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EFFECT OF NITROGEN FERTILIZATION ON THE QUANTITY OF SEED YIELD OF SELECTED *Poa pratensis* L. CULTIVARS

WPŁYW NAWOŻENIA AZOTEM NA WIELKOŚĆ PLONU NASION WYBRANYCH ODMIAN *Poa pratensis* L.

Abstract: The paper presents a compilation of results obtained from field and laboratory experiments conducted in 2005–2007 at the Malopolska Plant Breeding Station in Skrzeszowice near Krakow (220 m a.s.l) on three forage cultivars of *Poa pratensis* (Skrzeszowicka, Duna and Balin). The investigations aimed at determining the effect of mineral fertilization mainly with nitrogen on the quantity of seed. The studies analysed three nitrogen fertilizer doses (60, 90 and 110 kg N $\cdot$ ha^{-1}) which were used as a whole or divided into two or three parts. Moreover assessed were several dates of nitrogen application: early spring, "under the panicle" and the autumn date.

Both the dose of nitrogen and the date of its application significantly affected the number of plants per 1 m^2. Mineral fertilization with nitrogen dosed 110 kg N $\cdot$ ha^{-1} and divided into two parts resulted in about 5 times greater seed yields than in the objects without fertilization obtained from Balin cultivar (577.4 kg $\cdot$ ha^{-1}) and Skrzeszowicka cultivar (543.9 kg $\cdot$ ha^{-1}). A significantly lower crop yield was produced by Duna cultivar (245.2 kg $\cdot$ ha^{-1}).

Keywords: *Poa pratensis*, cultivars, fertilization, seed yield

In the group of non-cereal grasses meadow grass is considered a species of high economic importance. High potential of its utilization for pasture and non-feed purposes creates demand for sowing material [1, 2]. The source which supplies the sowing material to cover the national demand is cultivar reproduction and import, which currently constitutes even 67 %. The current scale of grass seed imports is definitely too high. It results mainly from low productivity of native seed grass plantations and therefore low profitability of seed production. The key to improve the profitability of seed production is increasing seed yields whereas the element most determining the productivity is fertilization [3]. A particular role in this respect has been ascribed to nitrogen fertilizers. In order to prevent plant lodging, nitrogen plant fertilization should

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be optimized considering its amount, frequency as well as the date of the dose application with simultaneous regard to species characteristics [4]. The investigations attempted at an assessment the impact of nitrogen fertilization dose and the date of its application on the amount of seed yield of three meadow grass cultivars.

Materials and methods

The research was conducted in 2005–2007 at the Malopolska Plant Breeding Experimental Station – HPB in Skrzeszowice (220 a.s.l) near Krakow, on degraded chernozem developed from loess.

The soil revealed the following chemical properties: pH_{KCl} – 6.9; available P – 54, K – 124 and Mg – 46 $g \cdot kg^{-1}$; organic N – 1.7 and total carbon – 15.7 $g \cdot kg^{-1}$ of soil.

The experiment was set up in the autumn 2004 using the randomised block method in four replications. The area of each plot was 10 m^2 (1 × 10).

The object of investigation was a seed plantation of three fodder cultivars of meadow grass (*Poa pratensis*): Skrzeszowicka (Eska 46SE), Duna and Balin.

Phosphorus, dosed 35 kg $P \cdot ha^{-1}$ as triple superphosphate (46 % P_2O_4) was used for fertilization conducted once in spring. Potassium, in the amount of 83 kg $K \cdot ha^{-1}$ as high grade potassium salt (60 % K_2O) was applied once, also in spring.

Nitrogen fertilization in the doses of 60, 90 and 110 kg $N \cdot ha^{-1}$ was applied on the following dates:

– once in the early spring;

– twice in two equal portions (in the early spring and at the beginning of earing stage);

– three times in three equal parts (in the early spring, at the beginning of earing and in autumn).

Chemical weed control on the seed plantation, with a dose of 1 $dm^3 \cdot ha^{-1}$ of Aminopielik Gold, was conducted each year at the beginning of April (when the vegetation started) and in September. Before the seed harvesting, single weeds were hand removed. Passages and single annual meadow grasses (*Poa annua*) counted as persistent weeds of meadow grass seed plantations were point sprayed with a Roundup dose of 4 $dm^3 \cdot ha^{-1}$.

In every year of the investigations, field observations and biometric plant measurements were conducted at the beginning of August. The number of plants was counted on individual plots on the length of 1 m, the length and width of panicles and the flag leaf were measured. The harvesting of the seed plantations was carried out in two stages. The first stage – hand cutting for cuts (cutting height 15 cm) was done at full kernel maturity and about five days later the cut cultivars were threshed using the Wintersteiger plot combined harvester. Harvested seed material was dried in a store-room. Dried kernels with water content below 14 % were rubbed to remove the hairs growing at the base of seedlings. The seeds prepared in this way were cleared on the winnower. The cleaning process involved separating kernels from chaff and spikelets unbroken during the earlier process. Subsequently, cleaned grains were weighed, the obtained yield was calculated per 1 ha and one thousand grain weight was determined.

The obtained results were verified statistically by means of the analysis of variance. The differences between means were estimated using the Student test at the significance level p = 0.05 and the correlation coefficient was calculated for selected features.

The annual precipitation total for the period of the investigations ranged from 463.8 to 615.9 mm, whereas the precipitation total for the six months (April–September) from 345.2 to 537.6 mm. Average annual temperature reached from 6.5 to 6.8 ^{o}C and between 11.8 and 12.6 ^{o}C during the vegetation season.

The work presents the mean results for the 3 years of the investigations.

Results and discussion

The level of nitrogen fertilization is a factor influencing generative shoot formation in meadow grass (*Poa pratensis*) seed plantations. In the Author's own research it significantly modified the number of generative shoots per area unit (Table 1). The greatest shoot density was registered after nitrogen application in a dose of 110 kg N · ha^{-1} divided into two portions (in the early spring and at the start of earing) in Skrzeszowicka c.v. – 346 shoots/m, which was 64 % more in comparison with the control object, 251 shoots/m in Duna c.v. (31 % more than in the control) and 341 shoots/m in Balin c.v., ie 56 % more than on the unfertilized object.

Table 1

The mean number of selected *Poa pratensis* cultivars (units)

Specification	Skrzeszowicka	Duna	Balin
Control	211	192	218
N_{60} – in one dose + $P_{35}K_{83}$	261	217	232
N_{60} – in two doses + $P_{35}K_{83}$	253	231	239
N_{60} – in three doses + $P_{35}K_{83}$	268	223	226
N_{90} – in one dose + $P_{35}K_{83}$	275	239	257
N_{90} – in two doses + $P_{35}K_{83}$	289	248	273
N_{90} – in three doses + $P_{35}K_{83}$	278	242	264
N_{110} – in one dose + $P_{35}K_{83}$	329	236	297
N_{110} – in two doses + $P_{35}K_{83}$	346	251	341
N_{110} – in three doses + $P_{35}K_{83}$	338	249	326
LSD (p = 0.05)	21.9	14.1	15.9

As stated by Marshall and Hades [5], grass seed plantations require nitrogen in the first place to form the adequate number of generative shoots. This thesis was confirmed by numerous literature sources [3, 6–8]. Interdependence of these features expressed by the correlation coefficient in the Wielkopolska region is very high, on the level r = 0.78 [8].

Nitrogen fertilization modifies also panicle structure, which beside generative shoot density is the most important factor determining the amount of seed yield on the plantation [3, 9]. It is evidenced by the correlation obtained in the Author's own

Table 2

The mean length and width of panicle of selected *Poa pratensis* cultivars [cm]

Specification	Skrzeszowicka		Duna		Balin	
	length	width	length	width	length	width
Control	4.2	4.6	5.0	5.8	4.7	5.0
N_{60} – in one dose + $P_{35}K_{83}$	5.7	6.5	6.6	5.9	5.8	5.2
N_{60} – in two doses + $P_{35}K_{83}$	6.4	6.9	7.0	6.2	7.0	5.6
N_{60} – in three doses + $P_{35}K_{83}$	6.0	6.9	7.4	6.0	6.1	6.5
N_{90} – in one dose + $P_{35}K_{83}$	7.0	7.1	8.0	6.1	8.5	6.9
N_{90} – in two doses + $P_{35}K_{83}$	7.6	7.1	9.2	6.4	9.0	6.8
N_{90} – in three doses + $P_{35}K_{83}$	8.7	7.5	8.3	6.5	8.4	7.0
N_{110} – in one dose + $P_{35}K_{83}$	8.4	8.2	9.1	5.9	9.3	6.8
N_{110} – in two doses + $P_{35}K_{83}$	8.8	8.5	9.7	6.5	9.7	7.5
N_{110} – in three doses + $P_{35}K_{83}$	8.0	8.3	9.3	6.6	9.0	7.3
LSD (p = 0.05)	0.83	0.77	0.88	0.99	0.64	0.89

Table 3

The mean yield [kg · ha^{-1}] and mass of thousand seeds [g] of selected *Poa pratensis* cultivars

Specification	Skrzeszowicka		Duna		Balin	
	yield	mass of thousand seeds	yield	mass of thousand seeds	yield	mass of thousand seeds
Control	117.5	0.235	98.1	0.221	121.7	0.231
N_{60} – in one dose + $P_{35}K_{83}$	254.9	0.263	134.7	0.278	276.4	0.284
N_{60} – in two doses + $P_{35}K_{83}$	279.8	0.308	156.3	0.349	295.1	0.320
N_{60} – in three doses + $P_{35}K_{83}$	269.3	0.295	147.2	0.300	280.3	0.286
N_{90} – in one dose + $P_{35}K_{83}$	346.7	0.331	161.9	0.313	357.8	0.330
N_{90} – in two doses + $P_{35}K_{83}$	395.4	0.351	208.5	0.350	412.5	0.358
N_{90} – in three doses + $P_{35}K_{83}$	357.2	0.335	186.3	0.332	367.9	0.346
N_{110} – in one dose + $P_{35}K_{83}$	487.4	0.340	214.5	0.339	536.2	0.343
N_{110} – in two doses + $P_{35}K_{83}$	543.9	0.344	245.2	0.346	587.4	0.350
N_{110} – in three doses + $P_{35}K_{83}$	497.1	0.348	223.4	0.352	567.3	0.351
LSD (p = 0.05)	15.2	0.017	9.3	0.016	8.9	0.017

research between the seed yield and the length and width of panicles (Table 4). In the Author's own research nitrogen fertilization significantly increased the length and width of panicles (Table 2). It was demonstrated that the elongation and width of panicles in *Poa pratensis* were most affected by nitrogen fertilization in an aggregate dose of 110 kg N · ha^{-1} applied in the early spring and at the start of earing. Under the influence of this dose panicles in Skrzeszowicka and Balin c.v. were elongated over twice and in Duna c.v. almost twice. Moreover, the width of panicles increased from 12 % in Duna c.v. to 85 % in Skrzeszowicka c.v.

Table 4

The value of corrleation coeffieient of selected features

Cultivars	Length and width of panicle	Number of plants per 1 m and seed yield	Length of panicle and seed yield	Width of panicle and seed yield	Seed yield and mass of thousand seeds	Length of panicle and mass of thousand seeds	Width of panicle and mass of thousand seeds
Eska 46	0.801	0.950	0.878	0.874	0.870	0.847	0.796
Duna	0.279	0.850	0.919	0.380	0.820	0.800	0.360
Balin	0.779	0.942	0.902	0.744	0.832	0.912	0.744

Poa pratensis seed yield is a synthesis of morphological and biological traits, influenced by nitrogen fertilization. It is also a cultivar feature [8, 10] so the production potential of cultivars results mainly from a considerable diversification in their ability to form the inflorescence shoots [11]. In the Author's own investigations, each dose of nitrogen fertilizers significantly diversified the seed yield (Table 3). The strongest response was registered under the influence of 100 kg N · ha^{-1} dose applied in the early spring and at the start of earing. On unfertilized treatments almost 5-fold higher seed yields were obtained from Balin c.v. (587.4 kg · ha^{-1}) and from Skrzeszowicka c.v (543.9 kg · ha^{-1}) and over twice higher from Duna c.v. (245.2 kg · ha^{-1}). On the other hand the highest thousand grain weight (about 50 % more than on the control) was registered as a result effect of the aggregate dose 110 kg N · ha^{-1}) applied three times: in the early spring, at the earing stage and in autumn.

Conclusions

1. Nitrogen fertilization in a dose of 110 kg N · ha^{-1}, applied on *Poa pratensis* seed plantations in the early spring and at the start of earing stage increased: generative shoot density by 31–64 %, width of panicles by 12–85 %, the length of panicles about twice and the seed yield from over 2 to almost 5-fold.
2. The highest seed yield per 1 m was generated owing to the inflorescence shoot density from 251 in Duna c.v. to 346 in Skrzeszowicka c.v.
3. The seed yield was positively correlated with the number of generative shoots per 1 m and also with the length and width of panicles.
4. The highest one thousand grain weight was registered under the influence of an aggregate nitrogen dose 110 kg N · ha^{-1} applied in the early spring, at the start of earing and in autumn.
5. The one thousand grain weight was positively correlated with yield and the length and width of panicles.

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WPŁYW NAWOŻENIA AZOTEM NA WIELKOŚĆ PLONU NASION WYBRANYCH ODMIAN *Poa pratensis* L.

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Abstrakt: Praca zawiera zestawienie wyników badań polowych i laboratoryjnych przeprowadzonych w Stacji Małopolskiej Hodowli Roślin – HBP w Skrzeszowicach koło Krakowa (220 m n.p.m.) w latach 2005–2007 z trzema pastewnymi odmianami wiechliny łąkowej (Skrzeszowicka, Duna, Balin). Badania miały na celu określenie wpływu nawożenia mineralnego, głównie azotem, na wielkość plonu nasion. W badaniach uwzględniono trzy dawki nawożenia azotem (60, 90 i 110 kg N $\cdot$ ha^{-1}), które stosowano jednorazowo bądź dzielono na dwie lub trzy części. Ponadto ocenie poddano kilka terminów stosowania azotu: wczesnowiosenny, na początku kłoszenia i termin jesienny.

Wielkość dawki azotu, jak również termin jego stosowania wpłynął na ilości roślin na 1 m^2. Pod wpływem nawożenia mineralnego azotem w dawce 110 kg N $\cdot$ ha^{-1} dzielonej na dwie części uzyskano w odniesieniu do obiektów nie nawożonych około 5-krotnie wyższe plony nasion u odmiany Balin (587,4 kg $\cdot$ ha^{-1}) oraz u odmiany Skrzeszowickiej (543,9 kg $\cdot$ ha^{-1}). Istotnie niższym plonowaniem odznaczyła się odmiana Duna (245,2 kg $\cdot$ ha^{-1}).

Słowa kluczowe: *Poa pratensis*, odmiany, nawożenie, plon nasion