UDC 633.32
Original scientific paper

RELATIONSHIPS BETWEEN GREEN FORAGE AND SEED YIELD COMPONENTS IN GENOTYPES OF RED CLOVER (*TRIFOLIUM PRATENSE* L.)

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Vasiljević S., G. Šurlan-Momirović, S. Katić, V. Mihailović, D. Lukić, and T. Živanović (2000): *Relationships between green forage and seed yield components in genotypes of red clover (Trifolium pratense L.).* – Genetika, Vol. 32, No. 1, 37-43.

Analyses of variance and covariance for green forage and seed yield components have been used to calculate the coefficients of genetic and phenotypic correlations in certain varieties and populations of red clover. The intention was to establish the existence of relationships among these characteristics. The study included 17 varieties and 16 populations of red clover in the second year of cultivation. Samples (30 plants per genotype) for the analysis of green forage yield components were taken at the stage of flowering of primary inflorescences from plants from the first cutting. Thirty randomly selected plants, *i.e.*, 150 inflorescences per variety or population, from the first cutting in the second year were sampled for analysis of the following characteristics: number of productive stems per plant, number of inflorescences per plant, number of florets per inflorescence, number of seeds per inflorescence and seed yield per plant.

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Key words: red clover (*Trifolium pratense* L.), variety, population, green forage and seed yield components, coefficients of genetic and phenotypic correlation

INTRODUCTION

Because of the physiological self-sterility and flower anatomy, the red clover (*Trifolium pratense* L.) is pronouncedly an open-pollinated entomophilous plant species. Pollinating insects must be present to ensure successful seed production. Moreover, some green forage and seed yield components are particularly important for successful seed production.

According to TAYLOR (1996), seed producers hesitate to engage in red clover seed production because of low yields, even when forage yields are high. A way to increase red clover seed yields is by breeding. In Russia, as reported by VORONČIHINA *et al.* (1985), breeding for high seed yield has been the focus of breeding programs for a long time.

Phenotypic and genetic correlations among the numerous quantitative characteristics are determined regularly in plant breeding, to be able to define breeding targets more precisely. It implies systematic analysis of correlations among green forage and seed yield components.

MATERIAL AND METHODS

The research included 17 varieties and 16 populations of red clover of different geographic origin (Table 1).

The experiments were conducted on the Rimski Šančevi experiment field of the Institute of Field and Vegetable Crops, in 1996-1997. In 1996, the experiment was set up the system of random blocks in three replicates. The basic plot size was 4 m^2 (0.8 m x 5 m). The planting was done in hills (80 x 20 cm) with two rows per plot. After emergence, in May, the stands were thinned to one plant per hill. Conventional practices and crop protection against pests and weeds were used.

The following green forage and dry matter yield components were determined in plants from the first cutting in the first year: plant stature (cm), number of internodes per stem, leaf area (cm^2) and the yield of green bulk per plant (g/plant). Samples were taken at the stage of flowering of the primary inflorescences of individual plants.

Plant stature (cm) was established by measuring 5-10 normally developed stems per plant.

Leaf area (cm^2) was calculated by the method of ALEKSEYENKO (cit. SARIĆ *et al.*, 1967): 1 g of fresh matter of red clover leaves = 77.1 cm^2

The following seed yield components were determined in plants from the first cutting in the second year: number of productive stems, number of inflorescences per plant, number of florets per inflorescence, number of seeds per inflorescence and seed yield per plant (g/plant). Seed yield components were analyzed at the time of full maturity of the primary inflorescences (80-90 % of the inflorescences are dark brown).

Table I. Analyzed red clover genotypes, ploidy level and country of origin

GENOTYPE	PLOIDY LEVEL	COUNTRY OF ORIGIN
Sk - 1	2n	FR Yugoslavia
Sk - 2	2n	FR Yugoslavia
Sk - 3	2n	FR Yugoslavia
Sk - 4	2n	FR Yugoslavia
Sk - 5	2n	FR Yugoslavia
Sk - 17	2n	FR Yugoslavia
Sk (I-V)	2n	FR Yugoslavia
M-7	2n	FR Yugoslavia
M-10	2n	FR Yugoslavia
M-11	2n	FR Yugoslavia
M-12	2n	FR Yugoslavia
M-13	2n	FR Yugoslavia
M-14	2n	FR Yugoslavia
Vlaška	2n	FR Yugoslavia
Orašak I	2n	FR Yugoslavia
Orašak II	2n	FR Yugoslavia
K - 9	2n	FR Yugoslavia
K -17	2n	FR Yugoslavia
BL -1	2n	Republika Srpska
BL - 3	2n	Republika Srpska
BL - 4	2n	Republika Srpska
BL - 5	2n	Republika Srpska
Kolubara	2n	FR Yugoslavia
Bosa	2n	FR Yugoslavia
Viola	2n	Poland
Start	2n	Czech Republic
Krasna	2n	Belarus
Diana	2n	Hungary
Junior GKT	2n	Hungary
Tetra 1	4n	Hungary
Tetra 2	4n	Hungary
GKT (4n)	4n	Hungary
Hungariatetra	4n	Hungary

The numbers of productive stems and inflorescences per plant were measured in 30 plants per genotype.

The average numbers of flowers and seeds per inflorescence were calculated after counting their respective numbers in 10 inflorescences per plant. Flowers and seeds were separated with a pair of pincers and counted.

Seed yield per plant (g) was determined after harvest of individual plants.

BIOMETRICAL METHODS

Analysis of variance of the studied characteristics was made according to the random block model (Table 2).

Table 2 ANOYA

Source of variation	Degrees of freedom	Sum of Squares	Mean of squares (MS)
Block	$(b - 1)$	Q_b	$MS_3\ Q_b / (b-1)$
Genotype	$(g - 1)$	Q_g	$MS_2\ Q_g / (g-1)$
Error	$(b - 1)(g - 1)$	Q_p	$MS_1\ Q_p / [(b-1)(g-1)]$
Total	$bg - 1$	Q	

The components of variance were calculated according to the following formulae:

σ^2_g-$(MS_2 - MS_1)/b$

$\sigma^2_f - \sigma^2_g + \sigma^2_p /b$

where

σ^2_g - genetic variance

σ^2_f - phenotypic variance

σ^2_p - experimental error variance

MS_2 - mean of squares for the genotype

MS_1- mean of squares for the experimental error

b - replication

Parameters from the analysis of variance and covariance were used to calculate the coefficients of genetic and phenotypic correlations between different characteristics of the red clover varieties and populations studied. Associations between the characteristics were established on the basis of the correlation coefficients. Correlation coefficients and standard errors were calculated by the formula:

$r_{ixy} - COV_{xy}/ (\sigma^2_x \cdot \sigma^2_y)1/2$ i - genetic (r_g) and phenotypic (r_f) correlation

COV_{xy} - covariance

$SE\ r_{ixy} = 1 - r^2_{ixy}/ 2^{1/2}$ $SE\ r_{ixy}$ - standard error

RESULTS AND DISCUSSION

The higher values of genetic coefficients than phenotypic coefficients indicate that environmental effects are significant (Table 3).

The coefficients of genetic correlations show that the level of seed yield per plant depended primarily on the number of florets per inflorescence (r_g = 1.000*), number of seeds per inflorescence (r_g = 0.796*) and the number of productive stems (r_g = 0.755*). The order of the coefficients of phenotypic correlations shows that the seed yield per plant depended on the number of inflorescences per plant (r_f = 0.592), number of seeds per inflorescence (r_f = 0.572) and the number of productive stems (r_f = 0.398). Highly significant positive correlations were found between the number of florets per inflorescence and the number of seeds per inflorescence (r_g = 1.000*), the number of inflorescences per plant and the number of florets per inflorescence (r_g = 1.000*) and the number of productive stems and the number of inflorescences per plant (r_g = 1.000*).

Considering the components of the yield of green mass (Table 3), significant positive correlations existed between leaf area on one side and plant stature and the number of internodes on the other, r_g = 0.808* and r_g = 1.000*, respectively.

It was interesting to note a strong relationship between leaf area and the yield of green bulk. The significant positive values of the genetic and phenotypic correlation coefficients, which were similar, indicate the small influence of the environment.

For practical purposes, the relationships among the components of the yield of green bulk and the components of yield of seed are most interesting. Significant positive genetic correlations were found between the number of inflorescences per plant on one side and the number of internodes per plant and the yield of green mass per plant on the other (Table 3).

The observed negative relationship between the yields of green mass and seed (r_g = -0.122) is detrimental for simultaneous selection for increased yield (Table 3).

Examining the relationships among the agronomically important characteristics of individual plants of a late red clover variety (Sivorickij 416), MUHINA (1978) found that plant stature in the first year was negatively correlated with the yield of green bulk in the second year and the yield of seed in the third year, r = -0.93 and r = -0.60, respectively.

Studying genetic correlation coefficients, JARANOWSKI (1986) concluded that the yield of seeds per plant in the tetraploid red clover depends in the first place on the number of inflorescences per plant, number of productive stems and the mass of 1000 seeds.

TAYLOR (1996) considers the number of inflorescences the most important component of seed yield, more important than the number of seeds per inflorescence. SMOLIKOVA *et al.* (1987) reported intermediate positive correlations between the yields of forage and seed in diploid and tetraploid varieties of red clover.

CONCLUSION

Genetic correlations for the examined characteristics had higher values than the corresponding phenotypic correlations, indicating the importance of environmental effects.

The positive and highly significant coefficients of genetic correlation indicate that the seed yield per plant depended predominantly on the number of florets per inflorescence, number of seeds per inflorescence and the number of productive stems.

Leaf area was highly significantly correlated with plant stature and the number of internodes.

The high and mutually similar values of the genetic and phenotypic correlation coefficients obtained for leaf area and the yield of green bulk indicate a small influence of environmental factors.

There existed positive and significantly high genetic correlations between the number of inflorescences per stem on one side and the number of internodes and the yield of green bulk on the other. This may be useful in breeding for increased yields of forage and seed.

The yield of green bulk was negatively correlated with seed yield.

Received March 27th, 2000
Accepted June 15th, 2000

REFERENCES

JARANOWSKI J. and Z. BRODA (1986): Hodowla tetraploidalnej koniezyny ezerwonej w kierunku zwiekszenia plenosci nasion."Rocz. AR Poznaniu. Rol.", *31*, 89-96.

MUHINA N. A. and E. I. ŠESTIPEROVA (1978): Klever. - Lenjingrad.

SARIĆ M., R. KASTORI, R. ĆURIĆ, T. ĆUPINA, and I. GERIĆ (1967): Praktikum iz fiziologije biljaka, str 25. Naučna knjiga, Beograd.

SMOLIKOVA M., J. KAILEROVA, and B. NEDBOLKOVA (1987): Correlation between fodder and seed traits in genotypes of red clover. Sbornik Vedeckyeh Praci Vyzkumneho a Slechtitelskeho Ustavu Picninarskeho v Troubsku u Brna. *10*: 83-92.

TAYLOR N. L. and K. H. QUESENBERRY (1996): Red Clover Science (Current Plant Sciences and Biology in Agriculture, vol 28).

VASILJEVIĆ S, G. ŠURLAN-MOMIROVIĆ, D. LUKIĆ, S. KATIĆ, and T. ŽIVANOVIĆ (1998). Interpendence of seed yield components in varieties and populations of red clover (*Trifolium pratense* L.), Proeeedings of 2nd Balkan Symposium on Field Crops. Novi Sad, Yugoslavia (16-20 June, 1998).vol. *1*, 449-452.

VORONČIHINA A. P. and L. M. ČETVERTNYH (1985): Sozdanie ishodnogo materiala dlja selekcii klevera lugovogo na semennuju produktivnost'. "Sozdanie nov. sortov mnogolet. trav i tehnol. ih vozdel. na sev.-zap. RSFSR".L., 48-51.

MEĐUZAVISNOST KOMPONENTI PRINOSA ZELENE MASE I SEMENA GENOTIPOVA CRVENE DETELINE (*TRIFOLIUM PRATENSE* L.)

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Izvod

Crvena detelina (*Trifolium pratense* L.) je zbog fiziološke autosterilnosti i građe cveta izrazito stranooplodna, entomofilna biljna vrsta. Analizom varijanse i kovarijanse komponenti prinosa zelene mase i semena kod ispitivanih sorti i populacija crvene deteline izračunati su koeficijenti genetičke i fenotipske korelacije. Posmatrajući vrednosti korelacionih koeficijenata može se zapaziti da su one veće za genetičke nego za fenotipske koralacije, što ukazuje da je uticaj faktora spoljašnje sredine na te odnose značajan. Koeficijenti genetičke korelacije pokazuju da je prinos semena po biljci najviše zavisio od broja cvetova po cvasti (r_g = 1,000*); broja semena po cvasti (r_g = 0,796*) i broja produktivnih stabljika (r_g = 0,755*). Posmatrajući komponente prinosa zelene mase mogu se uočiti pozitivne, statistički značajne genetičke korelacije između lisne površine i visine biljke (r_g = 0,808*), odnosno broja internodija (r_g = 1,000*). Za praksu je svakako najinteresantnije ispitati stepen međuzavisnosti komponenti prinosa zelene mase, s jedne strane i komponenti prinosa semena, s druge strane. Može se zapaziti da izmedu broja cvasti po biljci i broja internodija po stabljici, odnosno prinosa zelene mase po biljci postoje pozitivne i signifikantne genetičke korelacije. Negativna međuzavisnost (r_g = -0,122) izmedu prinosa zelene materije i semena predstavlja teškoću pri selekciji na povećan prinos.

Primljeno 27. III 2000.
Odobreno 15. VI 2000.