Rapeseed productivity in mixed crops of Tuva

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Abstract. In the steppe zone, the productivity of spring rape for green fodder was studied in single-species and poly-species crops with annual bluegrass and leguminous crops. It was established that single-species crops have high productivity; but they are characterized by low adaptive ability. Thus, their productivity in the steppe zone of Tuva depends on weather conditions. It was determined that in the crops of spring rape with peas, reliable increases in the yield of green mass were obtained. The economic efficiency of spring rape cultivation in two-component crops on the territory of Tuva republic is determined.

1. Introduction

Eastern Siberia covers an area of 4,122.8 thousand km² or 80.6% of the entire territory of the Siberian Federal District of Russia. The Republic of Tuva is included in this largest region of the country. The occupied area is 168.6 thousand km² [1]. Mountains dominate in the territory (82%), and the flat sections of hollows and intermountain valleys occupy about 18%. The most pronounced feature of the climate is extracontinental and cryoric [2]. Cold, snowless winters, hot summers, low rainfall, and a large amplitude of absolute and daily temperatures are characteristic features of the republic’s climate. Tuva is located in the risky farming zone, which directly affects the development of the agricultural sector.

The traditional livestock industry in the republic is sheep breeding. In 1991, the socio-economic conditions in the country changed, which also affected farming in the region. Currently, most animals are kept in private farms and in the private sector, where livestock are mainly kept year-round in the same place. In this regard, pasture degradation processes are observed.

The main reason for the low productivity of natural pastures in the republic is their unsystematic use. As a result of excessive, intensive cattle grazing, there is a decrease in pasture productivity and the nutritional value of grassland, and in some places - destruction of pasture lands. Therefore, natural pastures with their low productivity practically cannot provide for the increasing animal feed requirements. Therefore, in the strengthening of the forage base, the role of field fodder production is growing [3].

At the present stage, field fodder production in many farms does not meet the requirements of animal husbandry and potential soil potential. Therefore, the basis for high livestock productivity is the procurement of high-quality feed, providing for the widespread introduction of annual feed crops for the uninterrupted supply of plant materials from early spring to late fall [4-9].

The purpose of the study was to study the productivity of spring rape in mixed crops in the conditions of the steppe zone of Tuva.
2. Objects and methods of research
On the territory of the Kyzyl district in Bagrida a winter pasture is organized. It is located in the steppe zone. To regularly provide pasture animals with forage, a plot on the pasture was created at a distance of 3-5 km from the winter camp. A frost-resistant spring rape crop mixed with cereals and legumes is sown in strips 30-40 m wide.

The soil is prepared according to the type of subsurface cultivation, which is provided for in areas where soils are susceptible to wind erosion. Under presowing treatment, 60 kg of a.a. nitrogen and 40 kg a.e. phosphorus. During sowing, phosphorus fertilizers with a norm of 20 kg a.v. on 1 ha.

Sowing was carried out in the first ten days of June. Sowing was carried out manually by the scattering method, with seed placement to a depth of 3-6 cm. After sowing, rolling was performed with ZKKSh-6A rollers.

The experiment was carried out in triplicate with a randomized allocation of plots. Experiment design: 1) rape (control), 2) rape + peas, 3) rape + corn, 4) rape + Sudanese grass.

A variety of spring rape was sown - Argument, peas - Victoria, corn - Krasnodar 303 TV, Sudan grass - Tashebinskaya.

The soil of the experimental plot is agrozen texture-carbonate low-power sandy loam. The humus content is 2.27%, the thickness of the humus horizon is 22 cm. The availability of nitrogen is low, phosphorus is medium, and potassium is medium.

3. Results and their discussion
One of the most difficult problems in the agro-industrial complex of Tuva is providing livestock with full fodder in the conditions of a decline in agricultural production. The determining factor in the development of animal husbandry is the achievement of proportionality between feed supply and livestock. Providing cattle with a sufficient amount of complete feed requires a significant increase in the rate of their production, and a qualitative restructuring of the entire feed production. This should be achieved by increasing the productivity of natural fodder land, improving the organization of field feed production, improving the technology of harvesting and storage of feed.

At present, there are about 3,000 winter shepherd sites in Tuva. As of January 1, 2018, the number of animals amounted to 1,574.4 thousand, including small cattle - 1,140 thousand heads, cattle - 164 thousand heads, horses - 73.8 thousand heads, deer - 3.9 thousand, heads, camels - 208 heads, deer 657 heads, pigs 9.8 thousand and birds 182 thousand heads [1]. To maintain such a livestock of animals, it is necessary to create a sustainable forage base. In 2017, farms of all forms of ownership procured about 238 thousand tons of roughage, about 2000 tons of straw, 2.5 thousand tons of fodder. Due to the large number of livestock, harvested feed in the republic during the wintering season is not enough, especially with grazing.

One of the feed crops rich in protein is rape. Rapeseed feed is very rich in digestible protein, the amino acid composition of which is well combined with the needs of all types of farm animals. Of particular value is the green mass of spring and rape crops of spring rape in the autumn months - September, October and even November, until snow falls. Green rape can withstand autumn frosts of -8-10 °C, so it is especially important to feed it when transferring animals to winter-stall keeping or grazing. In 1 kg of green mass of rape contains 0.12 units. and 22 g of digestible protein. This food is well balanced in protein and is not inferior to legumes. With a good supply of moisture, it is able to give 2-3 mowing green mass during the summer. Having the feature of growing intensively after mowing or grazing, its crops can be used for grazing [10].

In the conditions of Tuva, in the 2nd or 3rd decades of October with the onset of stable frosts, overgrown plants can be cut into rolls, rolled, which makes it possible to conserve green mass, and in winter to conduct grazing on this territory.

The productivity of fodder agrogenoses according to the years of research is different (table 1). High productivity was obtained in 2017, which may have been affected by meteorological conditions of the growing season. The temperature regime of 2017 was at the level of long-term average data, but with insignificant deviations. The air temperature in May was 2.7 °C higher than normal, and in June
and July - 3.2 °C and 1.1 °C, respectively. The amount of precipitation was 164 mm, which is 13 mm lower than normal. The temperature regime in 2016 was abnormally arid, especially June. The average monthly temperature of the vegetation period was above the norm by 12.5 °C. The amount of precipitation for the year is 150 mm.

**Table 1.** Productivity of green mass of spring rape of single-species and poly-species crops.

| Predecessor                        | Productivity, t/ha | Average for 2016-2017 |
|------------------------------------|--------------------|------------------------|
| 1. Spring rape (control)           | 11.7               | 13.9                   |
| 2. Spring rape + peas              | 15.8               | 17.2                   |
| 3. Spring rape + corn              | 15.7               | 16.5                   |
| 4. Spring rape + Sudanese grass    | 13.5               | 15.5                   |
| HCP<sub>05</sub>                   | 2.17               | 3.19                   |

In 2016, the yield increase in the studied variants was 1.8–4.1 t/ha. The highest yield of green mass was obtained by co-sowing rapeseed + peas and rapeseed + corn, where the yield increase is higher than HCP<sub>05</sub>. Rapeseed with an erect stem, in joint sowing with creeping peas, provides him with the conditions for better growth and development.

When comparing the productivity of green mass in mixed crops in 2017, the same regularity appears as the previous year. Although the increase in yield was noted below the previous year (1.6-3.3 t/ha). All mixed crops of field crops gave an increase in yield, but a reliable increase only in the version of rape with peas (3.3 t/ha).

So, the maximum average yield of green mass was obtained by joint sowing of spring rape with peas, which is 22% higher in single-species sowing of rape. This is explained by the fact that the aboveground mass of cultivated plants develops in different tiers, due to this the use of solar energy by plants improves.

Based on materials by V N Zhulanova, V P Tulush, L D Balgan [11], in the Tuva steppe, an increase in the productivity of green mass of spring rape is observed in a mixture with cereals by 1.2 times in comparison with single-species crops of this crop. The yield increase in polyvideous crops (rapeseed + oats) is 2.7 t/ha (HCP<sub>05</sub> = 2.07 t/ha).

According to the studies of O T Andreeva, N G Pilipenko, L P Sidorova, N Yu Kharchenko [6], in the forest-steppe zone of the Trans-Baikal Territory throughout the summer-autumn period, the highest productivity of the first and second slopes of green mass provides mixed cereal crops with spring rape (22.2–24.2 t/ha).

Chemical analysis of green mass showed that rapeseed and pea crops were highly nutritious. The protein content in the experimental variants was higher when co-sowing rapeseed and peas. This can be explained by the fact that peas are a leguminous crop, and oilseed rape. The protein content ranged from 15.5 g to 26 g.

The analysis of economic efficiency showed that when cultivating spring rape in mixed crops, a net income of 4.5 to 6.9 thousand rubles/ha was obtained (table 2). The maximum net income was obtained when sowing rapeseed with peas, which is 3.6 thousand rubles/ha more than with the option of pure sowing of spring rape. High profitability was found in mixed sowing of rapeseed with peas (53%).

**Table 2.** Cost-effectiveness of spring rape cultivation in mixed crops.

|                         | Spring rape (control) | Spring rape + peas | Spring rape + corn | Spring rape + Sudanese grass |
|-------------------------|-----------------------|--------------------|--------------------|-----------------------------|
| Productivity from 1 ha, | 12.8                  | 16.5               | 16.2               | 14.5                        |
| Production costs for 1  | 12,104                | 12,911             | 13,611             | 12,897                      |
| ha, rubles              |                       |                    |                    |                             |
Production costs from 1 ha, rubles

|          | 15,360 | 19,800 | 19,440 | 17,400 |
|----------|--------|--------|--------|--------|
| Net cost, rubles/t | 946    | 783    | 841    | 890    |
| Net income from 1 ha, rubles | 3,256  | 6,889  | 5,829  | 4,503  |
| Profitability, % | 27     | 53     | 42     | 35     |

4. Conclusion

The maximum productivity of green mass was observed in mixed crops compared with single-species sowing of spring rape. The yield of green mass of spring rape on average for 2016-2017 amounted to 12.8 t/ha, in mixed crops - 14.5-16.5 t/ha (HCP_{05} 2.68 t/ha).

The maximum yield of green mass was obtained in mixed crops of spring rape with peas, where the increase was 3.7 t/ha.

The best supply of green mass with digestible protein was obtained when growing mixed crops of rapeseed with peas - 26 g per 1 feed unit.

The cultivation of mixed crops of spring rape is economically viable. Maximum net income and profitability were obtained in mixed crops of spring rape and peas.

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