Optimization of the Dry Matter Production Based on the Percentage Participation of Italian Ryegrass in Mixtures with Crimson Clover

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Abstract. Annual forage mixtures are forage crops consisting of forage grasses (e.g. Italian ryegrass etc.) and annual clovers (e.g. Berseem clover, Crimson clover etc.) or mixtures of spring or autumn vetch with grain cereal (e.g. oats, barley, etc.) that are known as spring or autumn mash. The goal of this paper is to find the functional dependency of the average dry matter production of the Italian ryegrass (in the 67th phenophase) and Crimson clover mixture based on their different percentage participation in order to obtain the technical optimum in two variant of fertilization (N0P0K0 and N100P50K50). For this, we studied Italian ryegrass (I.r.) and Crimson clover (C.c.), both in pure and mixed culture, in the following proportions: I.r.75%+C.c.25%, I.r.50%+C.c.50%, I.r.25%+C.c.75%. In this paper we take in consideration the average dry matter production obtained in the experimental years 2007 – 2011 that allow us to have a few conclusions on the Italian ryegrass production capacity but also about the adaptation capacity of Crimson clover in Banat plain conditions. Results show that in the fertilized variant, there is an increasing of the percentage participation of Italian ryegrass in mixtures for which the maximum of dry matter production is realized than in the case of unfertilized variant, which shows that Italian ryegrass has a better response to chemical fertilizers than Crimson clover.

Keywords: Italian ryegrass, Crimson clover, mixture, production, optimization.

INTRODUCTION

In order to increase the yields of the fodder plants is necessary an open and positive attitude towards intensive technologies and in the same time „environmental friendly” (Cojocariu et al. 2010).

One of the most important technological solutions is growing in mixture of grasses and legumes, with or without a minimum contribution of chemical fertilizers.

Beef and dairy cattle producers require a consistent supply of high-quality forage to maintain economical levels of animal production. Beef and dairy cattle producers in the southeastern USA rely primarily on annual ryegrass to meet their pasture needs for winter and spring (Daren D. Redfearn et al. 2002).

Annual legumes including arrowleaf (Trifolium vesuclulosum), crimson (Trifolium incarnatum) and berseem (Trifolium alexandrinum) clovers may be grown for forage and incorporating in soil, also Westerwolds ryegrass (Lolium multiflorum) is a fast growing annual grass which has a season long production from early summer to late fall (Boswall P. 2004).

The principal benefits of intercalating Italian ryegrass with annual clover are: conduct to the increase of total dry matter production and forage quality, improves the soil quality,
also are assured increased productions for successive cultures (Cojocariu L. et all 2008, Marian F. et all 2009).

Annual forage mixtures are forage crops consisting of forage grasses (e.g. Italian Ryegrass etc.), of annual clovers (e.g. Berseem clover, Crimson clover etc.) or mixtures of spring or autumn vetch with grain cereal (e.g. oats, barley, etc.) that are known as spring or autumn mash. These cultures have a shorter use, which makes them able to get in rotation with other forage plants.

Establishing the rapport of seeding between the components of a binary mixture, of fodder plants presents a particular importance, because it determines the operating mode and fertilization of culture (Marian F. at all 2011).

MATERIALS AND METHODS

The experiences were settled at The Experimental Didactic Station of The University of Agricultural Sciences and Veterinary Medicine of Banat, Timisoara.

The settlement area is on the West Plane of Romania and the soil on witch the experiences have been placed is chambic chernozem.

After Koppen, the perimeter’s climate is situated in a c.f.b.x. region, characterised by a temperate climate with precipitations all over the year, but with humidity deficit in the summer months.

As biological material we used Wesley variety of Italian ryegrass and Tardivo variety of Crimson clover.

We studied Italian ryegrass (I.r.) and Crimson clover (C.c.), both in pure and mixed culture, in the following proportions: I.r.75%+C.c.25%, I.r.50%+C.c.50%, I.r.25%+C.c.75%.

Another studied experimental factor was the fertilization. We studied the dry matter production dynamics of the mixtures in both variants, unfertilised and chemical fertilised (N_{100}P_{50}K_{50}).

In this paper we take in consideration the average dry matter production obtained in the experimental years 2007 – 2011 that allow us to have a few conclusions on the Italian ryegrass production capacity but also about the adaptation capacity of Crimson clover in Banat plain conditions.

In order to determine the dry matter production of mixture, the harvesting was done at 67^{th} phenophase (Flowering finishing: majority of petals fallen or dry) of Italian ryegrass (code BBCH - grasses - U. Meier, 2001).

The statistical analysis has been performed by Statistica 8 package.

The mathematical model used in this paper which expresses such relations between the two variables (namely fertilizer amount denoted by x and production volume denoted by y) is constituted by the function

\[ y = c + bx + ax^2, \text{ } a \neq 0, \]

which shows that the production is a quadratic function of x.

The graphical representation of this function is a parabola, which shows the technical maximum in the flexion point. After this maximal point, appears a gradual decrease of the effect exercised by the supplementary doses of fertilizers (Petersen R. G.,1994, Mead R. et all., 2002).
RESULTS AND DISCUSSION

The analysis of the experimental results recorded at Timisoara (2007-2011) highlights a quadratic functional dependency of the dry matter production on the proportion of the Italian Ryegrass and Crimson clover in mixture.

The goal of this paper is to find the functional dependency of the average dry matter production of an Italian ryegrass (in the 67th phenophase) and Crimson clover mixture based on their different percentage participation in order to obtain the technical optimum in two variant of fertilization.

The following statistical analysis established the technical maximum of dry matter production of Italian ryegrass and Crimson clover mixtures, in the unfertilized case.

A parabolic regression analysis of the average dry matter production of the unfertilized mixture based on the percentage participation of Italian ryegrass [Flowering finishing: (principal growth stage six from BBCH)] in mixture was performed (see Fig. 1).

It was determined that the proportion of variance was statistically significant for p under 0,05 (95% confidence interval), where the F ratio provided the test of statistically significance (see Tab. 1).

<table>
<thead>
<tr>
<th>Tab. 1</th>
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<tr>
<td><strong>ANOVA for regression coefficients of dry matter production based on the percentage participation of Italian ryegrass in unfertilized variant</strong></td>
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<tr>
<td><strong>SS</strong></td>
</tr>
<tr>
<td>Intercept</td>
</tr>
<tr>
<td>Italian ryegrass in mixture</td>
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<tr>
<td>Italian ryegrass in mixture^2</td>
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<tr>
<td>Error</td>
</tr>
</tbody>
</table>

The regression equation \( y=b_0+b_1x+b_2x^2 \) was used to fit the best parabolic line to the data (see Fig. 1).

Thus the average dry matter production obtained under the above circumstances in the experimental years was expressed in terms of the percentage participation of Italian ryegrass in mixture by the equation:

\[
y = 3,0874+0,0536\times x-0,0004\times x^2.
\]

The positive linear correlation, after the linearization, was reported by the Pearson coefficient \( r=+0,93 \) and determination coefficient \( r^2=0,86 \). The confidence intervals for the parabolic regression coefficients were \([1,601532, 4,573325], [-0,016841, 0,123972] \) and \([-0,001098, 0,000252] \) respectively.

The maximum dry matter production was estimated to 4,88 t.ha\(^{-1}\) for 67 % Italian ryegrass and 33% Crimson clover in mixture.
This maximum (see Fig. 1) was obtained as the local extremum of the quadratic function above and it was calculated by the vanishing of its first derivative.

\[
D.M.(N0) = 3,0874 + 0,0536 \cdot x - 0,0004 \cdot x^2
\]

\[
D.M.(N100) = 3,9434 + 0,0508 \cdot x - 0,0003 \cdot x^2
\]

Fig. 1. The effect of the different proportion of Italian ryegrass in unfertilized and fertilized mixture on the dry matter production

Under chemical fertilization applied to pure stand and mixtures, a parabolic regression analysis was performed (see Tab. 2) in the following.

It was determined that the proportion of variance was statistically significant for p value under 0,05 (95% confidence interval), where the F ratio provided the test of statistically significance (see Tab. 2).

The average dry matter production obtained under the above circumstances in the experimental years was expressed in terms of the percentage participation of Italian ryegrass in mixture by the equation:

\[
y = 3,9434 + 0,0508 \cdot x - 0,0003 \cdot x^2.
\]

The strong positive linear correlation, after the linearization, was reported by the Pearson coefficient \( r = +0,94 \) and determination coefficient \( r^2 = 0,89 \). The confidence intervals for the parabolic regression coefficients were \([2,372563; 5,514294], [-0,023587; 0,125278]\) and \([-0,001041; 0,000387]\) respectively.
The maximum dry matter production was estimated to 6.09 t.ha\(^{-1}\) for 84.66% Italian Ryegrass and 15.34% Crimson clover in mixture.

This maximum (see Fig. 1) was obtained as the local extremum of the quadratic function above and it was calculated by the vanishing of its first derivative.

Tab. 2

| ANOVA for regression coefficients of dry matter production based on the percentage participation of Italian ryegrass in fertilized variant |
|---|---|---|---|---|
| SS | Degr. of - Freedom | MS | F | p |
| Intercept | 17,55716 | 1 | 17,55716 | 116,6655 | 0,008463 |
| Italian ryegrass in mixture | 1,30007 | 1 | 1,30007 | 8,6388 | 0,098884 |
| Italian ryegrass in mixture\(^2\) | 0,58426 | 1 | 0,58426 | 3,8823 | 0,187597 |
| Error | 0,30098 | 2 | | 0,15049 |

We can remark an increasing dry matter production from unfertilized variant, which shows that Italian ryegrass has a very good response to fertilization with chemical fertilizers. Also we can remark an increasing dry matter production for the fertilized variant than for the unfertilized variant.

In the fertilized variant, there is an increasing of the percentage participation of Italian ryegrass in mixtures for which the maximum of dry matter production is realized than in the case of unfertilized variant, which shows that Italian ryegrass has a better response to chemical fertilizers than Crimson clover.

CONCLUSIONS

By this study we obtained mathematical models (quadratic functions) for the average dry matter production of mixture depending on the percentage participation of Italian ryegrass (Flowering finishing) and Crimson clover.

Based on these mathematical models we estimated the technical maximum for the dry matter production of mixtures.

Thus the dry matter production on pure stand and on different percentage participation of Italian ryegrass and Crimson clover in mixture, can be resumed as follows:

- In the unfertilized case, the maximum dry matter production was estimated to 4.88 t.ha\(^{-1}\) for 67% Italian Ryegrass and 33% Crimson clover in mixture;
- In the fertilized case, the maximum dry matter production was estimated to 6.09 t.ha\(^{-1}\) for 84.66% Italian Ryegrass and 15.34% Crimson clover;
- In the fertilized variant, there is an increasing of the percentage participation of Italian ryegrass in mixtures for which the maximum of dry matter production is
realized than in the case of unfertilized variant, which shows that Italian ryegrass has a better response to chemical fertilizers than Crimson clover.

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