THE EFFECTS OF SOWING AND HARVEST TERMS ON THE SEED QUALITY OF PEA*

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The differences in the seed size, viability and vigour during the seed development and maturation in combining and garden peas were evaluated in field experiments to determine the stage at which maximum seed quality is attained. The effect of two sowing dates on seed filling and quality of seeds was investigated. Samples of seed were harvested separately from 1, 2 and 3 fertile nodes at 3–4 day intervals from 14 to 45 days after the flowering of the 1st fertile node (DAF). Size and size frequency of seeds from 1, 2 and 3 fertile nodes were assessed. Maximum seed dry weight occurred gradually from 1st to 3rd fertile nodes at 38 DAF for sowing term I (1st fertile node) and 34 DAF for sowing term II (1st fertile node). Maximum laboratory germination and seedling growth was attained some 3 days earlier. There were no significant differences between laboratory germination and seedling growth of samples from the same fertile node harvested within period 27 to 41 DAF. The lowest value of individual leachate conductivity test coincided with maximum laboratory germination.

pea; seed quality; germination; conductivity; seedling

INTRODUCTION

Typical for pea is the sequential nature of flower production in a population of pods at a range of developmental stages of any time. Vegetative structures continue to grow during reproductive development. In order to understand and to simulate pea yield in a field, it is important to know how seeds are produced on a stem and developed their quality. Harrington (1972) suggested that maximum seed quality occurs at physiological maturity, defined as the stage in development when seeds attain maximum dry weight (Shaw, Loomis, 1950). On the contrary Ellis and Pieta Filho (1992) reported that maximum quality is not attained until some time

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after mass maturity. Similarly Ferguson et al. (1993) stated that maximum quality of peas was attained when seed moisture content was reduced to about 35%. The aim of this work was to describe and to determine the process of quality development of pea.

MATERIAL AND METHODS

Plant material

Pea (*Pisum sativum* L.) seeds of combining and garden cultivars were used. Olivin (early, green-seed combining variety, WTS 250 g) and Bornella (early, green-seed garden variety, WTS 160 g), respectively, which were sown in two terms (2. 4. and 25. 4. 1993), were harvested separately by 1, 2 and 3 fertile nodes at 3–4 day intervals from 14 to 45 days after the flowering of the 1st fertile node (DAF). Seeds were gently air-dried in climabox at 30 °C to moisture content 14%.

Germination Tests

Germination tests (ISTA, 1993) were conducted at 20 °C using four replicates of fifty seeds each. All germination tests were conducted using filter papers.

Individual Conductivity Test

Four replicates of 50 seeds were placed individually in cells in seed trays. 5 ml deionised water were added to each cell. After 24 h at 20 °C, the electrolyte leakage from each seed was measured using automatic seed analyser (ASTIK-2). All measured seeds were tested to germination and growth rate (Hosnedl et al., 1993).

Sorting of Seeds

The samples of 400 seeds from 1st and 3rd fertile nodes were manually sorted using the balance Meter PJ-300, resolved to 0.1 mg. Data from experiments were analysed using ANOVA procedure of STATGRAPHIC.

RESULTS

The moisture content of harvested seeds declined by time from 80% at 13 DAF to 14% at 41 DAF. The moisture of seeds declined slowly during period 13–27 DAF and rapidly within 27–41 DAF. The highest content of water (CW) was in seeds of 3 fertile nodes. Both cultivars showed similar decrease in moisture content of seeds (Tab. I).

The distribution of seed mass was changed by time of ripening. The seed mass of the Olivin and Bornella samples was distributed similarly in early stages of ripening, in a period of 13 DAF (Fig. 1a, d). The Olivin samples in a period of 27 and 37 DAF had higher average masses than those of Bornella (Tab. II). The distribution was not significantly affected by the sowing time. At the sorting, the moisture content of the seeds was about 14%.

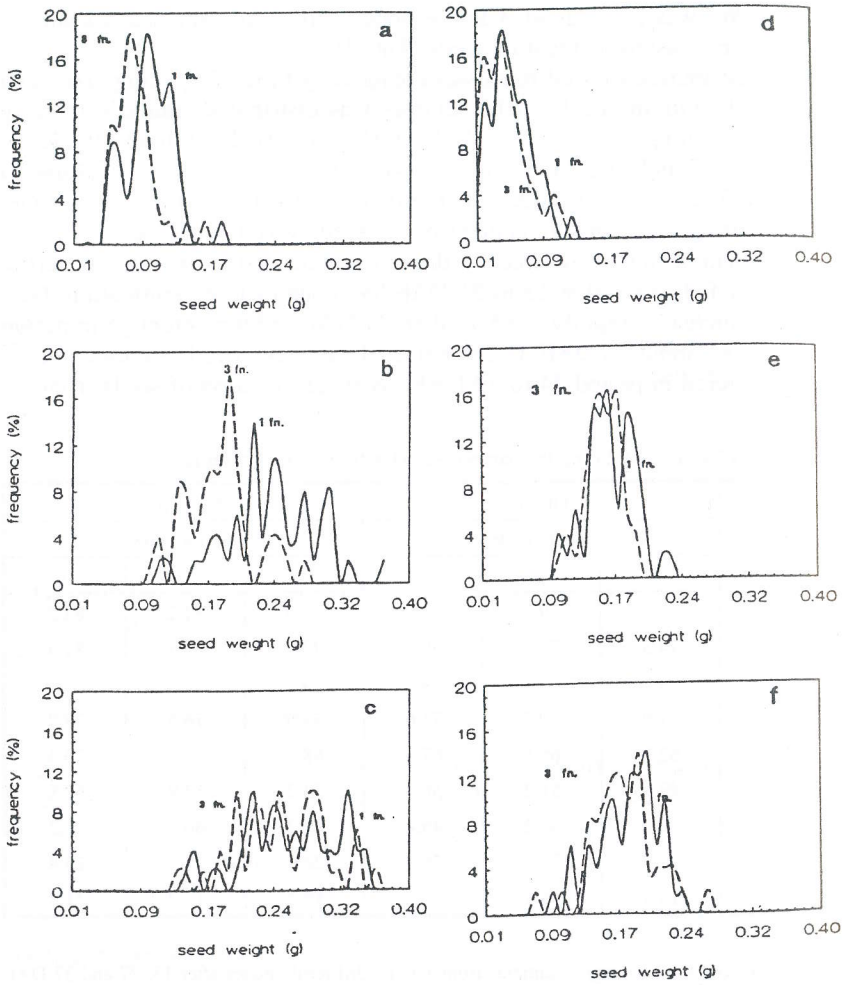
Germination highly differed by the term of harvest as well as by fertile nodes. Seeds harvested at 13 to 21 DAF had none or low germination. Germination increased rapidly to 95% about 24 DAF and maximum germination was reached about 36 DAF. Germination of samples of fertile nodes significantly differed in period 24 to 30 DAF, when germination of seeds from 1st

I. Moisture of seeds (%) during the harvest (samples from sowing term II)

DAF	Olivin			Bornella		
	fertile node			fertile node		
	1	2	3	1	2	3
13	77.5	79.6	81.2	79.9	81.2	83.2
16	74.3	76.5	79.9	77.8	80.1	81.5
19	+	+	+	+	+	+
23	67.9	70.2	71.6	74.5	76.3	78.7
27	62.1	65.8	67.3	68.7	70.2	73.3
30	49.1	51.2	56.2	53.2	57.9	62.8
34	32.7	36.2	45.4	35.2	40.2	45.2
37	19.0	23.5	26.4	22.6	25.3	29.8
41	13.9	15.5	17.2	16.2	17.2	21.8

II. Average seed masses (mg) in samples from 1st and 3rd fertile nodes after 13, 27 and 37 DAF (term of sowing II)

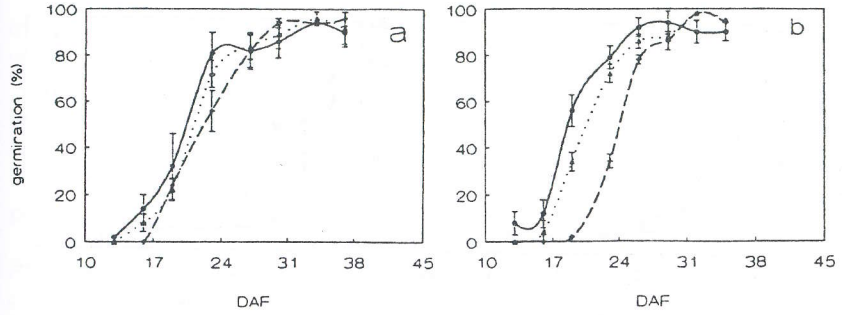
Cultivar	Node	Term of harvest (DAF)								
		13	16	19	23	27	30	34	37	41
Olivin	1	105	153	185	221	235	241	254	253	253
	3	64	95	168	183	221	232	241	242	241
Bornella	1	51	72	98	124	145	158	162	161	161
	3	39	50	62	78	134	149	157	158	158



1. Distribution of seed mass in samples of Olivin at 13 (a), 27 (b), 37 (c) DAF and Bornella at 13 (d), 27 (e), 37 (f) DAF. Difference between samples from 1st and 3rd fertile node (fn.)

fertile node was higher than 2nd and 3rd fertile node. Course of germination during ripening was similar for Olivin and Bornella in both terms of sowing (Fig. 2).

Values of individual conductivity test were observed in broad range from 1 000 to 20 000 $\mu S.g^{-1}$. Conductivity decreased during observation from



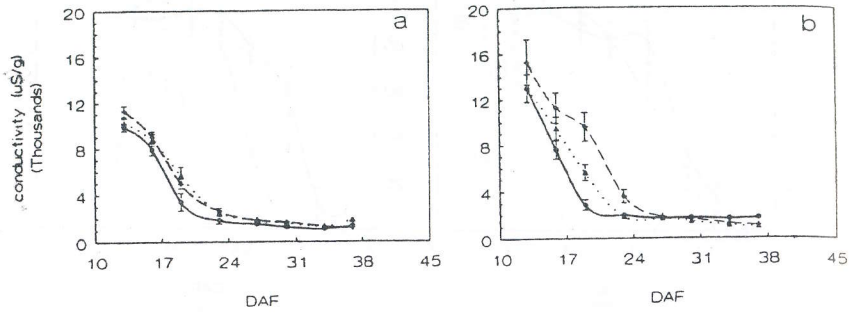
2. Germination of samples of Olivin (a) and Bornella (b) during period of ripening (13–40 DAF). Seeds of 1st fertile nodes (——), seeds of 2nd fertile nodes (· · ·), seeds of 3rd fertile nodes (– – –)

12 000 and 16 000 $\mu S.g^{-1}$ for Olivin and Bornella samples, respectively, at 13 DAF to 1 000 $\mu S.g^{-1}$ for both cultivars at 37 DAF. The course of conductivity during ripening of seeds describes two periods of ripening, i) 13–23 DAF rapid decreasing of conductivity, which reflected the period with low germination of samples ii) 24–41 DAF quite constant conductivity, when germination reached level about 90%. Final conductivity did not differ between Olivin and Bornella, even conductivity of Bornella at 13 DAF was significantly higher (Fig. 3).

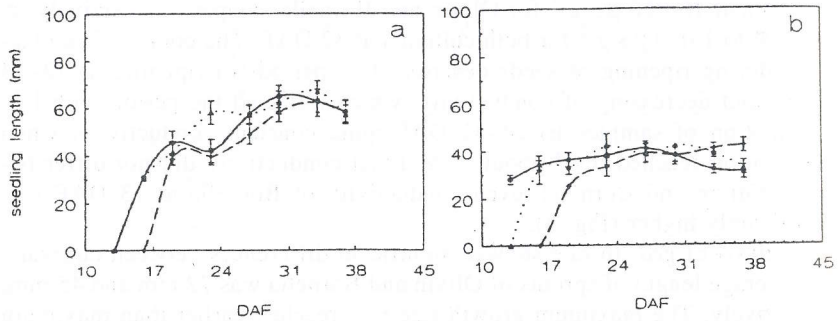
Analysis of growth rate showed significant differences between cultivars. The average length of sprouts of Olivin and Bornella was 72 mm and 45 mm, respectively. The maximum growth rate was reached earlier than maximum germination 27 DAF. Growth rate of viable seeds of any time of harvest differed very slightly (Fig. 4).

DISCUSSION

These results indicate that maximum seed quality (germination, conductivity and growth rate) occurs before physiological maturity. Because of seed to seed differences in maturation that can occur on a plant, we have separately evaluated seeds from different nodes, so nearly all the seeds tested were at the same stage of seed development. In some experiments conducted by Ellis et al. (1993) and Sanhewe, Ellis (1995) seeds were removed from entire plant which may have resulted in some mixed quality in samples. This may provide an additional explanation for different results. Our conclusion is supported by TeKrony and Egli (1997) by studies of seed development of nine crop species, when maximum seed quality occurred before



3. Individual conductivity of samples of Olivin (a) and Bornella (b) during period of ripening (13–40 DAF). Seeds of 1st fertile nodes (——), seeds of 2nd fertile nodes (· · ·), seeds of 3rd fertile nodes (– – –)



4. Growth rate of viable seeds in samples of Olivin (a) and Bornella (b) during period of ripening (13–40 DAF). Seeds of 1st fertile nodes (——), seeds of 2nd fertile nodes (· · ·), seeds of 3rd fertile nodes (– – –)

physiological maturation in crop species producing small seeds (tobacco, canola, lettuce), large seeds (wheat, maize, soybean) and a variety develop in fleshy fruit. Maximum seed quality in our experiments was attained some 3 days before physiological maturity. Ferguson et al. (1993) described maximum seed quality of peas about 60 DAF in a day of physiological maturity. Difference of developmental time when maximum seed quality occurred may have been explained by climatic conditions of experiments (Horčička, 1995). There were no significant differences between laboratory germination and seedling growth of samples from the same fertile node harvested within period 27 to 41 DAF. A similar pattern of results was obtained for wheat and barley (Ellis et al., 1993), that seed quality can remain stable for some time about maximum quality.

We speculate that the differences between results regarding the time of maximum seed vigour during seed development relate primarily to differences in harvest and methods of drying and testing and not to seed vigour.

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Vliv termínu setí a sklizně na kvalitu semen hrachu.

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Cílem práce bylo posoudit vliv zrání hrachu na utváření kvality semen v jednotlivých patrech rostliny a její determinaci charakterem zrání.

V polních podmínkách byly v období zrání sledovány rozdíly ve velikosti, životaschopnosti a vitalitě semen hrachu setého polního (odrůda Olivín) a dřeňového (odrůda Bornella) s cílem stanovit termín dosažení nejvyšší kvality semen. Hodnocen byl vliv termínu setí na nalévání a kvalitu semene prvních třech plodonosných pater. Lusky z 1., 2. a 3. plodonosného patra byly idividuálně sklízeny ve 3–4denních intervalech od 13. do 48. dne po kvetení prvního nodu (DAF). Byla posuzována velikost a distribuční rozdělení semen.

Obsah vody v semenech se postupně snižoval z 80 % v 13 DAF na 14 % ve 41 DAF, se shodným průběhem u obou testovaných variet hrachu (tab. I). Distribuční rozdělení hmotnosti semen bylo na počátku zrání, 2 týdny po kvetení prvního nodu (obr. 1a, d), u obou variet hrachu stejné. V dalším průběhu zrání vykazovala odrůda Olivín jiné rozdělení hmotnosti semen (obr. 1b, c, e, f) a vyšší průměrnou hmotnost semen.

Klíčivost semen je výrazně ovlivněna termínem sklizně a pozicí lusku na lodyze. K rychlému nárůstu procenta klíčivosti na 95 % došlo již v termínu 24 DAF, maximálních hodnot klíčivosti bylo dosaženo v 36 DAF (obr. 2).

Individuální konduktometrický test ukázal dvě periody zrání. V prvním období, charakterizovaném termíny 13–23 DAF, hodnoty vodivosti exsudátu suchých semen postupně klesaly z 16 000 $\mu S.g^{-1}$ na 1 500 $\mu S.g^{-1}$. Ve druhém období, tj. 24 až 41 DAF, zůstávaly hodnoty konduktometrické vodivosti exsudátu téměř konstantní (obr. 3).

Analýza intenzity růstu ukázala na významné rozdíly mezi odrůdami Olivín a Bornella. Maximální rychlosti růstu klíčků dosahují zrající semena dříve, než dosáhnou semena v porostu maximální hodnoty klíčivosti. Intenzita růstu životaschopných semen se liší minimálně (obr. 4). Semena dosahují maximální hmotnosti postupně od 1. k 3. nodu v termínu 38 DAF. Tři dny před tímto termínem má hrách maximální laboratorní klíčivost a růst klíčků. V období 27 až 41 DAF se klíčivost a délka klíčku mezi vzorky významně nelišily. Nejnižší hodnota konduktometrického testu koresponduje s nejvyšší klíčivostí.

Lze se domnívat, že maximální kvality ve smyslu semenářském dosahují semena před ukončením akumulace sušiny. Dřívější teorie o maximální hmotnosti a maximální kvalitě jsou stále diskutovány a výsledky je nutné vždy porovnávat s přihlédnutím k rozdílům v uplatňovaných metodikách.

hrách; kvalita semen; klíčivost; konduktivita; klíční rostlina

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