds) of ripening legume seeds

Ripeness	Number of days after flowering	Series A			Series B		
		on day of germination rate	on day of germination capacity	after 10 days	on day of germination rate	on day of germination capacity	after 10 days
		<i>Pisum sativum</i>					
Green	20	0.0	0.0	0.0	307.1	307.1	307.1
Green-wax	26	0.0	0.0	0.0	340.2	340.2	340.2
Wax	32	68.1	132.0	141.4	1037.4	1037.4	1037.4
Full	38	492.7	547.0	563.0	2408.7	2472.4	2408.7
LSD $p = 0.05$		58.89	56.32	65.50	282.07	300.44	282.07
		<i>Pisum arvense</i>					
Green	21	3.2	14.3	23.4	721.6	825.4	825.0
Wax	35	1205.4	1231.4	1244.4	4828.0	5028.0	5028.0
Full	41	3756.0	3756.0	3788.0	3402.6	3417.0	3417.0
LSD $p = 0.05$		621.37	631.85	655.05	593.66	808.94	808.94
		<i>Lupinus luteus</i>					
Green	44	992.6	1177.0	1177.0	192.0	209.0	209.0
Wax	50	2418.8	2478.4	2478.4	2539.2	2539.2	2539.2
Full	55	2597.8	2608.0	2608.0	2528.0	2528.0	2528.0
LSD $p = 0.05$		284.96	267.62	267.62	284.17	283.02	283.02

Table 7

The total dehydrogenase activity in embryo axes of ripening legume seeds (in mg triphenyl-tetrazolium formazane per embryo axis per 24 hr)

Ripeness	Number of days after flowering	Series A	Series B
<i>Pisum sativum</i>			
Green	20	1.9	56.8
Green-wax	26	21.5	44.4
Wax	32	32.5	59.7
Full	38	54.0	69.3
LSD $p = 0.05$		0.55	0.45
<i>Pisum arvense</i>			
Green	29	47.2	57.1
Wax	35	76.9	100.4
Full	41	109.5	119.8
LSD $p = 0.05$		0.84	1.58
<i>Lupinus luteus</i>			
Green	44	81.3	52.8
Wax	50	108.0	97.5
Full	55	117.4	111.0
LSD $p = 0.05$		1.26	1.11

e. The protein content was additionally determined in the legume seeds of various ripeness. It was shown (Table 8) that as the seeds matured, their total protein content increased. Two-week storage in pods extended seed maturation and increased their protein content. The total protein content in ripening seeds showed a similar pattern to that of vigour in these seeds.

DISCUSSION

Seed vigour is the potential for producing healthy and strong seedlings with high degree of tolerance to environmental conditions (Grzesiuk and Kulka 1988) and depends, among others, on the degree of maturity and development of seeds in particular species of plants (Górecki 1982, 1986).

The seeds of the studied legumes, *P. sativum*, *P. arvense* and *L. luteus*, matured at different rates, giving, however, with maturation more and more

Table 8

The total protein content of ripening *Pisum sativum*, *Pisum arvense*, *Lupinus luteus* seeds (in mg per g seeds meal)

Ripeness	Days after flowering	Series A	Series B
<i>Pisum sativum</i>			
Green	20	123.4	152.6
Green-wax	26	151.6	179.8
Wax	32	179.3	185.4
Full	38	182.5	187.6
<i>Pisum arvense</i>			
Green	29	168.4	189.7
Wax	35	195.8	209.6
Full	41	211.2	234.5
<i>Lupinus luteus</i>			
Green	44	339.5	348.2
Wax	50	353.6	365.4
Full	55	368.9	371.5

uniform seed batches. The degree of hydration and weight of newly harvested seeds could serve as preliminary and tentative measures of their ripeness and even viability (Obendorf et al. 1980, Rachidian and Le Deunff 1986a, b), but a high variability and dependence of these parameters (Table 2) on the climatic conditions and species characters (topophysical variability) do not allow to take them as even approximate measures for the vigour of these seeds.

The germination of legume seeds of different degrees of ripeness (Table 3) showed that the rate of germination is not only a measure of the viability of these seeds, but is also a good indicator of their vigour. The greater the readiness of the *P. sativum*, *P. arvense* and *L. luteus* seeds to germinate, the shorter the average germination time and higher germination rate (the first germinability assay). Such a relation of seed vigour to germination rate was obvious since the rate of forming healthy seedlings (performance) has its basis in some of the methods of testing vigour, e.g.: the testing of the sprout growth energy (the Hiltner Test – Anonym (1983)), methods for sprout growth analysis (the Germ method – Grzesiuk and Kulka (1981)). However, the germinating unripe seeds did not always produce well-developed seedlings (Table 4), which suggests that maturing seeds attain full vigour later than full

viability (Grzesiuk and Kulka 1988). This is confirmed by the increased vigour of seeds stored in pods for 14 days as determined by the rate of germination (Table 3), the vigour index (Table 6) and by the total dehydrogenase activity (Table 7).

The use of several generally accepted methods for testing of vigour (Grzesiuk and Górecki 1981, Perry 1981, Anonym 1983) of unripe legume seeds showed that some of them are inapplicable to assaying seeds of different ripeness. The basic method for testing the vigour of legume seeds, viz. seed leachate conductivity, gave variable and uncertain results (Table 5) when applied to seeds of various degrees of ripeness (both when expressed per 100 seeds and per gram of seeds). The reasons for variable leaching of electrolytes from unripe seeds can be as follows: non-uniformly developed membranes in seed cells, particularly in embryo axes; different development of seed coats and the various permeability connected with that (Duke and Kakefuda 1981, Duke et al. 1983) and possible damage to fresh seeds during harvest and rapid drying. Abdul-Baki (1973, 1980) has reported similar reasons for decreased vigour. The conductivity test also did not agree with the results of evaluating the vigour of unripe seeds by the growth rate method. Therefore, the seed leachate conductivity test cannot be used to assess the vigour of not fully ripe legume seeds.

Other method of testing vigour, namely sprout and seedling growth analysis, vigour index (VI), total dehydrogenase activity and total protein content, generally allowed a good characterization of the vigour of maturing legume seeds. This vigour progressively increased with seed maturation (Tables 4, 6, 7 and 8) and only in *P. arvense* seeds stored in pods for 14 days (series B) did it attain its maximum value as early as in wax ripeness (Tables 4 and 6). This last statement resulted, however, from the sprout growth analysis and the rate of germination (Tables 3, 4 and 6), but not from the total dehydrogenase activity (Table 7) and total protein content (Table 8).

The different results obtained by different methods suggest that *P. arvense* seeds harvested at full ripeness undergo shallow and short-termed post-harvest dormancy while stored in pods. Although this dormancy partially masks the vigour of the seeds, it does not really reduce it. This is also confirmed by the high total dehydrogenase activity in the dormant seeds. Although the VI, based on two biological methods of determining vigour, does detect dormancy, it underestimates the final vigour potential.

The vigour of the studied seeds was also related to their total protein content (Table 8). According to Abdul-Baki (1980), this kind of relationship is more the result of the formation of integrated protein biosynthesis systems (enzymes and structural proteins) than the accumulation of reserve proteins. All of the proteins in seeds affect their density, and this is also a good parameter of vigour of live seeds (Górecki 1982, Górecki and Grzesiuk 1983). However, the total protein content in seeds was found to be more

dependent on the species than on the degree of their ripeness (Table 8); therefore, this parameter can serve only as a preliminary and approximate vigour measure of an unknown seed batch.

From the data presented so far it can be concluded that the vigour of maturing legume seeds is a complex phenomenon and can be relatively well determined by the simultaneous use of several tests such as: rate of germination, growth analysis of sprouts and seedlings, vigour index (coefficient) and total dehydrogenase activity.

The vigour of ripening legume seeds increases as they attain morphological maturity. This is supported by the two-week storage of seeds of various ripeness in pods, when even seeds at wax ripeness attained full maturity and maximal vigour. However, ripening seeds attain full vigour usually later than full viability, which indicates that the vigour criterion gives a dependent physiological characterization of seed viability and a deeper and more biologically comprehensive description than does the seed viability criterion.

Testing the vigour of newly harvested legume seeds of various degrees of ripeness should be done, as a rule, by the concurrent use of several methods, both biological (e.g. germination rate, sprout growth analysis, VI) and biochemical (e.g. total dehydrogenase activity). It is not possible, however, to determine the vigour of fresh, unripe seeds by the biophysical method (seed leachate conductivity). It should be emphasized that the biological methods for testing vigour allow, along with the determination of total dehydrogenase activity, to detect seed dormancy, particularly its depth and duration.

REFERENCES

- Abdul-Baki A. A., 1973. Vigor determination in soybean seed by multiple criteria. *Crop Sci.* 13: 630-633.
- Abdul-Baki A. A., 1980. Biochemical aspects of seed vigor. *HortSci.* 15: 765-771.
- Anonym, 1983. Seed vigor testing handbook. Contribution No. 32. AOSA. USA.
- Duke S. H., Kakefuda G., 1981. Role of the testa in preventing cellular rupture during imbibition of legume seeds. *Plant Physiol.* 67: 449-456.
- Duke S. H., Kakefuda G., Harvey T. H., 1983. Differential leakage of intracellular substances from imbibing soybean seeds. *Plant Physiol.* 72: 919-924.
- Górecki R. J., 1982. Viability and vigour of ageing pea seeds with various densities. *Acta Soc. Bot. Pol.* 51: 484-488.
- Górecki R. J., 1983. Przyczyny zmienności fizjologicznych właściwości nasion. *Zesz. Probl. Post. Nauk Roln.* 258: 61-74.
- Górecki R. J., 1986. Studia nad wigorem nasion roślin strączkowych. *Acta Acad. Agricult. Tech. Olszt., Agricult., Nr 42, Suppl. A:* 1-60.
- Górecki R. J., Grzesiuk S., 1982. Badania fizjologicznych właściwości nasion kilku gatunków roślin strączkowych. *Hod. Rośl. Aklim.* 26: 173-187.
- Górecki R. J., Grzesiuk S., 1983. Pozyskiwanie nasion grochu bobiku i łubinu żółtego o najwyższym wigorze. *Hod. Rośl. Aklim.* 27: 407-420.
- Grzesiuk S., Górecki R. J., 1981. Wigor nasion jako nowe kryterium ich wartości siewnej oraz metody jego określania. *Post. Nauk Roln.* 6: 39-56.

- Grzesiuk S., Kulka K., 1981. Fizjologia i biochemia nasion. PWRiL, Warszawa.
- Grzesiuk S., Kulka K., 1988. Biologia ziarniaków zbóż. PWN, Warszawa.
- Grzesiuk S., Tłuczkiewicz J., 1982. Viability and vigour of ageing winter wheat grains. Acta Soc. Bot. Pol. 51: 251-262.
- Knypl J. S., 1979a. Assessment of soybean (*Glycine max*) vigour by the seed leachate conductivity assay. Acta Soc. Bot. Pol. 48: 267-277.
- Knypl J. S., 1979b. Podwyższenie wigoru nasion metodą infuzji substancji czynnych. Kosmos, Biol. A — 28: 701-713.
- Lowry O. H., Resenbrough J. N., Farr J. N., Randall J. R., 1951. Protein measurment with the Folin phenol reagent. J. Biol. Chem. 193: 215-275.
- Obendorf R. L., Ashworth E. N., Rytko G. T., 1980. Influence of seed maturation on germinability in soybean. Crop Sci. 20: 483-486.
- Perry D. A. (ed.), 1981. Handbook of vigour test methods. Int. Seed. Test. Assoc., Zurich.
- Pollock B. M., Roos E. E., 1972. Seed and seedling vigor. In: Seed biology. T. T. Kozlovski (ed.) vol. 1. Acad. Press, New York-London, pp. 313-388.
- Powell A. A., 1986. Cell membranes and seed leachate conductivity in relation to the quality of seed for sowing. J. Seed Technol. 10: 81-100.
- Rachidian Z., Le Deunff Y., 1986a. Qualite germinative des semences de pois. I Developpement de la gousse et des graines: incidence sur la germination des semences avec on sows sache. Agronomie 6: 463-468.
- Rachidian Z., Le Deunff Y., 1986b. Qualite germinative des semences de pois. II. Suivi conductimetrique des graines an cours de leur developpement; incidence du relargage des nutiments nur la Croissance des plantules. Agronomie 6: 623-628.
- Sobolev A. M., Zhdanova L. P., 1983. Otlozhenije veshchestv v zapas. In: Fizjologia semjan. A. Prokofev (ed.), Izd. Nauka, Moskva. pp. 48-101 (in Russian).

Zależność wigoru nasion roślin strączkowych od ich dojrzałości i sposobu zbioru

Streszczenie

Za pomocą kilku metod zbadano wigor i żywotność nasion roślin strączkowych (*Pisum sativum* L. cv. Hamil, *Pisum arvense* L. cv. Mazurska i *Lupinus luteus* L. cv. Tomik) zbieranych w trzech zasadniczych fazach dojrzałości nasion (zielonej, woskowej i pełnej). Nasiona badano zarówno bezpośrednio po zbiorze (seria A), jak i po 2 tygodniach przechowywania w strąkach (seria B). Stwierdzono, że: 1) wigor dojrzewających nasion roślin strączkowych, początkowo bardzo mały, zwiększa się w miarę osiągania przez nasiona coraz to większej dojrzałości; 2) późniejsze przechowywanie nasion w strąkach podnosi stopień ich dojrzałości i zwiększa odpowiednio wigor nasion; 3) pełny wigor nasiona osiągają później niż pełną żywotność; 4) metoda konduktometrii eksudatów wód nastoinowych z nasion błędnie określa wigor nasion niedojrzałych; 5) pełny natomiast wigor dojrzewających nasion o różnej dojrzałości można dobrze określić za pomocą kilku jednocześnie stosowanych metod zarówno biologicznych (np. analiza wzrostowa kielków, IW), jak i biochemicznych (np. ogólna aktywność dehydrogenaz).