Effect of genotype on seed yield in lupine *Lupinus luteus* L., *Lupinus angustifolius L.* and resistance to fungal diseases (C*olletotrichtum lindemuthianum* Br. et Cav., *Fusarium oxysporum* Schl.*)*

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Lupine anthracnose (*Colletotrichtum lindemuthianum* Br. et Cav.) infests without exception all lupine species, however yellow lupine is affected most. At present, at the Vokė Branch of the Lithuanian Institute of Agriculture great attention is paid to the creation of yellow lupine and angustifoliate lupine pabulum varieties with higher resistance to fusariosis and anthracnose. Hence, in 1998–2000 three yellow lupine and four angustifoliate lupine hybrid numbers of pabulum type were investigated and assessed for resistance to fungal diseases. Plant species, genotype and agrometeorological conditions were established to produce the major effect on resistance to fungal diseases. All investigated hybrid numbers of angustifoliate lupine hold high seed productivity and anthracnose resistance.

Key words: yellow lupine, angustifoliate lupine, genotype, fungal diseases, disease resistance, yield

INTRODUCTION

The increase of food resources is based on a sophisticated modelling of crop growing technological lines and production intensification. In plant-growing intensification criteria are enlargement of crop areas and rising of productivity by applying latest research and technological achievements. Improvement of plant species and varieties and selection of adequate agrotechniques predetermine both higher productivity and a more efficient use of resources [1–3].

Under market economy conditions, when on farms with intensive grain production soil is exhausted and mineral fertilizers are expensive, growing of legumes for seeds, green fodder or green manure is perspective. One of the oldest agricultural crops widely used in the world not only as a protein source in fodder production, but for soil improvement as well is lupine [4–5]. Lupine belongs to the leguminous (*Fabaceae* Lindl.) family of the genus *Lupinus* L.. They are annual and perennial herbs with bulky branches – stem root system. In Lithuania there are cultivated only annual yellow (*Lupinus luteus* L.) and angustifoliate (*Lupinus angustifolius* L.) lupine species, and perennial polyfoliate lupine (*Lupinus polyphyllus* Lindl.) under natural conditions is found in forests and on roadsides. Up till now, of all lupine species yellow lupine has received most attention in Lithuanian agriculture. According to the figures of the Central Statistics Department, yellow lupine was grown most widely in 1969 (74 thou. ha). However, since 1970 areas under lupine have started to decrease rapidly in Lithuania. In 2000 the area under lupine was 1.9 thou. ha [6]. The decline in lupine production is caused by the shortage of high reproduction seeds, unfavourable meteorological conditions and a new widely spreading disease – lupine anthracnose (*Colletotrichtum lindemuthianum* Br. et. Cav.) [7]. In Lithuania the disease was registered in 1997, while in the Ukraine the disease has been spreading since 1983 and in the neighbouring Belarus since 1987 [8–9]. Lupine anthracnose infests without exception all lupine species, but yellow lupine crops suffer most. At present, at the Vokė Branch of the Lithuanian Institute of Agriculture great attention is paid to the creation of angustifoliate pabulum lupine varieties with a higher resistance to

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fusariosis (*Fusarium oxysporum* Schl.) and anthracnose (*Colletotrichtum lindemuthianum* Br. et. Cav.).

The objective of the work was to assess new perspective breeding numbers of yellow and angustifoliate lupine of pabulum type for seed productivity and resistance to fungal diseases.

MATERIALS AND METHODS

Trials were carried out at the Vokė Branch of the Lithuanian Institute of Agriculture in 1998–2000. The soil in the trial field was sod podzolic sand loam on gravel (Eutri–Haplic Arenosol) according to the new classification of Lithuanian soils DKL-99 [10]. Ground waters were at a depth of 6.0–7.0 m. The relief was a slightly curved plain. The plough layer was 20–22 cm, soil pH 4.8–6.0, humus 2.0–2.1 percent, medium levels of nitrogen, phosphorus (113.2–147.3 mg/kg) and potassium (126.4 mg/kg).

The soil for lupine was prepared according to the generally accepted technology: deep autumn plough, in spring cultivated twice. Before sowing or 2–3 days following it the field was sprayed with gezagard (0.5–0.75 kg active ingredient/ha). Lupine was sown by hand (20 seeds in a linear meter). Record area – 3.0 m^2, 4 replications, variants arranged in a randomised order. The trial included three breeding numbers of yellow lupine and four breeding numbers of angustifoliate pabulum lupine and the control yellow lupine variety 'Trakiai'. During vegetation phenological observations were performed. At the stage of full germination, the field germination level was estimated by calculating plants in each replication. In phases of seedling, bud and green pod the disease-infested plants were recorded and eliminated from the plot. At the end of vegetation all infested plants were calculated, disease prevalence was computed and lupine resistance to fungal diseases was assessed in a 9-point scale according to the method [11–12]. In the phase of maturity, healthy plants and their productivity were computed. Experimental findings were statistically analysed by the dispersion method using ANOVA software [13].

Meteorological conditions were observed each year during the whole vegetation period. The record summary of 1998–2000 of Vilnius Meteorological Station was applied for the analysis. In the trial years meteorological conditions varied and exercised a significant effect on the yield of the study plants, fusariosis and anthracnose development and prevalence.

RESULTS AND DISCUSSION

In 1998, the sufficient amount of precipitation and warm temperatures at the beginning of vegetation produced favourable conditions for germination, plant growth and development. First fusariosis signs were registered in the seedling phase in angustifoliate lupine trials. In separate variants disease prevalence ranged from 6.0 to 9.0%, meanwhile in yellow lupine in the seedling phase fusariosis infested 1.0 to 1.5% of plants. The humid and cool weather in June–August stipulated not only high setting of lupine pods and a substantial yield of green mass, but also a severe prevalence of fungal diseases. Anthracnose, whose pathogens spread via air and precipitation, is most harmful to the lupine crop. In lupine fields, centres of infested plants form around a sick plant. The symptoms are most distinctive in bud and green pod phases. In the bud phase inflorescences deform, part of flowers fall down, and oblong wounds covered with a pink covering form on the stem. Stems of anthracnose-infected plants usually break down at the injured place. In the green pod phase injury appears on developing pods, deforming them. Seeds that ripen in anthracnose-infected pods are smaller in size, with a brownish or pink coating. Yellow lupine is most susceptible. In bud and green pod phases anthracnose killed 50% to 54% of yellow lupine crops, while the amount of fusariosis-infested plants was only 3.0% to 4.1% (Table). Yellow lupine is fairly fusariosis-resistant; the resistance is estimated to 7 points, while anthracnose resistance is low – 1 point. Angustifoliate lupine holds a notably higher anthracnose resistance. Anthracnose infested from 20.2% to 24.3% of plants, resistance was 5 points, and fusariosis damaged 12.5–14.6%, resistance being 5 points. Though meteorological conditions were rather favourable for pod setting of yellow lupine, the seed yield was very low (0.5–0.6 t/ha). Seed yield of angustifoliate pabulum lupine in comparison with yellow lupine was high (2.0–2.4 t/ha). Angustifoliate lupine ripened in the first decade of September, while maturation of yellow lupine extended till the third decade of September.

In 1999 meteorological conditions for lupine growth were unfavourable. In the cool and dry weather the germination of lupine was late. Anthracnose was not registered in the seedling phase, while fusariosis infected from 1.0% to 2.5% of plants in angustifoliate lupine plots. From the beginning of June till the end of August dry and hot weather prevailed. At the end of July – beginning of August a severe draught took place. Underdeveloped lupine set pods and ripened seeds. Though the high temperature inhibited the prevalence of fungal diseases, in yellow lupine plots anthracnose infested 41.0% to 50.0% of plants; anthracnose resistance was evaluated by 3 points, fusariosis resistance by 7 points. Seed yield ranged from 0.7 to 1.0 t/ha. In angustifoliate pabulum lupine plots anthracnose infested from 8.1% to 9.9% of all plants; anthracnose resistance was high – 7 points. Fusariosis infested from 7.8% to 9.3% of plants; fusariosis resistance was

Table. **The influence of resistance to fungal diseases on lupine seed yield**

Treatment	1998			1999			2000		
	Yield of seeds t/ha	Fusarium oxysporum %	Colletotrichtum lindemuthianum %	Yield of seeds t/ha	Fusarium oxysporum %	Colletotrichtum lindemuthianum %	Yield of seeds t/ha	Fusarium oxysporum %	Colletotrichtum lindemuthianum %
Trakiai	0.6	3.0	50.0	1.0	3.1	41.0	0.2	3.9	85.0
Nr. 1550	0.5	4.1	52.3	0.8	3.5	48.0	0.1	3.1	78.0
Nr. 1551	0.5	3.8	54.5	0.9	4.2	47.0	0.05	4.2	88.0
Nr. 1556	0.5	3.0	50.0	0.7	4.5	50.0	0.05	4.5	86.0
R_{05}	0.03			0.04			0.006		
Trakiai	0.6	3.5	55.0	1.0	2.9	43.7	0.2	4.2	72.5
Nr. 1670	2.0	12.5	20.2	1.4	7.8	9.4	1.0	8.6	19.2
Nr. 1671	2.4	14.6	22.5	1.5	9.1	9.9	1.8	8.7	9.1
Nr. 1672	2.1	13.3	24.3	1.6	9.3	8.1	0.2	9.0	31.0
Nr. 1675	–	–	–	1.6	8	8.9	1.02	7.3	9.3
R_{05}	0.12			0.09			0.07		

evaluated by 7 points. Not only fungal diseases, but also the prevailing high temperatures had a negative impact on seed yield of angustifoliate lupine. The seed yield ranged from 1.4 to 1.6 t/ha. Lupine matured in the first decade of August.

Water deficit in April–May 2000 negatively affected lupine germination. It was late, the crop was thin. In the seedling phase anthracnose was not registered; fusariosis infested only angustifoliate pabulum lupine. Meteorological conditions for spreading of fungal diseases were favourable. Anthracnose infested 72.5–88.0% of yellow lupine plots, the seed yield ranged from 0.05 to 0.1 t/ha. In angustifoliate lupine anthracnose infested No 1672 most– 31% of plants, anthracnose resistance was evaluated by 3 points. Resistance of the rest angustifoliate lupine was assessed by 7 points. Fusariosis infested 7.3–9.0% of plants. Seed yield of anthracnose-resistant lupine breeds No 1670, No 1671 and No 1675 ranged from 1.0 to 1.8 t/ha.

At present, in the world lupine genetic bank no lupine species with absolute resistance to fungal diseases are available. Based on the submitted data, we can draw a conclusion that lupine resistance to fungal diseases is mainly predetermined by the species, plant genotype and agrometeorological conditions.

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GENOTIPO REIKŠMĖ LUBINŲ *LUPINUS LUTEUS* L., *LUPINUS ANGUSTIFOLIUS* L. SĖKLŲ DERLIUI IR ATSPARUMUI GRYBINĖMS LIGOMS (*COLLTOTRICHTUM LINDEMUTHIANUM* BR. ET CAV., *FUSARIUM OXYSPORUM* SCHL.)

Santrauka

Lubinų antraknozė (*Colletotrichtum lindemuthianum* Br. et. Cav.) pažeidžia be išimties visas lubinų rūšis, tačiau labiausiai nukenčia geltonieji lubinai. Pastaruoju metu Lietuvos žemdirbystės instituto Vokės filiale didelis dėmesys skiriamas geltonųjų ir siauralapių lubinų pašarinių veislių, pasižyminčių didesniu atsparumu fuzariozei bei antraknozei, kūrimui. Tam tikslui 1998–2000 m. buvo tiriamas ir vertinamas trijų geltonojo lubino ir keturių siauralapio pašarinio tipo hibridinių numerių atsparumas grybinėms ligoms. Nustatyta, kad grybinių ligų atsparumui didelę reikšmę turi augalo rūšis, genotipas ir agrometeorologinės sąlygos. Visi tirti siauralapių lubinų hibridiniai numeriai pasižymi dideliu sėklų derliumi bei atsparumu antraknozei.