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INFLUENCE OF STORING SEEDS ON SEED VIGOR AND SEEDLING MEADOW AND TALL FESCUE AFTER FIVE YEARS

UTICAJ NAČINA ČUVANJA SEMENA NA KLIJAVOST I VIGOR KLIJANACA LIVADSKOG I VISOKOG VIJUKA NAKON PET GODINA

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ABSTRACT

In our tests, the seeds were stored for five years at temperatures of 4 °C, 18 °C in a warehouse conditions (factor method of seed storage). Seed was stored at all temperatures in the paper, a cloth and plastic bags (factor package for seed storage). It was used the seed of meadow and tall fescue (factor species). For testing was used the three lots by both species (factor seed lots).

At five years old seed germination was determined in accordance with the ISTA rules (on filter paper, and at temperature of 20 °C in the dark). Vigor was determined by measuring each seedling (root length cm, shoot length cm and biomass of seedlings g.).

The factor method of seed storage and packaging factor was significantly acted in germination and vigor ($P<0.05$, $P<0.01$), which influenced to meet germination of seeds for placing on the market (germination >75 %). Other examined factors (species and lots) did not have significant effect on seed germination and seedling vigor after five years of storage.

***Key words*:** *F. pratensis and F. arundinacea, seed quality after five years, seedling vigor.*

REZIME

Livadski vijuk (Festuca pratensis Huds.) je značajna krmna vrsta koja se koristi uglavnom za smeše sa višegodišnjim krmnim leguminozama. Visoki vijuk je (Festuca arundinacea Schreb.) je vrsta koja je veoma srodna livadskom vijuku koja se pored korišćenja sa krmnim leguminozama za proizvodnju kvalitetne krme, koristi i za zasnivanje travnjaka specijalnih namena takođe uglavnom u smeši sa odgovarajućim višegodišnjim leguminozama (parkovi, sportcki tereni, okućnice i sl.). U našim ispitivanjima seme je čuvano pet godina na temperaturama: 4^oC, 18^oC i u magacinskim uslovima (faktor način čuvanja semena). Seme je na svim temperaturama čuvano u papirnim, platnenim i plastičnim kesama (faktor anbalaža za čuvanje semena). Za ispitivanje je korišćeno seme po tri partije (faktor partija semena) od ispitivanih vrsta: livadckog, i visokog vijuka (faktot vrsta).

Faktori način čuvanja semena, anbalaža u kojoj je seme čuvano i, vrsta kao i nihove interakcije su delovali značajno na klijavost i vigor klijanaca ($P\leq 0,05$, $P\leq 0,01$) što je i uticalo na zadovoljenje klijavosti za stavljanje semena u promet (klijavost >75%). Ostali, ispitivani faktor (partija) nije imao značajnog uticaja na klijavost semena i vigor klijanaca nakon pet godina čuvanja.

Ključne reči: *Livadski i visoki vijuk, kvalitet semena nakon pet godine, vigor klijanaca.*

INTRODUCTION

Meadow fescue (Festuca pratensis Huds.) is an important forage species that is used mainly for mixtures with perennial forage legumes. Tall fescue (Festuca arundinacea Schreb.) is a species which is very akin meadow fescue. According Ghesquiere and Jaders-Hecart (1995), Schreber (1771) was first isolated tall fescue as a separate species. Tall fescue and meadow is often used with forage legumes for the establishment of grass-legume mixtures and production of high-quality feed, but is increasingly used for the establishment of special purpose pitch, mixed with a suitable perennial legumes (parks, sports fields, yards, etc.).

Establishing these lawns can be performed seeds of different ages. Reduced germination and seedling vigor weaker can be from seed which is not physiologically ripe *(Simson 1990; Stanisavljević et al., 2013, 2015)*. After the release of seeds from dormancy, appearances greatest germination period and during this period it is best to use seeds. After this period the seed occurring physiological and biochemical processes that lead to the reduced germination (Adkins et al., 2002). According to the existing law on seeds, seeds of meadow and tall fescue shall have a minimum germination of 75 %. In agronomic practice reduced seed germination is compensated by increasing the amount of hay to obtain the desired number of plants per unit area. However, reduced germination is very often closely related to the initial increase in seedling (seedling vigor) which may be a key moment in establishing the relationship between the projected grasses and legumes. In view that the use of meadow and tall fescue in the mixture for about five years, the correct ratio of the components in the mixture is inevitably reflected on the yield and quality of feed and/or durability of decoration if the lawn is based for special purposes.

Therefore, the aim of this research was that, after storage for five years in a variety of storage conditions (4 °C, 18 °C; storage places) and in three different packaging (paper, textile, plastic bags), examine seed quality and vigor of meadow and tall fescue.

MATERIAL AND METHOD

After three parties [B1, B2, B3, (factor seed lot -B)] seed of meadow (A1) and tall fescue (A2) - factor species -A, was taken from a commercial production in eastern Serbia. The seed then was dry (classically-floor) up to 12 % humidity and placed in paper (C1), linen (C2) and PVC (C3) bags (factor C - packaging for storage of seeds). In all three packagings seed is stored at

constant temperatures: 4 °C (D1), 18 °C (D2), and in warehouse conditions, D3; factor storage conditions - D (Table 1). The seeds were stored for five years, after which it was tested germination (4 x 100 seeds was done on filter paper under alternate temperatures of 20/30 °C (dark/light). Germination (%) seed test of meadow fescue and tall fescue seeds was determined on the 14th day. From seed germination seedling vigor was determined by measuring each seedlings: stem length (cm), radicle length (cm), seedling fresh weight (g); ISTA Rules (2003).

Table 1. Maximum and minimum temperature and relative air humidity values in seed storage rooms (fifth of everage)

Month	Temperature (°C)			Relative air humidity (%)		
	Aver.	Min.	Max.	Aver.	Min.	Max.
January	2	2	2	81	75	86
February	6	4	9	80	70	90
March	10	5	15	80	70	90
April	12	7	16	65	48	82
May	13	7	18	66	48	83
June	20	15	24	63	45	80
July	24	17	31	65	49	81
August	24	17	31	68	52	84
September	12	9	23	74	65	82
October	11	5	17	76	68	84
November	7	3	11	78	71	84
December	3	0	6	79	72	85

The results were analyzed by statistical analysis of variance (ANOVA) and adapted to a completely randomized block design. Assessment of the significance of the difference between the mid-treatment was carried out by Tukey test method. Data of dormancy and germinating percentage were arcsine transformed prior to the analysis [sqr (x/100)]. For statistical analysis, the program Minitab 16.1.0 (statistics software package) was used.

RESULTS AND DISCUSSION

Testing of seed germination was done in the laboratory which includes optimal and controlled conditions for germination (pad, humidity, temperature, light). In general, what kind of results can be a good indicator of seed germination under field conditions, which are usually less favorable conditions (temperature and humidity, soil structure, soil pests, etc.) *(Tabaković et al., 2013; Knežević et al., 2014; Vujaković et al., 2015).*

The aging process is affected seed genetic characteristics of the species, variety, time, and manner of keeping seeds *(Andersson and Milberg 1998; Walters et al., 2004, 2005).*

This problem is important in preserving germplasm and the most important factors for storing seeds are temperature and humidity *(Ratkovic, 1996).* Generally high seed germination is the main or one of the main prerequisites for the successful establishment of fodder and horticultural grasses which is closely related to the use of seed that is stored for several years in a different packaging.

In our tests factor species, method of seed storage and way of packaging acted significantly on germination and seedling vigor (P<0.05, P<0.01, P<0.001) which influenced on suitability for placing on the market (75 % of germination). Factor seed lot, had no significant effect on seed germination and seedling vigor after five years of storage.

Seeds of meadow fescue, after five years of storage at 4 °C (D1) retained high germination regardless of the packaging in which it is stored (84 % C1 to C3 78 %). In the same conditions (D1), with the seeds of tall fescue, in all types of packaging was also obtained high germination (90 % C2 and 82 % C3) to (C1 to C3) to 5 %. (Tab 3 and Tab 4).

Table 2. Results from analysis of variance (ANOVA) for: germination (G) and vigor,seedling (shoot, radicle, seedling biomass). Sources of germination and variation include: species (A), seed lot (B), way of packaging (C) storage conditions (D). After five years of seed storage

Source	Degrees of freedom	Germi.	Seedling vigor		
			Shoot	Radicle	Seedling biomass
A	1	***	*	*	*
B	2	ns	ns	ns	ns
C	2	***	**	*	*
D	2	***	*	*	*
Interactions					
A×B	2	ns	ns	ns	ns
A× C	2	*	ns	ns	ns
A×D	2	*	ns	ns	ns
B×C	4	ns	ns	ns	ns
B×D	4	ns	ns	ns	ns
C ×D	4	**	*	*	*
A ×B× C	4	ns	ns	ns	ns
A ×B× D	4	ns	ns	ns	ns
A ×C× D	8	***	**	**	**
B× C× D	8	ns	ns	ns	ns
A×B×C× D	8	ns	ns	ns	ns

ns: Not significant F tests at the P ≥ 0.05 level of significance,
**Significant F tests at the P < 0.05 level of significance,*
***Significant F tests at the P <0.01 level of significance,*
****Significant F tests at the P <0.001 level of significance.*

Table 3. Seed germination, seedling vigor of F. pratensis after five years of storage in three different seeds and way of packaging in three ways

Feature	Factor C Factor D	C1	C2	C3	$\overline{X}$
Germination (%)	D1	84aA	88aA	78 a B	83 a
	D2	74 b A	73 b A	70 b B	72 a
	D3	64 c A	63 c A	59 c B	62 a
	$\overline{X}$	74 A	75 A	69 B	-
Stem (cm)	D1	17.5 a	17.8 a	17.0 a	17.4 a
	D2	16.6 b A	16.4 b A	15.9 b A	16.3 b
	D3	12.7 c A	12.6 c A	10.4 c B	11.9 c
	$\overline{X}$	15.6 A	15.6 A	14.4 B	-
Radicle (cm)	D1	13.4 aA	13.3 aA	12.5 a B	13,1 a
	D2	12.5 b A	12.3 b A	10.4 b B	11,7 b
	D3	10.3 c A	10.5 c A	8.30 c B	9,7 b
	$\overline{X}$	12,1	12,0	10,4	-
Seedling biomass (g)	D1	0.732 aA	0.755 aA	0.601 a B	0,696 a
	D2	0.614b A	0.619 b A	0.531 b B	0,588 b
	D3	0.502 c A	0.478 c A	0.325 c B	0,435 c
	$\overline{X}$	0,616 A	0,617 A	0,486 B	-

a, b (different lowercase) significant influence (P<0.05; Tukey's Multiple Range Test) for column
A, B (different capitalization) significantly (P<0.05; Tukey's Multiple Range Test) to red

Table 4. Seed germination, seedling vigor of F. arundinacea after five years of storage in three different seed packages and in three ways of storage

Feature	Factor C / Factor D	C1	C2	C3	$\overline{X}$
Germin. (%)	D1	88 aA	90 aA	82 a B	87 a
	D2	79 b A	78 b A	75 b B	77 b
	D3	71 c A	73 c A	69 c B	71 c
	$\overline{X}$	79 A	80 A	75 B	-
Stem (cm)	D1	18.6 a	18.9 a	17.9 a	18.5 a
	D2	17.3 b A	17.5 b A	16.3 b A	17.0 a
	D3	13.8 c A	14.1 c A	11.1 c B	13.0 a
	$\overline{X}$	16.6 A	16.8 A	15.1 B	-
Radicle (cm)	D1	14.1aA	14.0aA	12.5 a B	13.5 a
	D2	12.9 b A	13.1 b A	9.7 b B	11.9 b
	D3	10.9 c A	11.1 c A	7.9 c B	10.0 c
	$\overline{X}$	12.6 A	12.7 A	10.0 B	-
Seedling biomass (g)	D1	0.771 aA	0.789 aA	0.678 a B	0.746
	D2	0.653 b A	0.667 b A	0.602 b B	0.641
	D3	0.545 c A	0.498 c A	0.396 c B	0.480
	$\overline{X}$	0.656	0.651	0.559	-

a, b (different lowercase) significant influence ($P<0.05$; Tukey's Multiple Range Test) for column
A, B (different capitalization) significantly ($P<0.05$; Tukey's Multiple Range Test) to red

In meadow fescue seed stored at 18 °C was determined by lower germination compared to seeds stored at 4 °C (D1). Depending on the packaging germination differed by 4%. For tall fescue seed stored at 18 °C was determined by lower germination by 10 % compared to seeds stored at 4 °C (D1). Depending on the seed packaging is also distinguished by 4 %.

Seeds of meadow fescue, which is stored in a conventional storage conditions (D3) showed the greatest decrease in germination (62 %) and did not meet the criteria for placing on the market. In the same conditions reducing of seed germination was the biggest (C1 64 %, C2 65 %, C3 59 %) in the PVC packaging. Seed of tall fescue in these conditions (D3) achieved higher germination by 9 % (C) in relation to seed of meadow fescue.

From the seeds of tall fescue is determined longer increase of stem (D1 and C1 to C3 18.5 cm; D2 17.0 cm C1 to C3; D3 C1 to C3 13.1 cm) in relation to the meadow fescue (D1 and C1 to C3 17.4 cm; D2 C1 to C3 16.3 cm D3 C1 to C3 11.9 cm). For both species, seed with the highest germination gave the largest increase of stems.

Also, the increase of radicle was longer in the seed of tall fescue (D1 and C1 to C3 13.5 cm; D2 11.9 cm C1 to C3; D3 10 cm C1 to C3) in relation to the meadow fescue (D1 and C1 to C3 17.4 cm; D2 C1 to C3 16.3 cm; D3 C1 to C3 11.9 cm). The weight of seedlings is the result of longevity of shoot and radicle, which caused the same trend as the increase of stem and radicle lenght (Tables 3 and 4).

CONCLUSION

After five years of storage tall fescue seed is better kept germination compared to meadow fescue.

For both species seed stored at 4 °C, regardless of way of packaging has retained a high germination (87 % tall fescue and 83 %meadow fescue). For tall fescue seed at temperatures 18 °C and paper and textile bag packaging, had a high enough seed germination for the placing on the market (79 % of paper packaging and 78 % linen packaging). The seed kept in PVC packaging had a germination of 75 %, which was on the border of legislation for the placing on the market (germination >75 %).

On the meadow fescue seed at temperatures 18 °C and in paper and textile packaging had germination under the legislation for the placing on the seed market (74 % of paper packaging, 73 % linen and 70 % in PVC packaging).

Seedling vigor (stem - cm, radicle - cm, weight of seedling - g) in both species followed germination.

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