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The effect of differences of conventional and organic farming agrotechnical measures on the compliance of the fodder galega 'Gale' seed production to the certification requirements

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Abstract Different sowing rates, row spacing, optimal and reasonable mixtures of herbicides were investigated for the seed production of the Estonian fodder galega Gale (Galega orientalis Lam.). The control of dicotyledonous weeds with herbicides is well justified in the year of sowing because the control remains insufficient in the years of seed production. However, the control of weeds in the years of seed production diminishes the expenditures for seed gathering, drying and cleaning. The control of couch grass is necessary to avoid ergot sclerotia in seed production and gives good results in the years of seed harvesting. The average seed yield of fodder galega was 259 kg ha^{-1} Desicant Basta 150 SL (glyfosinate-ammonium 158 g l^{-1}) with rate of 1.0 l ha^{-1} was used before seed harvesting in order to dry the green parts of plants, to favour uniform ripening and to diminish the losses in seed harvesting, which gave an extra yield of 35%. Due to a higher competative ability of weeds, it is expedient to use a bigger sowing rate in the ecological farming, i.e. 10 kg ha^{-1}.

Keywords: fodder galega,, seed production, , herbicides, sowing rate, conventional farming, organic farming

INTRODUCTION

Along with other legumes fodder crops like lucerne and clovers, goat's rue, i.e. fodder galega has been grown in Estonia for almost forty years. The advantage of the variety "Gale" that is bred in Estonia is a stable seed yield and high persistence – ten years or even more. On break-stony soils and non-acid loamy sands and loams stable average seed yields of 253–357 kg ha^{-1} have been obtained over five years. Under the two-cut regime fodder galega is a high yielding (7–10 t ha^{-1} dry matter) and protein rich fodder plant (20–22% dry matter)(Raig et al., 1993, 2001; Nõmmsalu & Meripõld, 1996; Iwabuchi et al., 2005). It has shown good adaptability and winter resistance even in the soil and climatic conditions of the island Hokkaido in Japan (latitude 43° 47`N), where the total sowing area amounts to 500 hectares.

Although the seed yield of legumes is mostly determined by the climate and the number of pollinators, weed control still plays an important role. The aim of the reseach was to specify the agrotechnical measures for the seed production of the fodder galega 'Gale' (*Galega orientalis* Lam.) both in conventional and organic farming.

MATERIALS AND METHODS

In the trials of conventional farming the effect of different sowing rates, suitable herbicide mixtures and desicant on the seed yield of fodder galega and the quality of yield were investigated. The trials were carried out in the seed fields established in 2002 and 2004. The seed fields were established at Saku on a typical soddy-calcareous soil the agrochemical indicators of which were as follows: pH_{KCl} 7.4 (ISO 10390); humus content C_{org} 4.1% (NIRS method) and contents of lactate soluble P and K 97 and 166 mg kg^{-1} (Mehlich III methods), respectively.

The fodder galega variety 'Gale' was sown in May, in a pure stand, in wide-apart rows with the row spacing of 60 cm. The sowing rates were 6.0 and 10.0 kg ha^{-1}. The seeds were treated just prior to sowing with a host-specific nodule bacterium. The trials were sown with a Kongskilde sowing machine in 4 replications the size of the harvested plot being 50 m^2. In the year of sowing the weed control was carried out in the stage of two-three true leaves of galega, in the year of harvest at the beginning of June. The fertiliser P_{-35} and K_{-90} kg ha^{-1} was applied in autumn.

Herbicide mixtures in the year of sowing:
1. Stomp *(pendimethalin 330 g/l))* 1.5 l ha^{-1} + MCPA 0.6 l ha^{-1}.
2. Basagran *(bentazone 480 g/l)* 2.0 l ha^{-1}.

Herbicide mixtures in the year of harvest:
Basagran *(bentazone 480 g/l)* 1.5 l ha^{-1} + MCPA 0.6 l h^{-1} a+ Zellek Super *(haloxyfop-R methyl ester 108g/l)* 1.0 l ha^{-1}.

At the stage of flower bud formation the seed fields were treated with Soluboor at the rate of 2.0 kg ha^{-1}. In 2004 the galega seed field was treated prior to harvesting with the desicant Basta 150 SL (glyfosinate-ammonium 158 g l^{-1}) with a dose of 1.0 l ha^{-1} to remove green material and to ensure a uniform ripening of seeds. The seed field was field certified. The seed yield was combine-harvested in one phase (Sampo 500), the seeds were dried in a warm-air box drier and cleaned in the Petkus and Kamas-Westrup laboratory seed cleaners. In the trials the seed yield and its quality were determined.

The organic farming production trial was established in Villu Mahlak's organic farm in Lepassaare in the Põlva County in 2004. The seed field was sown on soddy-podzolic soil with the sowing rate of 10 kg ha^{-1}, prior to sowing the seeds were treated with a host-specific nodule bacterium. The seed field was field certified; the seed analyses were made at the Seed Testing Laboratory of the Agricultural Research Centre.

The year of 2004 was unfavourable; there were night frosts (-7°C) in May, destroyed 30 cm high galega plants. July was particularly rainy, the amount of precipitation in Saku was 492 mm (normal 90 mm). The seed fields lodged, the second crop grew through.

The vegetation period of 2005 was more favourable for the seed production of legumes than the previous one. A cool June was followed by a relatively warm July. The average temperature of the month was 17.2°C being thus a couple of degrees higher than usual. Aridity that affected the seed fields already at the end of June

continued also in July. August on the other hand was very rainy, during the first 10 days the amount of precipitation in Saku was 66 mm, on the average of the month 136 mm, i.e. 186% of the usual amount. Heavy storms caused lodging and growing through of the second crop.

The particularly cold winter without snow cover in January 2006 (in Saku in the plough layer up to - 23°C) damaged and partially destroyed the selection and seed gardens of fodder galega. The vegetation period of 2006 was relatively favourable for the seed production of legumes. During flowering and seed maturation the temperature was higher and the amount of precipitation lower than the average of many years. In June the amount of rainfall was 19.2 mm and in July 14.6 mm, which was 16% of the normal amount. The average air temperature of 17.9 degrees in July was a couple of degrees higher than usual. August was richer in precipitation; in Saku the amount of rainfall was 65.4 mm. The autumn turned out to be a warm and long one.

In 2007 the vegetation period started early (14 April), but there were night frosts at the end of April and beginning of May (-4°C). The end of May was extraordinary warm (17–23°C). In the second half of June the amount of precipitation was 22 mm (39% of the normal amount) and in July 87 mm (97% of the normal amount). The 1st and 2nd ten-day periods in August were dry and warm.

The trial results were processed statistically by the method of dispersion analysis.

RESULTS AND DISCUSSIONS

In the year of sowing, the following weeds dominated in the seed fields: goose foot (*Chenopodium album*), European field pansy (*Viola arvensis*), drug fumitory (*Fumaria officinalis*) and several cruciferous weeds (*Capsella bursa-pastoris, Sinapis arvensis*). Corn spurry (*Spergula arvensis*), common chickweed (*Stellaria media*), cleavers (*Galium aparine*), hempnettle (*Galeopsis spp*.), scentless mayweed (*Matric*a*ria perforata)*, and garden yellowrocket (*Barbarea arcuata*) were present in a great number. In the conventional farming the efficacy of both herbicide mixtures was effective in controlling annual weeds, whereas the Basagran mixture destroyed scentless mayweed better, Stomp was better for European field pansy. In the control of common chickweed MCPA and Stomp and their mixtures gave a satisfactory result, the impact of Basagran mixtures was effective. In the year of harvest also graminaceous weeds occurred in the seed field. Therefore, for controlling grasses Zellek Super (half of the recommended dose) was added to Stomp and Basagran, and Basagran and MCPA during spraying. Zellek Super increased the effect of other herbicides on dicot weeds due to good stickiness, but at the same time it had a damaging effect on the crop (Paide, 1996; Meripõld et al, 2001; Meripõld, 2005).

In Estonia, fodder galega's seeds ripen at the beginning of August, at a suitable time for combine harvesting. In 2004, the desicant was used in this experiment before harvesting to remove fodder grass from the fodder galega 'Gale' seed field and to ensure uniform ripening of seeds and avoid a decrease in the yield. Weather had an essential effect on the seed yield of fodder galega. While in 2004, when the weather was unfavourable (amount of precipitation in July 492 mm), the seed yield was only 150–170 kg ha^{-1}, then in the favourable conditions of 2005 the seed yield amounted to 321–345 kg ha^{-1} (Table 1). When the sowing rate was increased to 10.0 kg ha^{-1}, a

sporadic lodging of fodder galega occurred. On the average of five years the seed yields of the fodder galega 'Gale' were bigger with the lower sowing rate (6.0 kg ha^{-1}). The average seed yield over five years was 259 kg ha^{-1} (Table 1). When the sowing rate was increased to 10.0 kg ha^{-1}, a sporadic lodging of fodder galega occurred.

On the average of five years the seed yields of the fodder galega 'Gale' were bigger with the lower sowing rate (6.0 kg ha^{-1}). The average seed yield over five years was 259 kg ha^{-1} (Table 1).

Conventional farming

Table 1. The impact of sowing rate on the seed yield of fodder galega.

Species	Sowing rate	Seed yield, kg ha^{-1}				
Va riety	kg ha^{-1}	2004	2005	2006	2007	Average
Galega orientalis Lam	6	170	345	286	234	259,0
Gale	10	150	321	244	230	236,0
PD95 /LSD95%						9,40

Organic farming

Table 2. Certified seed yields of fodder galega in organic farming.

Species	Sowing rate	Seed yield, kg ha^{-1}		
Variety	kg ha^{-1}	2006	2007	Average
Galega orientalis Lam				
Gale	10	166	143	155
PD95 /LSD95%				3,02

According to the field certification report, the organic farming seed field was invaded by couch grass (*Elymus repens*.), creeping thistle (*Cirsium arvense*) and mugwort (*Artemisia vulgaris*). In the conventional farming it is possible to avoid the spreading of graminaceous weeds with chemical weed control. The chemical weed control of grasses prevented also the seed contamination with sclerotia of ergot (*Clavceps purpurea Tul)*, which are difficult to be separated during sorting (Meripõld, 2005). A repeated sorting had to be performed for the seed grown in the organic farming conditions in order to meet the certification and export requirements, and it increased the expenditures. There were no other diseases on the seeds while fodder galega is quite resistant to the diseases of legumes (Lõiveke, 2008).

As the result of foliar boron fertilization, the flowers had an improved fertilization. Seeds had a more uniform maturation, the biological value of seeds increased – the 1000-seed weight increased by 0.04–0.07 g, and the seed yield increased on average 30%. The climatic conditions in Estonia are quite favourable for

producing green fodder, but quite often unfavourable for obtaining good seed yields of other legumes.

CONCLUSIONS

Conventional farming

In the conventional farming the use of herbicides enables to kill both the annual and perennial weeds that hinder the development of fodder galega.

As a rule, the chemical control of dicot weeds in the year of sowing was effective. The mixture with Basagran destroyed scentless mayweed better, Stomp was better for European field pansy. In the years of harvest the control of couch grass gave good results as it prevented the seed contamination with sclerotia of ergot.

The highest yields were obtained with the sowing rate of 6.0 kg ha^{-1}.

The use of B fertilizer provided an extra yield of 30% and increased the biological value of seeds.

The use of desicant in the years of unfavourable weather improved the harvesting conditions and enhanced the maturation of seed yield.

Organic farming

In order to reduce the negative effect of weeds on the development of fodder galega in the year of sowing, both the annual and perennial weeds must be eliminated through repeated mechanical cultivation methods. Due to a higher competative ability of weeds, it is expedient to use a bigger sowing rate in the ecological farming, i.e. 10 kg/ha.

A repeated sorting had to be performed for the seed grown in the organic farming conditions in order to meet the certification and export requirements, and it increased the expenditures.

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