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INFLUENCE OF THE AIR DRYING TEMPERATURE ON GERMINATION AND DORMANCY OF COCKSFOOT SEEDS (*Dactylis glomerata L.*)

UTICAJ TEMPERATURE VAZDUHA TOKOM SUŠENJA NA KLIJAVOST I DORMANTNOST SEMENA JEŽEVICE (*Dactylis glomerata* L.)

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ABSTRACT

Cocksfoot is one of the most important forage grasses, with specific reference to arid conditions. It is mainly used as a component for the preparation of grass-legume forage mixtures. One of the major problems in the production of grass seed is seed dispersal and loss of some yeld. However, harvesting can be done before the stage of technological maturity of seeds where the losses are reduced but, the quality of the seed may be a problem in this case. On the other hand immediately after harvesting, as well as a period of time after harvesting the seed, the grass is characterized by the presence of dormant seeds. Seed dormancy can be decreased with optimum temperature and moisture during the air seed drying. The harvested seed had the moisture content from 20% to 35%. Then the seeds are dried at temperatures of 9 0°C, 80 °C, 70 °C, 60 °C, 50 °C, 40 °C, 30 °C and at all temperatures the seeds exhibited 90, 60, 30 minutes. In laboratory conditions, seed germination (%), dormant seed are determined in six genotypes. Selection of the optimal temperature and drying time can significantly effect on the increase in seed germination of both seed moisture. Genotypes with high moisture according to the germination, showed low variability (moisture content was 20% and CV ranged from 2.0 to 4.1%; moisture content was 35% and CV ranged from 1.8 to 3.9%).

***Key words**: D. glomerata seed, the air drying temperature, dormancy, germination.*

REZIME

Ježevica je jedna od najznačajnijih krmnih trava, sa posebnim značajem za aridne uslove. Uglavnom se koristi kao komponenta za sastavljanje travno-leguminoznih krmnih smeša. Jedan od većih problema u proizvodnji semena trava je osipanje semena i gubitak dela prinosa. Međutim žetvu je moguće obaviti i pre faze tehnološke zrelosti semena gde se gubici smanjuju ali može biti problem sa kvalitetom semena. Na drugoj strani odmah nakon ubiranja žetve kao i neki vremenski period po žetvi semena, trave se odlikuju prisutnošću dormantnog semena. Ućešće dormantnog semena se može smanjiti a povećati klijavost uticajem optimalne temperature vazduha prilikom sušenja gde i vlažnost semena ima uticaja. Ispitivano je seme sa sadržajem vlage: 20% i 35%. Zatim je seme sušeno na temperaturama vazduha: 90 °C, 80 °C, 70 °C, 60 °C, 50 °C, 40 °C, 30 °C i klasično. Seme je vremenski izlagano na pomenutim temperaturama vazduha 90, 60 i 30 minuta. U laboratoriskim uslovima utvrđivana je klijavost (%) i dormantnost semena (%) šest genotipova ježevice. Izborom optimalne temperature vazduha i vremenom sušenja moguće je značajno uticati na povećanje klijavosti semena obe vlažnosti. Genotipovi sa visokom klijavošću su prema klijavosti ispoljili nisku varijabilnost (vlažnost 20% CV = 2,0-4,1%; vlažnost 35% CV = 1,8-3,9%).

***Ključne reči:** D. glomerata seme, temperature vazduha tokom sušenja, dormantnost, klijavost.*

INTRODUCTION

At the high importance of grasslands indicates that of the total agricultural area of Europe these plant communities occupying 73% of Iceland, 63% of England, 33% of Romania and Serbia, and 21% of Poland *(Peeters, 2009; Stosic and Lazarević, 2007)*. Cocksfoot is mainly grown in mixtures with forage legumes and contributes to the high yield and in good quality forage *(Lazarević and Stosic, 2007, Samuil et al., 2012)*. It is rarely grove in the individual sowing, but it is a very common component of natural grasslands *(Vuckovic, 2004)*. Importance of cocksfoot was higher in arid *conditions (Probert et al., 1985, Ruzic et al., 2011)*. However, grass seed production in Serbia is in deficit *(Stanisavljević et al., 2012)*, a lack of seed of most grass species is in Europe, too *(Jensen, 2010)*. One of the problems with this production is part of the dispersal and loss of yield *(Stanisavljević et al., 2010a)*. A possible solution to prevent these losses is collecting seeds before technological maturity when the seed had increased moisture content. After harvesting the seed, next step is drying to humidity of 12% or less. In practice, seed stretches to the thin layer and mixing, mainly on the flat concrete foundation. Drying in this manner requires laborious and relatively long time. Another possibility is the artificial drying at various temperatures and various times. On the other side, the grass immediately after harvesting possess a certain percentage of dormant seeds *(Simpson, 1990; Stanisavljević et al., 2010b, 2013, 2014)*, which germinate after sowing. That seed in the competition with the already developed seedlings usually do not have contribution in establishing grassland *(Bretagnolle et al., 1995)*. Cocksfoot seed, harvested in June, can be used for the autumn sowing (about three months after harvest) or for planting in subsequent years (autumn or spring sowing dates). The aim of this study was the investigate germination of seed samples with moisture content from 20% and 35%, and drying that seed at the air temperatures from 90 °C to 30 °C; at a time of 90, 60 and 30 minutes.

MATERIAL AND METHOD

Seed germination of six genotypes [Factor C (traits C 1 to C 6)] is determined when the moisture content of seed from 35% to 20% [Factor B (B1 and B2 traits)]. Seed in the layer thickness of about 1.5 cm was placed on drying at temperatures (T): 90 °C, 80 °C, 70 °C, 60 °C, 50 °C, 40 °C and 30 °C, in the duration of and 90, 60 and 30 minutes for each temperature. It is also applied classic foot dry; control [factor A (treatment AØ to A21)].

After applied treatments, if the seed moisture was above 12%, it was additionally dried (on the floor) to 12% of moisture.

Then the seeds put in the filter paper (four replications per 100 seeds) and placed it in the germination chamber. Germination was read 21 days in accordance with the rules (ISTA rules). Germinated seed is the seed that gave the seedling radicle and stem by 0.5 cm or more. On ingeminated seeds is done tetrazolium test for identification the dormant from dead seeds (ISTA rules).

By applying the F test showed the mean effect of the three factors and their interactions (ANOVA). To determine variability of genotypes, for seed germination and dormancy of seeds, was calculated coefficient of variability (CV %). Data of germinating and dormancy percentage were transformed to arcsin N/100 prior to analysis. Significant differences among treatments were determined by Duncan's multiple range test at P≤ 0.05. These analysis procedures were performed using the STATISTICA for windows software (Stat Soft 8.0).

RESULTS AND DISCUSSION

Table 1. Significance according to F test for temperature trait, seed moisture and genotype, main effects on seed germination and seed dormancy

Source	df	Seed germination (%)	Seed dormancy (%)
Temperature A	21	***	***
Seed moist. cont. B	1	NS	NS
Genotype C	5	NS	NS
Interactions			
AxB	21	*	* *
AxC	105	NS	NS
BxC	5	NS	NS
AxBxC	105	NS	NS

*Significant at the 0.05 probability level. **Significant at the 0.01 probability level.

*** Significant at the 0.001 probability level. †NS, not significant

Temperature treatment showed significant effect ($p \leq 0.001$) on seed germination and dormancy. In interaction with moisture seeds (B) influenced significantly on germination ($p \leq 0.05$) and on seed dormancy ($p \leq 0.01$). This suggests the possibility of choice drying temperature according to seed moisture at harvest. Other factors and their interaction had no significant effect (Table 1).

On seed harvested from the 20% moisture using the optimum treatment temperature, in addition to a more efficient and more rapid drying is possible to increase the maximum germination of 17% (Table 2).

Table 2. Applied drying temperature on seed harvested with 20% moisture. Effect on seed germination G (%) and dormancy D (%) of cocksfoot genotypes

Genotype / Trait		Germination (%)						Dormancy (%)						CV %		Average	
		1	2	3	4	5	6	1	2	3	4	5	6	G	D	G	D
Control	AØ	70	80	75	70	81	76	8	12	16	14	10	12	6.3	23.6	75^{d}	12^{a}
T°C 90	90′ - A1	0	0	0	0	0	0	0	0	0	0	0	0	-	-	0^{g}	0^{g}
	60′ - A2	0	0	0	0	0	0	0	0	0	0	0	0	-	-	0^{g}	0^{g}
	30′ - A3	0	0	0	0	0	0	0	0	0	0	0	0	-	-	0^{g}	0^{g}
T°C 80	90′ - A4	0	0	0	0	0	0	0	0	0	0	0	0	-	-	0^{g}	0^{g}
	60′ - A5	9	15	12	13	11	12	0	0	0	0	0	0	16.7	-	12^{f}	0^{g}
	30′ - A6	44	50	40	43	48	46	0	0	0	0	0	0	7.9	-	45^{e}	0^{g}
T°C 70	90′ - A7	70	84	79	75	76	78	0	0	0	0	0	0	6.0	-	77^{d}	0^{g}
	60′ - A8	85	75	82	78	77	83	2	3	1	2	1	3	4.8	44.7	80^{cd}	2^{e}
	30′ - A9	84	80	79	85	82	82	2	1	2	3	2	2	3.1	31.6	82^{c}	2^{e}
T°C 60	90′ - A10	80	98	89	87	91	89	2	2	1	3	2	2	6.6	31.6	89^{ab}	1^{f}
	60′ - A11	94	88	92	90	91	91	4	2	3	3	2	4	2.2	29.8	91^{a}	3^{e}
	30′ - A12	90	93	87	95	85	90	7	5	6	6	5	7	4.1	14.9	90^{a}	6^{c}
T°C 50	90′ - A13	92	90	94	88	91	91	1	0	2	1	1	1	2.2	63.2	91^{a}	1^{f}
	60′ - A14	90	94	92	92	95	89	5	5	4	3	3	4	2.5	22.4	92^{a}	4^{d}
	30′ - A15	88	90	92	92	88	90	10	6	6	6	5	9	2.0	28.6	90^{a}	7^{c}
T°C 40	90′ - A16	93	85	89	88	90	89	5	6	7	8	4	4	2.9	28.8	89^{ab}	6^{c}
	60′ - A17	84	88	92	88	90	86	10	11	9	6	7	9	3.2	21.5	88^{ab}	9^{b}
	30′ - A18	85	87	86	90	82	86	9	9	11	13	13	10	3.0	16.9	86^{b}	11^{a}
T°C 30	90′ - A19	90	86	88	88	84	92	8	8	6	7	10	9	3.2	17.7	88^{ab}	8^{b}
	60′ - A20	80	85	88	87	88	88	9	11	9	13	13	11	3.7	16.3	85^{b}	11^{a}
	30′ - A21	84	85	86	80	90	85	10	10	12	12	11	11	3.8	8.1	85^{b}	11^{a}

Values followed by different letters within columns are significantly different ($p \leq 0.05$) according Duncan's multiple range test.

The time of exposure to the air drying temperature of 50 °C (A12-A15) and 60 °C with time 60 and 30 minutes (A11 and A12) resulted in a high germination (>90%). In these treatments, the seed dormancy is maintained at 1% to 7%, indicating a possible increase in germination when the seed dormancy breaking down (Table 2). Genotypes on which the seed treatments are applied (A11 to A15) which had a germination of <90% were characterized for the germination of the low variability (CV = 2.0 - 4.1%).

On the other side of the air drying temperature of 90 °C and 80 °C at all times is not affected by the absence of dormant seeds and the total mortality to reduced seed germination percentage at 45% (A6) (Table 2).

It seems that the grass species-specific behavior to the influence of the air drying temperature on the increase germination. For example, on the type of *Brachiaria brizantha*, temperature treatment application of 75 °C during 10 and 15 minutes seemed optimal to increase germination *(Martins and Silva, 2001)*. According to *Stanisavljević (2012)* even on grass species from the same genus (*Festuca*) seeds are significantly different in response to the optimal temperature to increase germination.

On seed harvested from the 35% moisture is optimum treatment was possible to increase germination of 2% less than the optimum treatment applied to the seed of 20% moisture content (table 2 and 3). On the seed with high moisture treatments genotypes alfalfa showed low variability for germination from 90 to 92% (CV=1.8% and CV = 3.9%).

Drying from 90 to 60 minutes on temperatures on 50 °C and 60 °C are affected in breaking ormancy and achieve medium to high germination (80 to 91%) (Table 3). Results of favorable lower the air temperature for drying seeds with moisture content 30-40% are consistent with the results obtained in the seeds of *B. brizantha (Fumagalli and Freire, 2007)* and *L. perenne* seeds *(Nellist and Callaghan, 1971)*.

Table 3. Applied the air drying temperature on seed harvested with 35% moisture content. Effect on seed germination G (%) and dormancy D (%) of cocksfoot genotypes

Genotype / Trait		Germination (%						Dormancy (%)						CV %		Average	
		1	2	3	4	5	6	1	2	3	4	5	6	G	D	G	D
Control AØ		78	76	85	70	78	77	12	10	8	10	12	8	6.2	17.9	77^{d}	10^{a}
T°C 90	90′ - A1	0	0	0	0	0	0	0	0	0	0	0	0	-	-	0e	0^{d}
	60′ - A2	0	0	0	0	0	0	0	0	0	0	0	0	-	-	0e	0^{d}
	30′ - A3	0	0	0	0	0	0	0	0	0	0	0	0	-	-	0e	0^{d}
T°C 80	90′ - A4	0	0	0	0	0	0	0	0	0	0	0	0	-	-	0e	0^{d}
	60′ - A5	0	0	0	0	0	0	0	0	0	0	0	0	-	-	0e	0^{d}
	30′ - A6	20	25	25	30	27	23	0	0	0	0	0	0	13.6	-	25^{g}	0^{d}
T°C 70	90′ - A7	50	53	44	40	48	46	0	0	0	0	0	0	9.8	-	47^{f}	0^{d}
	60′ - A8	50	60	55	56	54	55	0	0	0	0	0	0	5.9	-	55e	0^{d}
	30′ - A9	80	70	75	75	74	76	0	0	0	0	0	0	4.3	-	75^{d}	0^{d}
T°C 60	90′ - A10	82	83	75	79	80	81	0	0	0	0	0	0	3.5	-	80^{c}	0^{d}
	60′ - A11	88	89	86	86	81	86	0	0	0	0	0	0	3.2	-	86^{b}	0^{d}
	30′ - A12	86	90	88	84	92	88	1	1	1	1	0	0	3.2	77.5	88^{ab}	1^{d}
T°C 50	90′ - A13	95	87	87	89	90	87	0	0	0	0	0	0	3.5	-	89^{ab}	0^{d}
	60′ - A14	89	93	91	93	87	90	0	0	0	0	0	0	3.9	-	91^{a}	0^{d}
	30′ - A15	90	96	88	90	90	91	3	4	2	2	4	4	3.0	31.0	90^{a}	3^{c}
T°C 40	90′ - A16	94	92	91	91	90	94	5	3	3	2	3	3	1.8	34.7	92^{a}	3^{c}
	60′ - A17	88	91	95	93	89	90	6	5	5	6	4	5	2.9	14.6	91^{a}	5^{bc}
	30′ - A18	90	88	92	91	89	90	9	9	6	6	6	7	1.8	20.5	90^{a}	7^{b}
T°C 30	90′ - A19	95	90	85	91	89	90	6	8	6	7	5	5	3.6	19.0	90^{a}	6^{b}
	60′ - A20	86	90	88	88	93	83	9	6	9	6	6	6	3.9	22.1	88^{b}	7^{b}
	30′ - A21	86	81	91	87	85	86	10	10	8	8	9	8	3.8	11.1	86^{b}	9^{a}

Values followed by different letters within columns are significantly different ($p \leq 0.05$) according Duncan's multiple range test.

As it has been expected, seed of different moisture content of other plant species showed different conditions for temperature and drying effects on germination *(Tabaković et al 2013; Koštić et al 2012)*. Which indicates that it is necessary to find a technological development program in order to improve the quality of seeds of each species.

CONCLUSION

In order to increase germination with 20% moisture content should be dried at 60 °C in a short time (30 or 60 minutes); or 50 °C in 30 to 90 minutes. Seeds harvested from the 35% moisture content achieved maximum germination if dried at 40 °C in a time of 30 to 90 minutes; or at 50 °C for 30 or 60 minutes. To treatments which achieved germination <90% genotype effect showed a low germination variability for seed with moisture content of 20% (CV = 2.0% and CV = 4.1%); and with 35% (CV = 1.8% and CV = 3.9%). The air drying temperature of 90 °C and 80 °C affected the total mortality of seeds in a high percentage. The air drying temperature of 70 °C, particular in the seeds with moisture content of 35% is also affected by the loss of germination in a high percentage.

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