

# Experience of introduction of perennial wild species of vetch (*VICIA* L.) in the conditions of the Middle Urals

Anna Abramchuk  
Plant Growing and Selection  
Department  
Ural State Agrarian University  
Ekaterinburg, Russia  
[fito41@mail.ru](mailto:fito41@mail.ru)

Mikhail Karpukhin  
Vegetable and Fruit Growing  
Department n.a. Prof. N.F. Konyaev  
Ural State Agrarian University  
Ekaterinburg, Russia  
[mkarpukhin@yandex.ru](mailto:mkarpukhin@yandex.ru)

Sergey Mingalyov  
Plant Growing and Selection  
Department  
Ural State Agrarian University  
Ekaterinburg, Russia  
[fito41@mail.ru](mailto:fito41@mail.ru)

**Abstract**— Research on the introduction of perennial wild species of vetch was carried out for 5 years (2007-2011) in "Uralets" work-study unit located in the Beloyarsky district of the Sverdlovsk Region on the educational-experimental plot of the Faculty of Agricultural Technologies and Land Management. Experimental scheme included 3 variants: *Vicia sepium* L. (bush vetch) - control; *Vicia sylvatica* L. (wood vetch); *Vicia megalotropis* Ldb. (Siberian vetch). Once-cut stand, cutting was carried out in the phase of heavy flowering of the studied plants. It was found that during years of research wood vetch was developing most intensively. It is characterized with the highest average daily growth which ranged from 2.6 to 3.5 cm. Siberian vetch showed lower values, its average daily growth during all years of research did not exceed 1.1-1.5 cm. Average productivity of studied species during all years of observations (2008-2011) was as follows: *Vicia sepium* L. - 13.6 t/ha; *Vicia sylvatica* L. - 17.9 t/ha; *Vicia megalotropis* Ldb. - 11.7 t/ha.

**Keywords**— wild vetch species, phenological phases, productivity.

## I. INTRODUCTION

At present, a small range of traditional legumes, such as: red clover, alsike clover, white clover, variegated alfalfa, etc., is used for feed production in the Russian Federation. [1-3]. Wild species of legumes (vetches, peas) which are of great interest for providing animals with high-value and protein-enriched feed are practically not used [4-8]. From huge variety of wild vetch species, their number which underwent cultivation does not exceed 2.5%. Eurasian species of vetch which are valuable feeders include the following: *Vicia sepium* L., *V. sylvatica* L., *V. megalotropis* Ldb, which, unlike other legume species, have green leaves until late autumn without reducing their nutritional value. *Vicia sepium* L. and *V. megalotropis* Ldb are the most protein-rich ones. Vetches are perennial plants with fairly high possible productivity during 5 or more years [4].

In addition to feeding value, vetches being an important component of meadow and forest plant communities can be used as valuable honey-bearing, ornamental and medicinal plants [9]. In recent years, quercetin and

kaempferol diglycosides were extracted from the aboveground biomass of studied vetch species. A rather high content of flavonoids (% of absolutely dry basis) was found in the aboveground biomass: wood vetch – 3.3-6.2; a bit less in Siberian vetch – 3.4-5.1; significantly lower in bush vetch – 2.7-3.4. Flavonoids are characterized with high biological activity: they are antioxidants, reduce capillary permeability and fragility, are widely used in the treatment of cardiovascular and other diseases [10].

## II. RESEARCH METHOD

The experiment of studying the characteristics of growth and development of perennial wild species of vetch during introduction was carried out in "Uralets" work-study unit located in the Beloyarsky district of the Sverdlovsk Region on the educational-experimental plot of the Faculty of Agricultural Technologies and Land Management.

The soil of the experimental plot was heavy loamy, podzolized chernozem of medium depth. Total depth of humus horizon (A+B) was on average 54-67 cm. Humus horizon was enriched in exchangeable bases, 70% of them was calcium. Humus content according to the method of Tyrin – 6.9%; cation exchange capacity – 33.7 m/mol/100 g; total exchangeable bases – 9.5 m/mol/100 g; hydrolytic acidity – 4.2 m/mol per 100 g of soil. Soil of the plot is distinguished by a rather high level of macro-elements – phosphorus, potassium, and nitrogen.

The experiment was established on May 15, 2007. Wide-row planting, spacing width 30 cm, planting depth 2-3 cm, seeding rate 8-10 kg/ha. For the plating of wood and bush vetches, the seeds of local coenopopulations gathered in the vicinity of "Uralets" work-study unit were used. Seeds of Siberian vetch were taken from Siberian flora (were gathered on the forest ecotope of Shegara district, Tomsk region) [4]. Experimental scheme included 3 variants: 1 variant – *Vicia sepium* L. (bush vetch) – as a control one; 2 variant – *Vicia sylvatica* L. (wood vetch); 3 variant – *Vicia megalotropis* Ldb. (Siberian vetch). The area of registration plots was 10 m<sup>2</sup>, threefold replication. Once-cut grass stand, cutting was at the end of June and beginning of July (in the phase of heavy flowering of studied plants). Care of crops: harrowing on seedlings (for the destruction of soil cap and weeds), spacing processing,

in subsequent years only early-spring harrowing was carried out.

### III. EXPERIMENTAL

The goal of this research was to study the features of growth and development of perennial vetch species during their introduction. In the course of study, observations were made of the dynamics of height and average daily growth, and of the periods of going through phenological phases. The nature of the distribution of aboveground biomass in vertical profile, the structure of generative shoot, and productivity were determined.

### IV. RESULTS AND DISCUSSION

Three types of vetch were selected as study objects; they differ significantly in their biological and ecological characteristics.

*Vicia sepium* L. (bush vetch, crow pea) is a perennial, rhizomatous plant, 30-60 cm tall, stem slightly branched, erect. Eurasian species, with wide distribution in the European part of Russia, in Western and Eastern Siberia. It can be found on forest edges, near water bodies, along roads, it rises in the mountains up to 2550 m A.S.L. where it can be found in subalpine meadows. In the Middle Urals, bush vetch is widespread in dry meadows, in mixed forests, among shrubs, along field edges. It refers to mesophilic meadow species [9]. It has a high crude protein (25.3%) and digested protein (up to 15.7%) content.

*Vicia sylvatica* L. (wood vetch) is a perennial, rhizomatous plant, 50–200 cm high, stem is thin, climbing, falling. Boreal Eurasian species. It can be found in the forest zone of the European part of Russia, in Siberia. In the Middle Urals, wood vetch is quite widespread in the forest and forest-steppe zones in wooded areas, under the shelterwood of rain mixed forests [1,9]. Outside Russia it can be found in Scandinavia, Central and Atlantic Europe. It grows in mixed and deciduous forests on moist and rich ecotopes. It is classified as mesophilic forest species. Like other legumes, it is a good feed plant. Before flowering phase, *Vicia sylvatica* L. accumulates up to 27.1% of protein. It is eaten by all species of herbivores.

*Vicia megalotropis* Ldb. (Siberian vetch) is a perennial, well leafy plant, 30-80 cm high, stem is weakly falling. Mountain forest species. It is widely distributed in southwestern Siberia, from the Ishim basin to the Angara – on the edges of birch and mixed forests, along forest roads, along grassy slopes. Outside Siberia, this species can be found only in the territory of Central Asia. It is classified as xero-mesophilic species [1]. Among Siberian species, *Vicia megalotropis* Ldb. possesses high feed value.

One of experimental tasks was studying of the dynamics of height and average daily growth of studied vetch species. The height of plants in the conditions of introduction in different years of vegetation differs quite significantly. During the years of research, wood vetch developed the most intensively, it significantly exceeded other species in height. During harvesting period, plant height of studied species was as follows: wood vetch – 107-125 cm; Siberian vetch – 63-71 cm; bush vetch – 56-79 cm. Weather conditions have a great influence on the average daily growth of plants. In the period of

precipitation, the average daily growth of plants increased significantly. The highest increase was observed in wood vetch, it ranged from 2.6 to 3.5 cm per day. Siberian vetch showed lower rates, its average daily growth was significantly lower during all years of study and did not exceed 1.1-1.5 cm per day.

Meadow herbaceous plants differ as regard to the going through phenological phases and the intensity of aboveground biomass growth. In the course of this research, it was established that the earliest growth is characteristic for bush vetch; it started vegetating in the second half of May, 5–7 days earlier than wood vetch and 8–10 days earlier than Siberian vetch. Phenological phases in these plants took place much earlier than those in Siberian vetch. Transition to the generative stage of development in bush and wood vetch was observed in the first decade of June what is 9-12 days earlier than that stage in Siberian vetch.

In the structure of generative shoot, the lowest number of leaves and inflorescences and the maximum share of fruits were obtained in bush vetch. During harvesting period, the share of leaves in the structure of generative shoot of the studied species amounted for (during three years of observations 2008-2010): 36.5-39.1% for bush vetch; 36.4-40.9 for wood vetch; 43.1-46.8% for Siberian vetch. In 2011, the maximum participation of leaves in the structure of generative shoot was obtained in Siberian vetch – 46.1% (Table 1). Siberian vetch was the leader in this parameter during all years of research. During cutting season, Siberian vetch was in the phase of heavy flowering, so the maximum percentage of inflorescences in aboveground biomass was obtained, there were practically no fruit in shoot structure (0.2%), they had no enough time to form.

TABLE I. STRUCTURE OF THE GENERATIVE SHOOT OF PERENNIAL *VICIA* L. SPECIES, 2011

Experimental variants (vetch species)	Units of measurement	Aboveground biomass			
		leaves	inflorescences	stem (shoot)	fruit
1. <i>Vicia sepium</i> L. – control	number, pcs.	42	9	1	10
	weight, g	5.4	2.6	4.2	2.2
	%	37.5	18.0	29.2	15.3
2. <i>Vicia sylvatica</i> L.	number, pcs.	75	12	1	5
	weight, g	10.9	5.2	8.5	4.3
	%	37.7	18.0	29.4	14.9
3. <i>Vicia megalotropis</i> Ldb.	number, pcs.	46	10	1	2
	weight, g	5.6	2.9	3.6	0.5
	%	46.1	24.0	29.7	0.2

In the course of experiment, the features of distribution (stratification – Lat. stratus means layer) of aboveground biomass (Table 2) were studied. It is established that *Vicia megalotropis* Ldb has the highest biomass concentration which was noted in the horizons: 15-30 cm – 23.1%; 30-45 – 24.4%; 45-60 cm – 24.7%. The main part of biomass of *Vicia sylvatica* L. (75%) was located in horizons up to a height of 85 cm, in surface horizon – 2.5%. The highest

biomass concentration is observed in five horizons: 30-45 cm – 15.5%; 45-60 cm – 20.1%; 60-75 cm – 18.9%; 75-90 – 16.2%. *Vicia sepium* L. occupies an intermediate position. In general, all three types of vetch belong to the type of grass stands with a relatively balanced distribution of aboveground biomass along the vertical profile and low concentration of biomass in surface horizon (0-7 cm).

TABLE II. DISTRIBUTION OF ABOVEGROUND BIOMASS OF STUDIED VETCH SPECIES BY VERTICAL PROFILE (%), AVERAGE FOR 2008-2011.

Experimental variants (vetch species)	Aboveground biomass								
	vertical profile (horizons, cm)								
	Parts of plants	0-7	7-15	15-30	30-45	45-60	60-75	75-90	90-105
1. <i>Vicia sepium</i> L. – control	leaves	-	3.7	7.9	11.4	10.9	5.7	-	-
	stems	2.8	5.1	6.3	6.7	7.2	6.8	-	-
	inflorescences	-	-	-	1.6	2.9	1.8	-	-
	fruit	-	-	6.2	5.6	5.2	2.2	-	-
2. <i>Vicia sylvatica</i> L.	leaves	-	2.6	6.3	7.5	9.3	7.8	4.9	2.9
	stems	2.5	3.7	4.2	4.4	5.1	4.3	3.5	1.9
	inflorescences	-	-	-	-	-	3.6	5.2	4.2
	fruit	-	-	-	3.6	5.7	3.2	2.6	1.0
3. <i>Vicia megalotropis</i> Ldb.	leaves	-	7.9	10.7	11.9	11.4	4.4	-	-
	stems	2.3	5.8	7.6	6.4	6.0	1.7	-	-
	inflorescences	-	-	4.8	6.4	7.3	5.4	-	-
	fruit	-	-	-	-	-	-	-	-

The most important criterion of effectiveness during plant introduction is productivity. In our study, the use of grass stand was once-cut, cutting was performed in all variants during the period of heavy flowering of studied species. Results obtained in the course of experiment are

shown in Table 3. Siberian vetch formed a rather thinned grass stand with plant cover, over the years of the study, not exceeding 85-90%; productivity (for 2008-2011) amounted to 11.7 t/ha.

TABLE III. PRODUCTIVITY OF ABOVEGROUND BIOMASS, 2008-2011.

Experimental variants (vetch species)	Herbage								
	Average for 2008-2010			2011			Average for 2008-2011		
	productivity, t/ha	deviation from control, (+,-)		productivity, t/ha	deviation from control, (+,-)		productivity, t/ha	deviation from control, (+,-)	
		t/ha	%		t/ha	%		t/ha	%
1. <i>Vicia sepium</i> L. (control)	15.4	-	-	11.7	-	-	13.6	-	-
2. <i>Vicia sylvatica</i> L.	20.8	+5.4	35.	14.9	+3.2	27.4	17.9	+4.3	31.6
3. <i>Vicia megalotropis</i> Ldb.	13.3	-2.1	13.6	10.1	-1.6	13.7	11.7	-1.9	14.0
Least significant difference <sub>05</sub>	-	-	-	1.2	-	-	-	-	-

Bush vetch showed a high adaptive capacity under cultivation, its productivity, on average over four years of research, was 13.6 t/ha. During harvesting period, the presence of fruits with mature seeds was noted in aboveground biomass.

Consistently high yield of aboveground biomass, during all the years of experiment, was provided by wood vetch. It should be noted that this species is characterized with lodging of grass stand what makes harvesting difficult. Therefore, when planting, in order to eliminate this drawback, it is necessary to add the seeds of supporting culture to the seeds of wood vetch. In the course of studies, it was found that loose bunchgrasses (20-25%), such as, meadow fescue (*Festuca pratensis* L.) or timothy grass (*Phleum pratense* L.), are effective as a supporting culture.

All vetch types formed their maximum productivity in the second year of life, starting from the third year a tendency to its reducing was observed, and winter with

little snow in 2010 had a negative effect. Especially poor winter-hardiness was observed in wood vetch whose productivity decreased by 7.1 t/ha. In 2011, the following was noted: slower growth of plants in spring, decrease in plant cover due to the appearance of plant mortality, and reduction in number of plants in plant communities and, as a result, a significant decrease in the productivity of aboveground biomass.

V. CONCLUSION

This study affords grounds to draw the following conclusions:

*Vicia sepium* L. (bush vetch) and *Vicia sylvatica* L. (wood vetch) belong to the group of early ripening plants, their cultivation will make it possible to obtain green feed in early periods when their deficit is acutely felt.

*Vicia sylvatica* L. developed most intensively, its height was significantly higher than in other species;

average daily growth, during years of research, ranged from 2.6 to 3.5 cm.

During harvesting period, in the structure of generative shoot, the share of leaves was: *Vicia sepium* L. – 36.5-39.1%; *Vicia sylvatica* L. – 36.4-40.9%; *Vicia megalotropis* Ldb. – 43.1-46.8%.

The most productive species was wood vetch which showed consistently high productivity during all the years of observations, an average increase compared to the control plant was 4.3 t/ha (31.6%).

#### REFERENCES

- [1] N.N. Ivanova, A.D. Kapsamun, and D.A. Vagunin. "Cenotic activity of perennial grasses in pasture grass stands on the drained lands of Non-chernozem belt," *Feed production*, No. 5, pp.10-14, 2018.
- [2] A.A. Kutuzova, E.E. Provornaya, and N.S. Tsybenko, "Efficiency of improved technologies for creating pasture grass stands using new varieties of leguminous species and agrotechnical techniques," *Feed production*, No.5, pp.7-11, 2018.
- [3] N.N. Lazarev, V.A. Tyulin, and S.M. Avdeev "Resistance of white clover and variegated alfalfa in hay and pasture grass stands during long-term use," *Feed production*. 2018. No.11. P.4-8.
- [4] A.V. Abramchuk, "Comparative evaluation of perennial species of *Vicia* L. during their introduction," Coll. "Topical issues of vegetable and fruit growing". Anniversary conference. Collection of articles of All-Russian Scientific and Practical Conference 2009. P. 257-265.
- [5] A.V. Abramchuk, "Introduction of pisiform grass pea (*Lathyrus pisiformis* L.)," *Agricultural education and science*, No. 3, pp.1-4, 2013.
- [6] A.V. Abramchuk, "Elements of the introduction of pisiform grass pea," *Collection of articles of International Scientific and Practical Conference of Ural State Agrarian University*, pp. 21-23, 2014.
- [7] A.V. Abramchuk, "Resistance of perennial wild leguminous plants under introduction conditions," *Collection of articles of International Scientific and Practical Conference of Ural State Agrarian University*, pp. 23-25, 2014.
- [8] A.V. Abramchuk, "Content of amino acids in wild plants of the Middle Urals," Coll. "Actual problems of conservation and development of biological resources", *Collected materials of International Scientific and Practical Conference*, pp. 9-12, 2015.
- [9] V.R. Laptev, and A.V. Abramchuk "Wild herbaceous plants," *Ekaterinburg*, 2012, 75 p.
- [10] A.V. Abramchuk, G.G., Kartasheva, K.S., Mingalyov, and M.Yu. Karpuhin, "Medicinal flora of the Urals," *Textbook for students of agronomic specialties, Ekaterinburg*, 2014, 738 p.