SEED YIELD OF BIRDSFOOT TREFOIL (*LOTUS CORNICULATUS* L.) CULTIVARS IN THE YEAR OF ESTABLISHMENT

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Abstract

Production of sufficient quantities of forage is a prerequisite for the development of livestock production. In South-East Europe in less favorable growing conditions especially in terms of climate and soil, in order to produce sufficient quantities of forage, a special attention is given to the cultivation of the birdsfoot trefoil (*Lotus corniculatus* L.). One of the solutions for improvement of birdsfoot trefoil production is the production of the sufficient quantity of quality seeds. Field trial was established in 2012, on soil type cambisol in a randomized block design with three replications. Cultivars of birdsfoot trefoil (K-37, Rocco and Zora) were sown at a inter row spacing of 20 cm, using 10 kg ha^{-1} of seeds. The aim of the study was to analyze in the year of establishment seed yield and yield components: number of stems m^{-2}, number of flowers per stem, number of inflorescences m^{-2}, number of flowers per inflorescence, number of pods per inflorescence, number of seeds per pod and thousand grains weight. Cultivar Rocco had significantly higher seed yield (408.6 kg ha^{-1}) in relation to the cultivars K-37 and Zora (85 kg ha^{-1} and 54 kg ha^{-1} respectively), which arises from the significantly higher number of flowers per stem and inflorescence m^{-2} in relation to the other cultivars. Cultivar Rocco had also a significantly higher number of pods per inflorescence than the K-37 cultivar. Number of flowers per stem, number of inflorescences m^{-2} and number of pods per inflorescence were significantly positively correlated with the seed yield.
Key words: birdsfoot trefoil, seed yield, yield components.

Introduction

Birdsfoot trefoil (*Lotus corniculatus* L.) is a perennial forage legume that is widely distributed in the world. Originates from Western Europe and North Africa (Buselinck and Grant, 1995). In the Republic of Serbia, there are no reliable statistics on the areas where it is grown and yields, although among perennial legumes according to the prevalence it takes the third place, after alfalfa and red clover. It is especially important in the hilly and mountainous areas of Serbia (Petrovic et al., 2011) with regard to its often use when establishing turf in some poor growing conditions (Dimitrova, 2010). According to Vučković (2004) average green forage yields of birdsfoot trefoil range from 35-40 t ha^{-1}, and hay from 8-10 t ha^{-1}. As a high level in potential of forage yield at this species was obtained, it is also necessary to include monitoring of the most important properties of seed yield and its components. Increasing the potential for seed yield is a rarely important criterion in the early stages of birdsfoot trefoils selection. Breeding for increased potential for seed yield is considerably more difficult due to the lack of clear interdependence between seed yield and its components. On the other hand, the existence of significant genetic correlation between harvest index and seed yield suggests the possibility of increasing seed yield, without affecting the forage yield (Elgersma and Van

Wijk, 1997). Seed yield of perennial legumes is mainly determined by genetic base of the variety, environmental conditions of the area, the moment of removing the first cut, the presence of the pollinating insects and the interaction between genotype and environment (Steiner et al. 1995). Potential seed yield of birdsfoot trefoil is estimated at 1200 kg ha^{-1}, while the average yields on global level are below 200 kg ha^{-1} (Turkington et Franco, 1980; Gullien, 2007). In the Republic of Serbia, the average seed yields range from 100-280 kg ha^{-1} (Vu koviC et al., 1997). According to Miladinovic (1967) with the full agricultural technology in our conditions the seed yields of birdsfoot trefoil can reach more than 350 kg ha^{-1}.

The aim of the research was to make a selection of the birdsfoot trefoil cultivars with higher potential for seed yield, out of the chosen cultivars, by analyzing seed yield and its components. Such genotypes would represent a good basis for further work on hybridization and the creation of new varieties, which would have higher seed yield, beside the high potential for forage yield.

Material and Method

The experiment was established near the town of Ljig, in 2012 on the soil in type of cambisol (according to the WRB classification), with medium amounts of nutrients. Primary tillage was conducted at a depth of 30 cm. Along with the primary tillage, the soil was entered 300 kg ha^{-1} $N_{15}P_{15}K_{15}$. Field experiment with three varieties of birdsfoot trefoil was set up using a randomized block design with three replications with plot size 5 m^2 (5x1m). The cultivars of birdsfoot trefoil: K-37 (Institute for forage crops Krusevac), Zora (Institute for agriculture and technological researches Zaje ar) and Rocco (Italian cultivar) were sown at the inter row spacing of 20 cm, with the seed amount of 10 kg ha^{-1}. Weed control was done mechanically on two occasions. Plants were grown without irrigation.

Seed yield and seed yield components were determined from the first cut in the year of the establishment. The following components of yield were determined on the field: number of stems per m^{-2}, number of inflorescences per m^{-2} (by counting on the area of 0.2 m^2 per elementary plot), inflorescences number per stem and number of pods per stem (counting on ten randomly selected tillers from the elementary plot). In laboratory were determined: number of flowers per inflorescence, number of pods per inflorescence and number of seeds per pod (a sample of ten inflorescences per elementary plot) and thousand grains weight (based on the weight 5x100 of seed). The actual seed yield was determined based on the yield components (number of inflorescences per unit area, number of pods per inflorescence, number of seeds per pod, weight of thousand grains) and converted to seed yield in kg ha^{-1}.

The obtained results were processed by analysis of variance of the single factorial experiment using the SPSS software (1995). Significance of differences between the mean values was tested using LSD test.

Results and discussion

The varieties didn't differ among themselves in the number of stems per m^{-2}, while there were significant differences between varieties recorded in the number of inflorescences per stem, which resulted differences in the number of inflorescences per m^2. A significantly higher number of inflorescences per stem and inflorescences per m^{-2} in relation to the other cultivars had the cultivar Rocco. McGraw et al. (1986a) indicate that the number of flowers per stem is the component of yield that the yield of birdsfoot trefoil is largely dependent on. Varieties had an average of 3.21 of flowers per inflorescence and 1.62 pods per inflorescence. Cultivar Rocco had a significantly higher number of pods per inflorescence than K-37.

The number of seeds per pod ranged from 8 in cultivar Zora to 10.22 in cultivar Rocco and thousand grain weight from 1.22 g in cultivar Zora to 1.25 g in cultivar K-37. Grant (1967) states that one gram has 750 to 800 grains of birdsfoot trefoil seed, or the mass of thousand grains is about 1.3 g. According to Hansen (1953) the average number of seeds per pod of birdsfoot trefoil genotypes was 19.

In full maturity pods easily shatter and seeds effuse. Shattering problem significantly limits the successful production of seeds (Fairey, 1994). According to Winch et al. (1985) losses in harvesting birdsfoot trefoil seeds are large, ranging up to 85 % of potential yield. In this paper, the birdsfoot trefoil seed yield is presented, recalculated on the basis of yield components, without taking into account the losses at harvest. The highest yield had variety Rocco (408.6 kg ha^{-1}), significantly higher than the cultivar K-37 (85.0 kg ha^{-1}) and Zora (54.0 kg ha^{-1}). This is mainly due to a larger number of inflorescences per stem and number of pods per inflorescence in cultivar Rocco in relation to the others. Potential seed yield of birdsfoot trefoil is estimated at 1200 kg ha^{-1}, while the average yields on the global level are below 200 kg ha^{-1} (Turkington et Franco, 1980; Gullien, 2007). According to McGraw and Beuselinck (1986a), the average yield of birdsfoot trefoil seed varies from 50-175 kg ha^{-1}, or in average it is about 100 kg ha^{-1} of seed. Seaney and Henson (1970) state that seed yields of birdsfoot trefoil range from 50-560 kg ha^{-1}. Seed yields of birdsfoot trefoil in USA range from 50 to 170 kg ha^{-1} (Fairey and Smith, 1999), in Uruguay between 120 and 150 kg ha^{-1} (Garcia et al., 1991; Artola, 2004) and in Argentina between 25 and 150 kg ha^{-1} (Mazzanti et al., 1988). According to Vojin et al. (2001), in agro-ecological conditions of Serbian republic in the area of Banja Luka, there was a birdsfoot trefoil seed yield of 272 kg ha^{-1}. In Serbia, seed yield ranges from 100-280 kg ha^{-1} (Vu koviC et al., 1997).

Birdsfoot trefoil can achieve good yields in seed production (PetroviC, 2011), so in combination with two cuts, considerable yield can be achieved for forage. Autor observed that highest yields of forage in the densest crop establishment do not match the highest seed yield in three-year production, but they have the highest potential in combined use.

Analyzing the seed yield of birdsfoot trefoil at three locations McGrew et al. (1986b) found that there were significant interactions genotype x environment, so the testing of the potential for seed yield should be done in an environment where the seed is commercially produced.

Table 1. Mean seed yield and yield components of birdsfoot trefoil varieties: stem number m^{-2} - SNM, inflorescence number per stem – INS, inflorescence number m^{-2} – INM, flower number per inflorescence – FPI, pod number per infleorence – PNI, seed number per pod – SNP, thousand seed weight - TSW and seed yield - SY (g).

		SNM	INS	INM	FPI	PNI	SNP	TSW	SY
Cultivars	K-37	450	0.89 b	415 b	3.5	1.80 b	9.57	1.24	85.0 b
	Rocco	428	3.50 a	1464 a	2.7	2.20 a	10.22	1.23	408.6 a
	Zora	513	0.58 b	297 b	3.4	1.87 ab	8.00	1.22	54.0 b
ANOVA		ns	*	*	ns	*	ns	ns	*

The values denoted with different small letters within columns are significantly different at (P<0.05) in accordance with the LSD test; *- F test significant at p<0.05; ns - F test non-significant.

Table 2. Correlation coefficients between stem number m^{-2} - SNM, inflorescence number per stem – INS, inflorescence number m^{-2} – INM, flower number per inflorescence – FPI, pod number per stem – PNS, pod number per infleorence – PNI, seed number per pod – SNP, thousand seed weight - TSW and seed yield – SY.

	INS	INM	FPI	PNS	PNI	SNP	TSW	SY
SNM	-0.42	-0.09	-0.12	-0.54	0.0	-0.38	-0.05	-0.04
INS		0.93*	-0.47	0.44	0.66	0.54	-0.02	0.89*
INM			-0.46	0.39	0.76*	0.51	0.01	0.99*
FPI				0.09	-0.08	0.11	0.02	-0.38
PNS					0.2	0.76*	0.05	0.38
PNI						0.26	-0.27	0.77*
SNP							0.09	0.54
TSW								0.05

* Significant at $p < 0.05$

Number of inflorescences per stem was strongly positively correlated with the number of inflorescences per m^{-2}, where both features positively correlated with the seed yield. A positive correlation was also found between the number of pods per inflorescence and the number of seeds per pod and number of pods per inflorescence and seed yield. According to StevoviC et al., (2011) the number of inflorescences per plant of red clover is positively correlated with the number of stems per plant and number of inflorescences per stem. The authors also reported a significant positive correlation between the number of inflorescences per plant and seed yield per plant. These results are in agreement with results of Montardo et al., (2003) and Herrmann et al. (2006). Nevertheless, Herrmann et al., (2006) report that the number of inflorescences per plant largely determines the seed yield of red clover.

Conclusion

Significant differences in the number of inflorescences per stem, inflorescence number per m^{-2}, number of pods per inflorescence and seed yield were detected among the cultivars. Cultivar Rocco had significantly higher seed yield (408 kg ha^{-1}) in relation to K-37 and Zora (85 kg ha^{-1} and 54 kg ha^{-1}, respectively) as a result of a significantly higher number of inflorescences per stem and number of inflorescences per m^{-2} in relation to the others. Cultivar Rocco also had a significantly higher number of pods per inflorescence than K-37.
The values of correlation coefficients indicate that the greatest influence on the yield had the following yield components: number of inflorescences per stem, number of inflorescences per m^{-2} and number of pods per inflorescence, so a further selection work should focus on increasing the value of these properties.
The results indicate that seed production of birdsfoot trefoil can be successful in the year of sowing with proper care and use of crop.

Acknowledgements

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