УДК 633.3 (517.3)
DOI: https://doi.org/10.33814/AFP-2222-5366-2023-4-15-23

INTRODUCTION OF RUSSIAN ALFALFA VARIETIES IN MONGOLIAN FOREST STEPPE ZONE

ИНТРОДУКЦИЯ РОССИЙСКИХ СОРТОВ ЛЮЦЕРНЫ В ЛЕСОСТЕПНОЙ ЗОНЕ МОНГОЛИИ

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ABSTRACT
There are two of commercial varieties of alfalfa (*Medicago varia* Mart.) 'Vega 87' and 'Nakhodka' originated from Russia, it are cultivated for introducing in Mongolian climate and ecological condition. Growth development of those varieties required from 136 to 143 days between regrowth in spring and the seed mature in the autumn. Wintering rate was 92.6% in 'Nakhodka' and 88.5% in 'Vega 87' in the first year and increased by 5.8 and 7.3% in the second year, respectively. Green biomass and hay yield of 'Nakhodka' were higher than 'Vega 87' and average green biomass of two years in 'Nakhodka' was 13.5 t/ha and 10.9 t/ha in 'Vega 87', the hay yield was 5.4 t/ha in 'Nakhodka' and 3.6 t/ha in 'Vega 87' at flowering stage.
Moreover, humus content, phosphorus, potassium content and texture were determined in the depth of 0–10, 10–20, 20–30 cm in control and alfalfa cultivated areas. Humus content ranged between 3.1–3.6% in the depth of alfalfa cultivated areas while 2.8% in control area in the depth of 0–20 cm and humus content was increased by 9.36–14.5% (in relative terms) in alfalfa cultivated areas compared to the control. Then phosphorus content was 4.93 mg/100 g in 'Nakhodka' cultivated area, 4.11 mg/100 g in 'Vega 87' cultivated area and 3.70 mg/100 g in control area in the depth of 0–10 cm. Potassium content was ranged between 23.4–23.9 mg/100 g in alfalfa cultivated areas while it was 20.6 mg/100 g in 0–10 cm of depth. According to the soil survey result, there is no difference in soil texture between treatments (alfalfa cultivated areas and control area), but humus content and content of phosphorus, potassium had increased in alfalfa cultivated areas.

АННОТАЦИЯ
Существуют два коммерческих сорта люцерны (*Medicago varia* Mart.) Вега 87 и Находка, выведенные в России, они культивируются для интродукции в климатические и экологические условия Монголии. Для развития этих сортов требовалось от 136 до 143 дней между отрастанием весной и созреванием семян осенью. В первый год перезимовка составила 92,6% у сорта Находка и 88,5% у сорта Вега 87, а во второй год увеличилась на 5,8 и 7,3% соответственно. Зеленая биомасса и урожайность сена у сорта Находка были выше, чем у сорта Вега 87: средняя зеленая биомасса за два года у Находки составила 13,5 т/га, у Веги 87 — 10,9 т/га, урожайность сена — 5,4 т/га у сорта Находка и 3,6 т/га у сорта Вега 87 в стадии цветения.

Кроме того, на контрольных и посевных площадях люцерны определяли содержание в почве гумуса, фосфора, калия и ее текстуру на глубине 0–10, 10–20, 20–30 см. Содержание гумуса в глубине посевных площадей люцерны колебалось в пределах 3,1–3,6%, на контрольном участке в глубине 0–20 см — 2,8%; содержание гумуса на посевных площадях люцерны повышалось на 9,36–14,5% (в относительном выражении) по сравнению с контролем. Содержание фосфора на посевном участке сорта Находка составило 4,93 мг/100 г, на посевном участке сорта Вега 87 — 4,11 мг/100 г и на контроле на глубине 0–10 см — 3,70 мг/100 г. Содержание калия колебалось в пределах 23,4–23,9 мг/100 г на посевных площадях люцерны, тогда как на глубине 0–10 см оно составляло 20,6 мг/100 г. По результатам почвенного обследования различий в механическом составе почвы между вариантами (посевные площади люцерны и контрольный участок) нет, но на посевных площадях люцерны увеличилось содержание гумуса, фосфора, калия.

KEYWORDS: perennial grasses, forage crop, alfalfa, variety.

КЛЮЧЕВЫЕ СЛОВА: многолетние травы, кормовая культура, люцерна, сорт.

INTRODUCTION

Mongolia is one of the few remaining countries with nomadic pastoral culture supported by extensive natural rangeland and around 75% of the total territory considered to Rangeland [1; 2]. Based on the 2016 pastureland monitoring data, 42% of the monitoring sites were belongs to non-degraded status, 13.5% in slightly degraded, 21.1% in moderately degraded, 12.8% in heavily degraded and 10.3% in fully degraded level [1]. In Mongolia, almost 97% of animal husbandry and nomadic livestock feed supply depending on the Pastureland throughout the year. Hence, during the harsh winter period, pastoral livestock lost its live weights and reduce productivity and animal resistance and sometimes exposure to the dzud (livestock dies due to starving and freezing).

Alfalfa (*Medicago* sp.) is one of the most important high-quality forage legumes in theworld and improving soil fertility by nitrogen fixation. Moreover, its suitable for haylage and improving the degraded land restoration [3]. In last decade, there have been an urgent need for improving fodder supply and its quality, increasing feed resources for nomadic livestock and semi, - intensive farming. For this reason, we had chosen Russian two commercial varieties of alfalfa (*Medicago varia* Mart.) for introduce Mongolian specific condition. Those varieties: ‘Vega 87’ and ‘Nakhodka’ are resistant to unfavorable environmental conditions such as cold, drought, disease and give high yield production with good quality. Both of those ‘Vega 87’ and ‘Nakhodka’ varieties of alfalfa was developed by Williams Fodder Research Institute and its branches in Russia. Currently, the Institute has created 207 varieties of various fodder crops, including 18 varieties of alfalfa [4–7].

MATERIAL AND METHODS

The field experiment carried out from the spring of 2019 to the autumn of 2021 at Ar gunt (47°56′04.7″ N, 105°5′87.5″ E, elevation 1252 m a.s.l) experimental site in the forest steppe zone of Mongolia under non-irrigated condition. Soils cultivated plough in 20 cm deep and seeded with commercial seeds of Russian varieties:

those are ‘Nakhodka’ and ‘Vega 87’ of alfalfa varieties. Seed rate of varieties were 10 kg per hectare and drilled on 15–20 in June by Omichka-2.1 seed machine in a depth of 1–2 cm with 15–20 cm in row space. Field germination rate and plant height determined in the first year of 2019 and wintering rate calculated by as a percentage of the total number of plants in autumn transitioned to the winter that regenerated in the following spring of 2020 and 2021. Plant development cycle, green biomass, hay/seed yields were determined from second year of life. The soil analysis was carried out in three variants: 1) alfalfa was grown for three years; 2) alfalfa was grown for two years; and 3) control area where is outside of the fences in the pastureland under light grazing pressure. Soil samples collected by 5 cm in diameter, 25 cm long conical soil corer in a depth of 0–40 cm. Soil structure and texture was determined in the field and soil segments from each A and AB horizon were collected with 3 replicated for the soil analysis. Soil physical and chemical analysis was carried out according to the standard of MNS 3310:1991. All of experiments replicated three to six times and analysis of variance evaluated using SAS software package. Comparison of the difference between treatments were described by Tukey test.

RESULTS AND DISCUSSIONS

First year growth and wintering of alfalfa varieties

Seeds were germinated within 12 to 14 days after sowing in the soil.

Field germination rate was ranged between 86 to 92% in alfalfa varieties and plant average height was 25–30 cm in tall with 2–3 nodes at the vegetative stages in the first-year wintering.

Wintering rate was 92.6% in ‘Nakhodka’ and 88.5% in ‘Vega 87’ at the first-year of 2019 winter and it had increased following year of 2020 winter with 98.4% in ‘Nakhodka’ and 95.8% in ‘Vega 87’ varieties. In brief, wintering rate was increased by 5.8% in ‘Nakhodka’ and 7.3% in ‘Vega 87’ in the second-year of 2020 winter. Between varieties, wintering rate of ‘Nakhodka’ was higher than ‘Vega 87’ during the field survey of 2019 and 2020.

Growth and development of introducing alfalfa varieties

Spring regrowth of ‘Nakhodka’ variety began on 20th to 22nd in April and lasted for 12 to 14 days. Vegetative stage continues 33 to 37 days, pre-budding stage 26 to 31 days, flowering stage 27 to 28 and seed maturation in 27 to 41 days and total development period last from 136 to 140 days while ‘Vega 87’ variety spring regrowth started on 28th in April and lasted for within 18–20 days. Vegetative stage lasts within 29 to 31 days, pre-budding stage 27 to 32 days, flowering stage 34 days and seed maturation 36 to 38 days, totally 144 days for growth development cycle (Table 1).

As a rule, in commercial alfalfa varieties, spring regrowth begins in the third decade of April, the vegetative stage — in the second and third decade of May, the budding stage — in the second half of June, the flowering stage — in the second half of July, and seed maturation — from late August to mid-September (Figure 1).

Table 1. Growth development of alfalfa varieties

Year	Cultivar	Growth development					Growing period
		Regrowth	Vegetative	Pre-budding	Flowering	Seed maturation	
2020	Nakhodka	IV.22	V.14	VI.16	VII.23	VIII.30	136
	Vega 87	IV.28	V.16	VI.20	VII.22	IX.5	Immature
2021	Nakhodka	IV.20	V.14	VI.16	VII.12	IX.5	143
	Vega 87	IV.28	V.28	VI.22	VII.19	IX.15	140

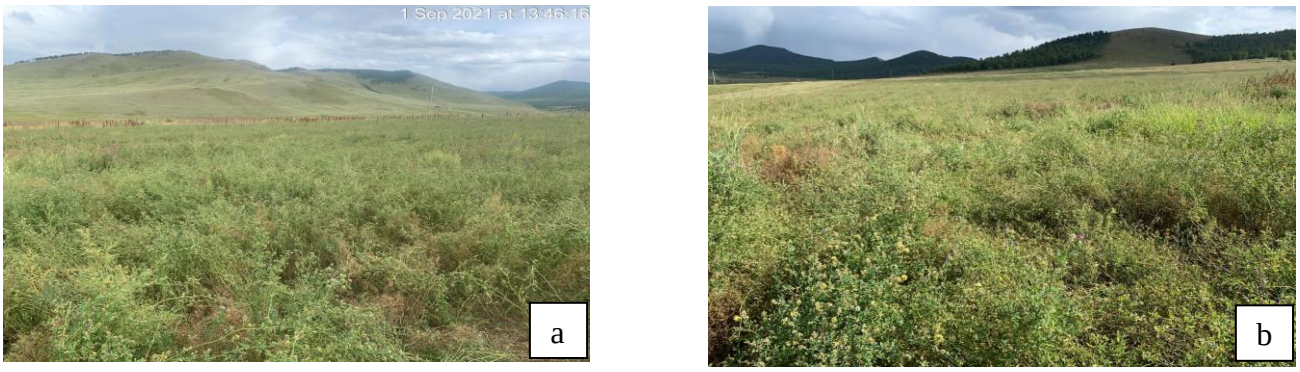

Figure 1. Alfalfa crops in field conditions: a) 'Vega 87', b) 'Nakhodka'

Green biomass and hay yield of varieties

Green biomass and hay yield determined at the flowering stage. Two years' average green biomass was 13.5 t/ha in 'Nakhodka' and 10.9 t/ha in 'Vega 87' while hay yield was 5.4 t/ha in 'Nakhodka' and 3.6 t/ha in 'Vega 87' variety. Green biomass and hay yield was higher in 'Nakhodka' than 'Vega 87' variety during the field examination. Seed number per pods were seven in 'Nakhodka' and five to six in 'Vega 87' variety (Table 2).

Table 2. Biomass and number of seed in alfalfa varieties

№	Alfalfa varieties	Green biomass, t/ha	Hay yield, t/ha	Number of seed, per pod
1	Nakhodka	13.5	5.4	7
2	Vega 87	10.9	3.6	5–6

Soil analysis of alfalfa cultivated and uncultivated areas

Soil analysis had done at three different treatments: 1) control or pastureland under grazing, 2) alfalfa 'Vega 87' variety cultivated for two years and 3) alfalfa 'Nakhodka' variety cultivated for three years (Table 3).

Table 3. Description of the treatments

Treatments	Control area – pastureland under grazing pressure	Alfalfa 'Vega 87' variety cultivated for two years	Alfalfa 'Nakhodka' variety cultivated for three years
Location	N 48°08′50.0″, E 106°42′54″	N 47°56′04.7″, E 105°54′87.5″	N 47°56′04.7″, E 105°54′87.5″
Elevation, m	1240	1252	1252
Slope, %	flat	flat	<2
Cultivated year	—	2020	2019
Current vegetation cover	*Potentilla bifurca* L., *Cleistogenes squarrosa* (Trin.) Keng., *Vicia cracca* L., *Potentilla acaulis* L.	Alfalfa 'Vega 87' variety	Alfalfa 'Nakhodka' variety

Soil structure and texture

Control area — A horizon occurred in a depth of 0 to 12 cm and color is dark brown, dry, sandy loamy texture with fine stone, cloddy granular and common and fine root, no difference with subsurface AB horizon in color. AB horizon between 12 to 24 cm in depth and coarse granular with fine stone, very dense and dry, color is brownish, fine root common, and there is difference with lower horizon in color. B horizon 24 to 53 cm in a depth sandy loamy texture, dry, cloddy granular, few fine roots spread, brown-gray colored. Difference with lower horizon not clear. Alfalfa variety 'Vega 87' cultivated for two years area — A horizon occurred in a depth of 0 to 14 cm. The soil color was dark and saturated with moisture. The structure of A horizon is granular, roots were common and well-formed loamy textured. Between A and AB horizon no differences in color. Lower AB horizon between 14 to 30 cm in a depth. The structure is coarse granular with fine stones, fine roots common and sandy-loam textured with dense. Color was brown and clear from lower horizon. Alfalfa variety 'Nakhodka' cultivated for three years — A horizon occurred 0 to 12 cm in a depth and granular structure with fine stones, brown colored sandy loamy textured, dry, common with roots and differences not clear with lower horizon in color. AB horizons between 12 to 24 cm coarse granular structured with fine stones, very dense sandy loamy textured, dry and brown colored, very fine roots common and clear difference from lower horizon (Figure 2).

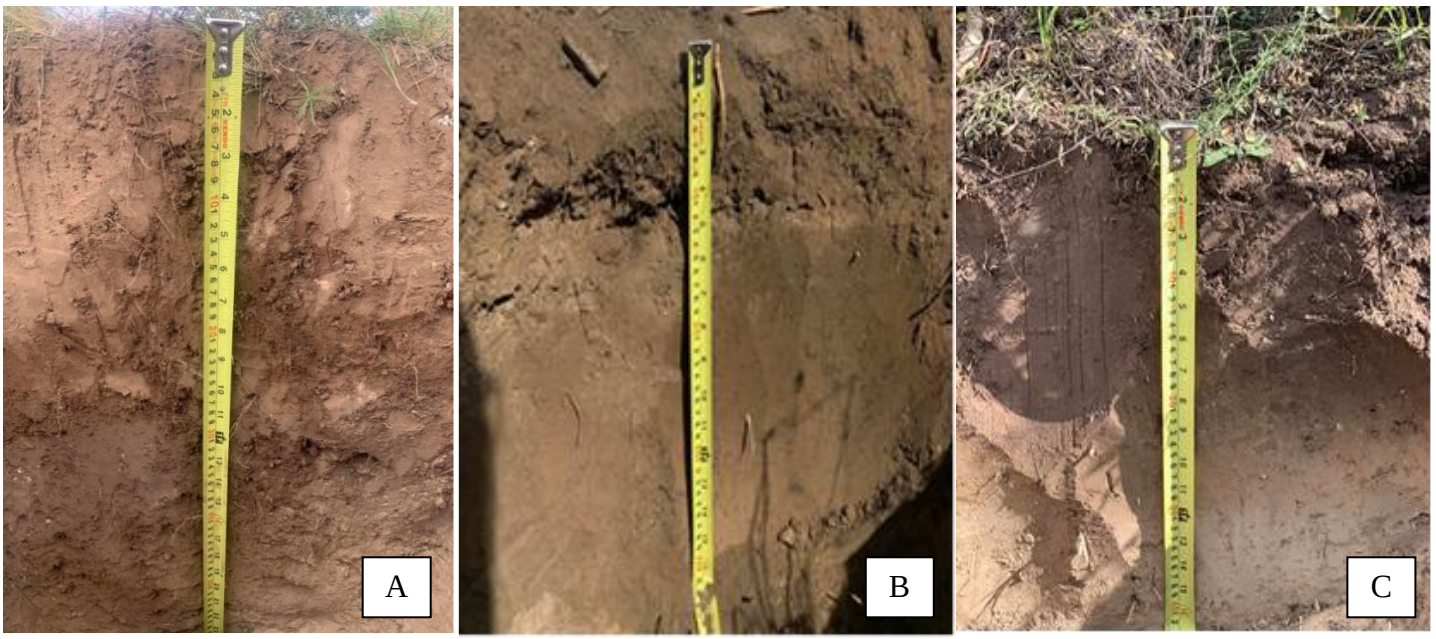

Figure 2. Soil profiles of the treatments:

A) Control area – Pastureland under grazing,
B) Alfalfa variety 'Vega 87' cultivated for two years,
C) Alfalfa variety 'Nakhodka' cultivated for three years

In a depth of 0 to 24 cm in the control area, the dampness was 8.1%, bulk density 1.24 g/cm^3, coarse and fine sand content between 66 to 66.8%, silt content was between 23.9 to 25.5%, clay content ranged between 7.6 to 8.03%. Moreover, lower horizon in a depth of 24 to 53 cm, coarse and fine sand content 65.7%, silt content 24.3% and clay content 9.9 %. The depth of 0 to 30 cm in 'Vega 87' variety cultivated area, the dampness was 8.3 to 10.6%, bulk density 1.18 g/cm^3, coarse and fine sand content was between 63.4 to 69.3%, silt content was ranged 22.9 to 28.4% and clay content was 9.8 to 11.0%. In a depth of 0 to 30 cm in this treatment dampness was 8.3%, bulk density 1.18 g/cm^3, coarse and fine sand content ranged between 59.5 to 60.8%, silt content 24.2 to 24.8, clay content between 12.3 to 13.5%, in a depth of 19 to 30 cm texture belongs to loamy with 56% sand, 23.0% silt, 14.5% clay content. According to the soil survey result, there is no difference in soil texture between treatments and the soil texture of all treatment were sandy clay loam except in a depth on 19 to 30 cm of alfalfa variety 'Nakhodka' cultivated area according to the soil description manual by NRCS [8]. Results showed on table 4.

Soil reaction (pH) of A and AB horizons at control area was 7.5 while alfalfa 'Vega 87' variety cultivated area was ranged between 6.8 to 6.9 and alfalfa 'Nakhodka' variety cultivated area was 6.6 (Table 5).

Table 4. Soil texture of the treatments

Treatments	Depth, cm	Moisture, %	Bulk density, g/cm^3	Texture composition scale, mm						
				1–0.25	0.25–0.05	0.05–0.01	0.01–0.005	0.005–0.001	<0.001	<0.01
Control area – pastureland under grazing	0–12	8.15	1.25	4.00	65.36	12.50	6.10	4.36	7.68	18.14
	12–24	8.11	1.24	7.31	56.18	15.02	6.21	7.25	8.03	21.49
	24–53	7.86	1.26	8.26	57.45	10.38	7.30	6.71	9.90	23.91
Alfalfa variety ‘Vega 87’ cultivated for two years	0–5	10.62	1.18	0.70	58.87	17.40	6.87	5.91	10.25	23.03
	5–14	10.51	1.18	0.52	60.33	16.24	8.65	4.44	9.82	22.91
	14–30	8.32	1.22	0.53	57.90	18.54	5.70	6.30	11.03	23.03
Alfalfa variety ‘Nakhodka’ cultivated for three years	0–5	10.62	1.18	0.82	58.36	16.30	6.87	5.29	12.36	24.52
	5–19	10.51	1.18	0.84	56.87	18.02	5.84	5.18	13.25	24.27
	19–30	8.32	1.22	0.87	55.18	12.97	10.10	6.38	14.50	30.99

Table 5. Soil chemicals at alfalfa varieties cultivated and control areas

Treatments	Soil depth, cm	pH	Salt, %	Soil EC, ds/m	Humus, %	$CaCO_3$, %	NO_3^-, mg/100g	Base exchange, mg/100g		Available elements, mg/100g	
								Ca^{-2}	Mg^{-2}	P_2O_2	K_2O
Control area – rangeland under grazing	0–12	7.5	0.015	0.042	2.67	0.0	1.18	22	6	2.71	20.2
	12–24	7.5	0.018	0.048	2.44	0.0	1.13	20	7	2.61	22.0
	24–52	7.4	0.019	0.052	1.59	0.2	0.22	25	2	2.34	26.3
‘Vega 87’ cultivated for two years	0–5	6.9	0.023	0.051	3.32	0.0	2.19	28	8	4.13	23.0
	5–14	6.8	0.026	0.072	3.10	0.0	2.24	25	6	4.66	20.2
	14–30	7.0	0.033	0.091	3.16	0.0	1.76	31	6	4.26	20.2
‘Nakhodka’ cultivated for three years	0–5	6.6	0.012	0.033	3.64	0.0	2.33	24	6	4.94	20.2
	5–19	6.6	0.007	0.028	3.39	0.0	2.41	23	5	3.68	21.0
	19–30	8.1	0.009	0.024	1.68	0.0	0.56	24	3	3.08	14.2

The value of soil reaction of control area was slightly higher than alfalfa varieties cultivated areas. A good quality agricultural soils have pH values around 6.0–7.0 [9]. Root growth is generally favored in slightly acidic soils, at pH values around 5.5–6.5 [10]. Soil reaction became favorable to plant growth, humus content in a depth of 0 to 24 cm at control area was ranged between 2.44 to 2.67% while alfalfa varieties cultivated areas were between 3.1 to 3.6% in a depth of 0 to 19 cm. Humus content was increased by 0.63 to 0.66% in the alfalfa variety 'Vega 87' cultivated for two years area and 0.83 to 0.93% in the alfalfa variety 'Nakhodka' cultivated for three years area in a depth of 24 cm. Nitrate nitrogen showed the similar results with humus content. In a depth of 0 to 24 cm in the control area nitrate valued 1.13 to 1.18 mg/100 g while 2.19 mg/100 g in the alfalfa variety 'Vega 87' cultivated for two years and 2.33 to 2.41 mg/100 g in the alfalfa variety 'Nakhodka' cultivated for three years. Nitrate nitrogen was increased by 1.01 to 1.06 mg/100 g at the 'Vega 87' cultivated for two years area and 1.2 to 1.23 mg/100 g at the alfalfa variety 'Nakhodka' cultivated for three years area comparing to the control area. The content of nitrate nitrogen in the treatments was in that order: alfalfa variety 'Nakhodka' cultivated for three years, alfalfa variety 'Vega 87' cultivated for two years and control area. Macro elements such as calcium, magnesium and phosphorus oxide amount were higher in the alfalfa varieties cultivated areas than control area whereas there are no differences between treatments on potassium amount (Table 5).

CONCLUSION

Two varieties of alfalfa: 'Nakhodka' and 'Vega 87' were cultivated in Ar gunt experimental station for seed multiplication. Green biomass was 13.5 t/ha in 'Nakhodka', 11 t/ha in 'Vega 87', the hay yield was 5.4 t/ha in 'Nakhodka', and 3.4 t/ha in 'Vega 87' variety.

According to the soil survey result, there is no difference in soil texture between treatments (alfalfa cultivated areas and control area), but humus and phosphorus content, potassium had increased in alfalfa cultivated areas.

Humus content was ranged between 3.1–3.6% in the depth of alfalfa cultivated areas while 2.8% in control area in the depth of 0–

20 cm and humus content was increased by 9.36–14.5% in alfalfa cultivated areas compared to the control.

Then phosphorus content was 4.93 mg/100 g in 'Nakhodka' cultivated area, 4.11 mg/100 g in 'Vega 87' cultivated area and 3.70 mg/100 g in control area in the depth of 0–10 cm. Potassium content was ranged between 23.4–23.9 mg/100 g in alfalfa cultivated areas while it was 20.6 mg/100 g in 0–10 cm of depth.

ACKNOWLEDGEMENT

This study was supported by KOPIA-Mongolia center of Rural Development Administration, Republic of Korea.

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