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ARTICLE

# Result of the research on Sainfoin (*Onobrychis sativa L*) varieties in the Great Lake region of Mongolia

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**Abstract:** This study aimed to determine a sainfoin variety best suited to the soil and weather conditions of the Great Lake Basin region inUlaangom soum of Uvs aimag (province). We carried out studies into five varieties of sainfoin, including *Peschany* 1251, *Tashyl* 3, *Novosibirsky* 1284, *Shortandisky* 83, and *Mikhailovsky*-5, which were compared with each other without irrigation trial. Sainfoin has a high resistance to cold winter conditions, high temperatures and and dry drought conditions. Sainfoin varieties growing in Mongolia are highly palatable perennial leguminous plants. According to the result of our research, sainfoin is well acclimatized to Uvs province's soil and weather conditions. The variety with the highest performance showing is *Taskhyl* 3, which was generated atthe Plant Research Center of Khakassia, a republic of Russia located in southern Siberia.

**Keywords**: *Sainfoin, Taskhyl 3, plant growth and development, regrowth, biologicalresistance;*

## INTRODUCTION

Sainfoin (*Onobrychis sativa L.*) is an important perennial leguminous plant, which is well adapted to the soil and weather conditions of Mongolia. It is suitable for growing good quality hay, fodder and seed in the forage steppe zone and in the irrigated mode.

In the steppe zone, wild sainfoin grows downhill, woodside and near water meadow. Sainfoin usually appears in the forest steppe zone, such as Orkhon, Selenge, Yuroo, Zuunkharaa, Batsumber [2].

The roots penetrate through deeper layers of the soil and supply a great amount of organic matter from the deep soil and also improve soil structure [11]. Organic matter is vitally important in the harsh and dry land conditions, which have low green mass. The tuber bacteria located deep in the

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in nitrates, which is very important in regions with a dry and cold climate and with low green mass of plants [12].

It is a valuable rotation for improving soil erosion and fallow land. Sanfoin is also a very good honey plant [13]. In the last 20 years, Mongolia's livestock population increased fast to reach 67.1 million heads of animals (2020), which coupled with the decline in the quality and quantity of pasture. Consequently, nomadic livestock breeding today faces numerous risks related to pasture degradation.

Therefore, plants that are highly palatable, with high nutritionand also drought and winter tolerant, are extremely important for the nomadic livestock breeding in Mongolia. In other words, testing suitable varieties of Sainfoin and growing and harvesting them at the right time of the year are critical for the country's animal husbandry. The purpose of our study is to properly test well adapted, high yield varieties of Sainfoin and observe their impact on soil improvement in the Great Lake region, and towards this end, we set the following objectives:

1.Observe development stages of different varieties, 2. Compare biotic potential, resistance and biometer indicators of the varieties, and, 3. Observe regrowth after harvest.

## MATERIALS AND METHODS

The research was carried out during the 2018-2021 growing seasons in Ulaangom soum, the administrative center of Uvs aimag in the country's extreme north east. The experiments established block design with 4 replications. The soil texture in the area is clay-loam, light brown colored and the thickness of the layer of nutritive soil is 18-30 cm.

The experiment included5 variants and 4 repetitions. The size of each experimental plot was3 sq.m. with the total plot equivalent to60 sq.m.The gross experimental field was123.8 sq. m., side protective belt -40 sq.m. and marginal protective belt was1m. The seeding rate was 9.6kg per hectare, 0.96 gr. of seed per square meter. 1,000 seed weight was equivalent to20gr.

*Peschany* 1251(St), *Tashyl*-3, *Novosibirsky* 1284, *Shortandisky* 83, *Mikhailovsky*-5 varieties were used as experimental materials. These varieties were compared with *Peschany*1251, which is well adapted to Mongolia. *Peschany* 1251 was selected as a control variety based on the report of *Peschany* 1251 varieties studied at the Animal Husbandry Institute in the years from1970 to 1980. 5 varieties were planted on the 20th day of the month of May.

The observation of the development stages was carried out applying the N.B. Beidman method, and the beginning of the stages was registered at 25% of the size of the total plot, and the un iformit when it transitioned to 75%.

We used the following main methods for the field experiment of the varieties that were subject to testing:

- Matskov method for testing heat resistance of the varieties
- Nekrasov method for testing drought resistance of the varieties.

## RESULTS AND DISCUSSION

Uvs aimag (province) is one of the coldest places in Mongolia. The winter is long with extremely low temperatures, while the summer is hot and short. Winter lasts from November to late April, the spring seasons is short only in May and summer begins in June through to September. There are 257 sunny days a year, often with clear cloudless skies.

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**Table 1.Humidity and temperature duringthe 3 years of the study**
**Hydrothermal parameters (2018-2020 )**

| Year | The sum of precipitation for an average temperature above 10° C (r) | The average daily temperature (°T) above 10°C decreased by 10 times | Hydrothermal coefficient (HTC) by g.t. Selyaninov |
|---|---|---|---|
| 2018 | 69.3 | 2445 | 0.28 |
| 2019 | 177.6 | 2406 | 0.73 |
| 2020 | 149.2 | 2427 | 0.61 |

Meteorological processing based on data from the Ulaangom weather station. The study years were relatively cool with abundant precipitation (Table 1).

**Table 2. Field germination and regrowth of the Sainfoin varieties**

| Varieties | 2018 | | 2019 | | 2020 | | Average of 3 years | |
|---|---|---|---|---|---|---|---|---|
| | plant, num/m $^2$ | Field germination,% | num/m $^2$ | regrowth, % | num/m$^2$ | Regrowth , % | num/m $^2$ | regrowth,% |
| *Peschany*1251(st) | 35 | 87 | 30 | 85 | 28 | 93.3 | 31 | 88.4 |
| *Taskhyl* 3 | 39 | 97 | 38 | 97 | 36 | 94.7 | 37.6 | 96.2 |
| *Mikhailovsky* 5 | 29 | 72 | 20 | 68 | 12 | 60 | 20.3 | 66.6 |
| *Plamingo* | 32 | 80 | 23 | 71.8 | 19 | 82.6 | 24.6 | 78.1 |
| *Shortandisky* 83 | 30 | 75 | 24 | 80 | 18 | 75 | 24 | 76.6 |

In varietal research experiments, it is important to pay attention to field germination and plant regrowth or density per unit area (P<0.01).
In the first year of the experiment, the field germination of all the 5 varieties was 75-97%, and when compared with the control variety, the *Taskhyl* 3 varietywas20% higher, *Mikhailovsky*variety15%, and the other twovarieties were lower by 12.7%, but as for the new varieties, these indicators evidence that they could adapt and grow in the local soil and the existing climatic conditions.

The main indicator of the life of the variety is the regrowth inthe following years. Except the*Mikhailovsky* variety, the regrowth of the *Taskhyl* 3 in 2019 and 2020 was 8.8% higher than the control indicator, while other varieties were below the control indicator, which however could be considered sufficient at the varietal level.

An average of 3 years of regrowth is 76.6-96.2%, which is an indication that Sainfoin varieties are better able to withstand the cold long winter.

***Table 3. First year observation of development stages of the Sainfoin varieties, (2018)***

| Varieties | Germination | | Branching | |
|---|---|---|---|---|
| | begin | Becoming even | Begin | Becoming even |
| *Peschany* 1251(st) | 06.1 | 06.7 | 6.21 | 7.20 |
| *Taskhyl* 3 | 06.1 | 06.9 | 7.11 | 7.23 |
| *Mikhailovsky* 5 | 06.3 | 06.8 | 7.15 | 8.5 |
| *Plamingo* | 5.28 | 06.4 | 7.6 | 7.29 |
| *Shortandisky* 83 | 6.5 | 06.12 | 7.22 | 8.4 |

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According to the development stage indicators of the 2018 growth period of Sainfoin varieties, the germination and branching of the varieties took place between 51st and 63rd days. In the first year, the stages of germination and branching took place 100 % on all varieties and few flowers appeared on the *Taskhyl* 3 variety.

***Table 4. Some pre-winter biometric parameters of Sainfoin varieties***

| Varieties | 2018 | | 2019 | | 2020 | |
|---|---|---|---|---|---|---|
| | Plant height, cm | Number of branches, pl/num | Plant height, cm | Number of branches, pl/num | Plant height, cm | Number of branches, pl/num |
| *Peschany* 1251(st) | 46 | 4.9 | 66.6 | 10 | 70.2 | 14 |
| *Taskhyl* 3 | 56 | 5.5 | 80.7 | 8.6 | 87.4 | 13.8 |
| *Shortandisky* 83 | 44 | 5.2 | 62 | 7.2 | 73.3 | 8.7 |
| *Plamingo* | 41 | 4.7 | 57 | 5.8 | 69.9 | 7.6 |
| *Mikhailovsky* 5 | 45 | 5.4 | 62.3 | 6.9 | 68.6 | 7.1 |

The development plant height and number of branchs by years are significantly different $P<0.01$. Measurements of plant height and number of branches in the second 10 days of September, when the plant growth phase is complete, show that the plant height and number of branches are increasing year by year. The tallest variety, *Taskhyl* 3, is 87.4 cm, and the shortest variety *Mikhailovsky* 5 is 68.6 cm. The *Taskhyl* 3 was 15-26.4 cm higher than the control variety and other varieties by these parameters, and the higher number of branches were 9-8.

***Table 5. Formation of growth stages suitable for harvest (date as of 2019, 2020)***

| Number of hay | Varieties | Regrowth | | Branching | | Budding | | Flowering | | Day of harvest |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Beg | even | Beg | even | Beg | even | Beg | even | |
| First | *Peschany* 1251(st) | 4.28 | 5.3 | 5.23 | 5.30 | 6.24 | 6.29 | 7.5 | 7.15 | 7.20 |
| | *Taskhyl* 3 | 4.28 | 5.5 | 5.19 | 5.26 | 6.27 | 7.1 | 7.7 | 7.15 | |
| | *Mikhailovsky* 5 | 4.30 | 5.2 | 5.18 | 5.25 | 6.26 | 7.4 | 7.10 | 7.18 | |
| | *Plamingo* | 4.30 | 5.6 | 5.20 | 5.27 | 6.29 | 6.30 | 7.8 | 7.18 | |
| | *Shortandisky* 83 | 4.28 | 5.3 | 5.17 | 5.24 | 6.24 | 6.29 | 7.8 | 7.19 | |
| Second | *Peschany* 1251(st) | 7.22 | 7.24 | 7.31 | 8.5 | 8.20 | 9.1 | 9.8 | 9.14 | 9.15 |
| | *Taskhyl* 3 | 7.22 | 7.25 | 8.1 | 8.5 | 8.24 | 9.3 | 9.10 | | |
| | *Mikhailovsky* 5 | 7.21 | 7.24 | 8.3 | 8.5 | 8.24 | 9.4 | 9.12 | | |
| | *Plamingo* | 7.23 | 7.26 | 8.3 | 8.6 | 8.26 | 9.6 | 9.11 | | |
| | *Shortandisky* 83 | 7.23 | 7.25 | 8.5 | 8.6 | 8.25 | 9.5 | 9.10 | | |

It is possible to go through two stages of development, meaning harvest Sanfoin twice during the growing season, as can be seen from the phenological observations of the varieties (Table 5). In 2020, the first harvest was carried out on 62-80 days after the regrowth stage, and the second harvest was carried out after 45-40 days.

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***Table 6. The height of plants regenerated after harvest, cm (Average of 2 years)***

| # | Varieties | Plant height, cm | | | | |
|---|---|---|---|---|---|---|
| | | 1 week later | 2 weeks later | 3 weeks later | 4 weeks later | 32 days later |
| 1 | *Peschany* 1251(st) | 13 | 22 | 26.6 | 33 | 39.2 |
| 2 | *Taskhyl* 3 | 16.5 | 24.5 | 29 | 38.8 | 47 |
| 3 | *Plamingo* | 16.5 | 22 | 25 | 36.5 | 40.5 |
| 4 | *Shortandisky* 83 | 12.5 | 16 | 21 | 26 | 39 |
| 5 | *Mikhailovsky* 5 | 12.5 | 16.5 | 21.5 | 31.5 | 39.5 |
| | P< | 0.002603 | 0.002603 | 0.00014 | 0.001084 | 0.003043 |

Post-harvest regenerated plants were measured at 7-week intervals. According to the result of measurement, the average 2 year plant height of *Taskhyl* 3 was 46.2cm, therefore, *Taskhyl* 3 varieties were 7.5 cm taller than the control varieties. It is possible to harvest the plants at least twice a year because the regrowth activity of the Sainfoin varieties' is very good.

***Table 7. The result of third year measurement of varieties' green mass yield,2020***

| Varieties | Regrowth, % | Density, num/m $^2$ | Plant height preharvest, cm | Green mass yield, t/ha | Absolute dry matter content, % | Dry matter yield, t /ha |
|---|---|---|---|---|---|---|
| *Peschany* 1251(st) | 93.3 | 28 | 46 | 18.0 | 24.78 | 4.28 |
| *Taskhyl* 3 | 94.7 | 36 | 44 | 32.1 | 24.72 | 8.02 |
| *Mikhailovsky* 5 | 60 | 12 | 45 | 20.4 | 20,45 | 4.55 |
| *Plamingo* | 82.6 | 19 | 56 | 26.5 | 26.3 | 5.65 |
| *Shortandisky* 83 | 75 | 18 | 41 | 19.7 | 23.5 | 3.51 |
| P< | 2.14497 | 2.14497 | 0.005136 | 0.000904 | 0.41121 | 0.00012 |

There is a significant difference in plant height, green mass yield and dry matter yield of the verieties (P<0.001).Compared to the varieties in terms of biomass and dry matter yield in the growing season of 2020, *Taskhyl* 3 has a higher biomass yield of 5.6-14.7 t/ha and dry matter yield is2.32-4.52 t/ha as compared toother varieties.

***Table 8. Biological tolerance assessment table, (Average of 2 years)***

| | Varieties | Regrowth % | High temperature resistance | | | | | Winter resistance | | | | | Disease and pest resistance | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | |
| 1 | *Peschany* 1251(st) | 85 | | | | | X | | | | X | | | | | | X | |
| 2 | *Taskhyl* 3 | 97 | | | | | X | | | | X | | | | | | X | |
| 3 | *Mikhailovsky* 5 | 68 | | | | | X | | | | X | | | | | | X | |
| 4 | *Plamingo* | 71.8 | | | | | X | | | | X | | | | | | X | |
| 5 | *Shortandisky* 83 | 80 | | | | | X | | | | X | | | | | | X | |

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Varieties have excellent resistance to high temperature, winter cold, and disease pest conditions.Pest and disease did not have any effect on Sainfoin varieties.Compared to the third year of experiment, the Taskhyl 3 variety was 1.4-34.7% higher than the other varieties. Other indicators gave a score of 4-5 points.

The green mass yield of Sainfoin varieties reached 18-32.1 t/ha in the third year, and the Taskhyl 3 variety (32.1 t/ha) had the highest yield, which was 14.1 t/ha more than the control variety. Sainfoin produces a rich grass yield in the forest steppe and in the steppe zone.The green mass of Sainfoin is more than 20 percent higher on irrigated land [6]. The Peschany1251 variety yielded 37.7 t/ha, and theMihailovsky5 variety yielded 35 t/ha on irrigated fields [8].

Studies by Vladeta Stevovik and Rade Stenisavlevik (2010) have shown that planting 50 cm wide rows of Sainfoin produces more powerful plants that are more suitable for seed and green mass crops. The number of plant stems depends on the distance between the rows. Planting at 80 cm wide rows of Sainfoin would increase the number of stems but was less .

resistance of varieties were evaluated by scoring during

than at 50 cm wide rows of seed and green mass.We planted the experiment in 50 cm wide rows, 5 cm apart between plants. Depending on the Sainfoin variety, yields up to 32.1 t/ha of green mass were obtained.

## CONCLUSIONS

In terms of field germination, Mikhailovsky 5 varietyhad the lowest germination rate of 72%, while Taskhyl 3 varietyhad the highest germination rate of 97% and were selected from other varieties. The field germination of Sainfoin varieties is higher than that of other forage plants.Compared to the regrowth after the first harvest, theTashkhil 3 varietyhad higher plant height and growth buds, and number of breeding buds was considerably than the control and other varieties

In terms of green mass, the amount per hectare is increasing every year. In the second year, Flamingo and Taskhyl 3 varieties yielded more green mass than the other varieties. In the third year, Taskhyl 3 variety yielded 14.1 t/ha more than the control varieties.

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