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Research Article

Agro-Environmental Justification of Meadow Clover Yield Development

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ABSTRACT:

The paper compares the ecological plasticity and the adaptability of late-ripening and early ripening varieties of meadow clover cultivated for fodder. The analysis of the yield data showed that the late ripening Perm local variety and the early ripening varieties Trio and Kudesnik are equivalent in terms of yield and ecological plasticity. It has been established that weather conditions and, to a lesser extent, genetic features of varieties, largely affect the yield of meadow clover.

According to the set of indicators, Kudesnik variety is the most adaptable for the Middle Urals conditions during the cultivation of fodder.

Keywords: meadow clover, early ripening, late ripening, yield, plasticity, adaptability

INTRODUCTION:

Soil fertility varies in space; the meteorological conditions vary significantly over time. This determines the need to develop the adaptive technologies to cultivate field crops for a particular landscape [4, 5]. The most important component of these technologies is the selection of varieties with high productivity and biological resistance in these conditions [6, 8].

The observation of agricultural technology for the cultivation of meadow clover, which is based on the biology of the culture provides 8-10 t/ha of dry matter [1, 7, 10].

The aim of our research is the comparative assessment of late-ripening and early-ripening varieties of meadow clover during its cultivation for fodder in the Middle Urals. Research objectives: to assess the ecological plasticity and the stability over time among the varieties of meadow clover according to the yield data.

Research methods. Research objects: the varieties of meadow clover allowed for cultivation in the Perm region: Perm local, late-ripening, diploid; Trio, early ripening, diploid; Kudesnik, early ripening, tetraploid.

In order to establish the relationship between the yield of meadow clover and abiotic conditions, they used the results of research obtained at the experimental field of FSBI HE Perm SATU, Inspection materials for the Perm Territory - the branch of the FSBI "RF State Commission for Cultivation Achievement Testing and Protection". The significance of differences between the yield of the studied varieties was carried out according to the method described by B.A. Dospekhov [3]. The ecological plasticity of varieties was compared according to the method proposed by S.A. Eberhart and W.A. Russell [9]. The coefficient of environmental stabil-

ity (CES) was calculated according to D.Zevis presented by A.A. Goncharenko [2].

Research results. Analysis of data for 2000-2011 shows that the yield of meadow clover at agricultural enterprises of the Perm Territory is lower by 3-4 times than in the conditions of the university experimental field and in the state variety-testing plots (VTP) of the Perm Territory. Low implementation of crop productivity potential in production may be conditioned by lower soil fertility, the non-compliance with its cultivation technology and the use of varieties with low adaptability.

In order to identify the adaptive potential of varieties recommended for cultivation, it is necessary to evaluate their response to agrometeorological conditions during the years of research. It has been established that the change in heat and moisture supply over the years of use and in the context of meadow clover mowings affects the passage of cultural development phenological phases. The development of clover varieties and the formation of their cutter mass occurs in contrasting conditions of moisture, both by years of use and by cutting.

During the first year of use (I y.u.) and the first cut, the minimum values of the hydrothermal coefficient were mostly noted during the "regrowth - branching" period, but this was not critical for the development of clover varieties, since they used the moisture reserves of the winter-spring period. Most often, a single-cut variety, during the period of maximum accumulation of the vegetative mass "branching - budding", fell into more moistened conditions than the two-cut ones. And vice versa, the period of "budding - flowering" of two cut varieties was accompanied by an abundant precipitation. The second mowing of two-cut varieties, especially during the "branching - budding" period, was formed more often during the lack of precipitation.

The average long-term data show that two-cut varieties fell into more moistened conditions during the growing seasons as compared to the single-cut variety.

The calculations of the linear correlation coefficient between dry matter yield and agrometeorological conditions showed the differences by grade (table 1).

1. The coefficients of linear correlation between dry matter yield and the agrometeorological conditions by development periods of meadow clover varieties

Vegetation period	Variety								
	Perm local[1]			Trio[1]			Kudesnik[2]		
	Period duration, days	The sum of active temperatures, ^{O}C	Precipitation amount, mm	Period duration, days	The sum of active temperatures, ^{O}C	Precipitation amount, mm	Period duration, days	The sum of active temperatures, ^{O}C	Precipitation amount, mm
First year of use, first cut									
Regrowth - branching	-0,26	-0,35	-0,50	-0,38	-0,44	-0,12	-0,64	-0,56	-0,90
Branching - budding	-0,11	-0,16	0,44	-0,20	-0,26	-0,11	0,19	0,10	0,68
Budding - flowering	0,21	0,46	-0,01	0,69	0,44	0,28	0,48	0,15	0,67
Regrowth - flowering	-0,44	-0,41	0,08	-0,39	-0,48	0,22	-0,35	-0,79	0,59
First year of use, second cut									
Regrowth - branching	0,15	0,05	0,34	0,00	-0,08	0,45	-0,25	-0,26	0,96
Branching - budding	0,14	0,10	0,45	-0,12	-0,32	0,10	-0,06	-0,36	-0,33
Budding - flowering	–	–	–	0,11	0,19	-0,68	-0,04	-0,06	-0,74
Regrowth - flowering	–	–	–	0,00	-0,14	0,16	-0,17	-0,31	0,56

Note: 1. Average for 2000, 2001, 2004, 2005, 2007-2011.

2. Average for 2008-2011.

During the first year of use, in the first crop, the average closeness of communication during the period of "branching - budding" was found in the Kudesnik variety from precipitation amount, the moderate one was revealed among the Perm local variety. During the period of "budding - flowering" they determined the moderate dependence (r = 0.46 and 0.44) on the sum of active temperatures among the diploid varieties Perm local and Trio, and the tetraploid variety Kudesnik had the average relationship (r = 0.67) with the precipitation amount. They also noted the tendency of relation closeness increase with the reduction of "budding - flowering" period duration among two-cut varieties. During the second crop, the yield depended more on the amount of precipitation (r = 0.38). Also, they preserved a strong dependence of yield on the amount of precipitation among the Kudesnik variety, but only during the period "regrowth - branching".

Thus, it can be noted that the formation of the first crop of diploid varieties depends more on the sum of active temperatures, and tetraploid variety first crop formation depends on the amount of precipitation. The growth and the formation of the second cut of clover varieties depends more on the amount of precipitation.

The differences in agrometeorological conditions over the years allow us to evaluate the varieties under study according by their ecological plasticity, stability and adaptability. The performed two-factor (A - years, B - varieties) dispersion analysis of meadow clover yield data showed that the varieties under consideration are comparable in yield ($F_f < F_{05}$) in the Middle Urals of the Perm Territory. Moreover, the contribution of the "year" factor was the leading one (73-97%), and the share of the "grade" factor contribution and the interaction "year x grade" was insignificant during all years (1-20%). This indicates the need to use the most adapted varieties.

2000, 2001 and 2011 were the most favorable for the development of forage productivity of meadow clover varieties Perm local and Trio (Table 2). Less favorable conditions were developed in 2008–2010, and the extremely dry year 2010 was particularly notable.

The strong influence of ecological conditions on the studied varieties during the years of research is confirmed by the value of environmental condition index (Ij). Its lowest value during the formation of dry matter yields was observed in the conditions of 2010 (Ij = -4.8), and the highest one in 2001 and 2011 (Ij = 2.7).

2. The yield of meadow clover varieties during the Ist y.u., t/ha of dry matter

Variety	Year									Average by variety
	2000	2001	2004	2005	2007	2008	2009	2010	2011	
Perm local	10,7	10,2	7,6	7,8	7,9	6,0	4,8	2,3	10,8	7,6
Trio	9,1	9,9	7,4	7,6	8,4	5,9	4,1	2,9	9,4	7,2
Average by year	9,9	10,1	7,5	7,7	8,2	6,0	4,5	2,6	10,1	7,4
Environment index	2,5	2,7	0,1	0,3	0,8	-1,4	-2,9	-4,8	2,7	

Note: $F\phi<F_{05}$ on the average

Thus, the analysis of dry matter yield data in nine years (2) shows that the analyzed varieties of meadow clover form the same yield in the first year of use ($F_f < F_{05}$).

According to the results of nine and four years of research, they revealed a strong variability of dry matter yield was found among the studied varieties, as evidenced by its significant run between the maximum and minimum levels, which were 8.5 t/ha among Perm local, or by 1-1.5 t/ha more than Trio and 0.6 t/ha more than Kudesnik (table 3). The maximum yield variability characteristic of the single-cut Perm local variety is confirmed by the calculation of variation coefficient, the minimum for the Trio double-cut variety, the intermediate position is occupied by the Kudesnik double-cut variety. The higher stability of the Trio variety yield in the Perm region is confirmed by the calculation of environmental plasticity ratio and environmental sustainability, which were the lowest and amounted to 0.9 and 2.2.

According to the ability to form higher yields in favorable agro-ecological conditions, they distinguish the variety Perm local, its coefficient of ecological plasticity was 1.1 against 0.9 for Trio and 1.0 for Kudesnik. That is, the single-cut Perm local variety (bi > 1) is more plastic and more responsive to the improvement of cultivation conditions. The two-cut variety Kudesnik showed the full correspondence of yield change to the cultivation condition change (bi = 1), which indicates its adaptability, and the Trio variety responds poorly to the change of conditions.

3. Meadow clover variety ecological plasticity and adaptability, Ist y.u.

Indicator	Average in 9 years[1]		Average in 4 years[2]		
	Perm local	Trio	Perm local	Trio	Kudesnik
Productivity, t/ha of dry matter	7,6	7,2	6,0	5,6	6,4
Yield fluctuations (min - max), t/ha of dry matter	2,3-10,8	2,9-9,9	2,3-10,8	2,9-9,4	2,7-10,6
Yield range, t/ha of dry matter	8,5	7,0	8,5	6,5	7,9
Variation ratio, % (V)	38	34	60	51	54
Environmental plasticity ratio (bi)	1,1	0,9	1,1	0,9	1,0
Environmental sustainability coefficient (ESC)	2,4	2,2	2,3	2,2	2,5
Genetic flexibility, t / ha (YY)	6,6	6,4	6,6	6,2	6,7
Adaptability ratio (Ka)	1,0	1,0	1,0	1,0	1,0
Intensity factor (Ki)	1,1	0,9	1,0	0,9	1,1

Note: 1. Average for 2000, 2001, 2004, 2005, 2007, 2008-2011.

2. Average for 2008-2011.

The highest genetic flexibility (GG = 6.7) is the evidence of the Kudesnik variety high adaptability, the Perm local (GG = 6.6) is of close value and the Trio is inferior to them (GG = 6.2-6.4).

According to the ability of fodder yield development in adverse conditions, the varieties are comparable, their adaptability coefficient is 1.0.

The single-cut clover of the Perm local variety turned out to be more intensive and able to generate higher yields in favorable years as compared to the double-cut Trio variety. But on the average, over four years of research, the intensity coefficient of the Perm local variety was 1.0 and was 0.1 less than that of the Kudesnik two cut varieties.

CONCLUSIONS.

Thus, in the Middle Ural region, the abiotic conditions make the greatest influence on the formation of dry clover mass yield. The change in the yield of the forage mass among varieties is determined by genetic characteristics only within 1–20%. There were no significant differences in yield between the single-cut Perm local variety and the double-cut varieties of meadow clover Trio and Kudesnik ($F_f < F_{05}$). A strong yield variability was established depending on the external conditions, which is confirmed by the environmental index value. For most integrated assessment indicators, the Kudesnik variety is the most adaptive one.

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