

## Possibilities of Alfalfa Cultivation Intensification and Biologization

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The important role in intensification and biologization of fodder production is played by the cultivation technology and the use of different plant formations. At that, the particular interest is paid to intense species and varieties of perennial legumes, and primarily, alfalfa. Therefore, we selected Kapchagai 80 variety of alfalfa differing by suitability for hay-pasture use. In the experiments on the study of the biologization and soil cultivation techniques for alfalfa sowing, in the most successful options we obtained high yields of hay with the highest protein content; plus minimum cultivation and seed treatment with nitragin at a rate of 50 grams/kilogram that had a favorable impact on the improvement of soil fertility. The conducted research revealed a significant effect of agricultural background and biologization on the productivity of alfalfa, where the yield increase amounted to 21.3-26.4 hundredweight per hectare (hwt/ha).

**Key words:** Alfalfa, Agricultural background, Technique, harvest.

In recent years in several regions of the Republic of Kazakhstan (RK) the acreage of perennial and annual grasses, including alfalfa, have declined markedly. These circumstances negatively affect the volume and quality of harvested hay and silage stocks. Moreover, a deficiency of fodder causes the uncontrollable increase in its price. Due to cost overruns on livestock and poultry management, the stock-raising enterprises are forced to raise the cost of production that leads to endemic rise in prices on food and feed. To solve this acute problem in strengthening forage base, as is indicated in the National Development Plan, outlined by the President of the RK N. Nazarbayev in his message "100 Concrete Steps to Implement Five Institutional Reforms", each farm must take care to ensure their own cattle grazing and stabling feed<sup>1, 2</sup>.

Rotation pastures and hayfields are created from meadow grass. At the same time, it is

known that in grassland pasture, leading place is occupied by intensive high-yielding alfalfa varieties with high protein content, resistant to diseases, as well as the methods of their cultivation. Here essential role is plaid by nutritional properties of agricultural background as well as methods of formation and use of seeded grass stands. Consequently, the goal of our research stems from the agrarian policy of Kazakhstan government aimed at ensuring food security and the country's competitiveness in crop production. In addressing these objectives, a key role belongs to industrial-innovative development strategy of forage production<sup>2, 3, 6</sup>.

For competitive livestock enhancement it is necessary to strengthen research to further improvement of the feed base. The composition and quality of currently produced forage does not meet the requirements of full feeding of animals that consists in an acute shortage of vegetable protein. In order to further develop this sector and reduce the cost of livestock production it is necessary to expand the acreage of high-protein perennial grasses, which provide the highest output of complete feed at a relatively low cost of

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labor and resources. One of these valuable herbs is alfalfa, which should take a leading position in field fodder production in South-Eastern Kazakhstan. This is due to the fact that in these climatic conditions alfalfa cultivar is characterized by stable yields, drought tolerance, responsiveness to soil wetting and fertilization, as well as the ability for rapid regrowth after mowing and grazing. Moreover, important is the fact that it is possible to obtain high-energy feeding-stuffs in the form of green mass, hay, silage, grass meal, etc. Palatability of this cultivar by all types of livestock is very high, while the economic storage life at high productivity can be maintained up to 4-5 years<sup>4, 7, 8</sup>.

When using rotation hayfields and pastures it is necessary to obtain not only greater vegetative mass, but also the greatest amount of digestible protein, as it is the cheapest way to eliminate the shortage of protein in the diets of animals. Here the emphasis is made on field fodder production and creation of seeded grasslands and pastures. To address this problem, it is recommended to use intense species and varieties of perennial legume grasses, and primarily alfalfa<sup>3, 5, 9</sup>.

It is also important that during the vegetation period with irrigation, alfalfa can provide 3-4 mowings, while in the harsh dry farming conditions - 2 full mowings. This greatly increases the efficiency of using forage acreage. In addition, alfalfa herbage restores soil fertility and serves as a good precursor for other crops. However, the issues of fodder production enhancement in the conditions of the foothill-steppe zone of the South-East Kazakhstan by means of cultivation of alfalfa employing innovative approaches is studied insufficiently. Therefore, the research topic concerned with the search of proper solutions to this problem is quite relevant.

In addressing the above issues, most promising for application are low-cost and resource-saving technologies focused on creation of seeded pastures and grazing land, providing for maximum returns at minimal cost. Here significant role belongs to factors of agricultural background, soil treatment techniques for alfalfa sowing, and agro-technical care of its herbage. Research conducted in different soil-climatic zones with regard to growing alfalfa show that the most

effective methods that increase the yield of alfalfa are various soil loosening techniques, such as beardless plowing, harrowing, scuffing, cultivation, paraploughing, and subplowing.

#### Methods

Field experiments were conducted at the scientific-experimental farm "Agrouniversity" of the Kazakh National Agrarian University and Kazakh Research Institute of Farming and Crop Production. In experiments we seeded Kapchagai 80 variety of alfalfa approved for the use in the Almaty region. The region's climate is continental, with high temperatures and moderate drought. The average annual air temperature ranges from 7 to 10°C, the daily average temperature in the hottest month of July ranges from 24 to 29°C, while that of coldest month of January varies from 7 to 12°C. The last possible frosts may occur in early May, while the first frosts may happen in September. The total duration of frostless period is 140-160 days, while the sum of effective temperatures for this period equals to 2800-3100°C. The annual rainfall is 350-510 mm reaching in spring maximum value of 40-45%, while it is almost twice less in summer and autumn periods. In winter the snow thickness does not exceed 15-20 cm, the snow precipitation is small (10-15%), while snow cover persists for 110-130 days.

Test sites are represented by meadow-chestnut soils. In accordance with the description of the Department of Soil Science and Agricultural Chemistry, the soil cover has the properties typical for the soils of the piedmont strip of the South-Eastern region of Kazakhstan. Soils are characterized by loamy granulometric composition with humus content ranging within 2-3%. The total content of nitrogen and phosphorus amounts for 0.12-0.29%, while the content of potassium is excessive.

Sowing was carried out on April 4 and 5, 2013. Record plot area was 100 m<sup>2</sup>, tests were conducted at the fourfold repetition. Farming technique corresponded to the zonal technology of alfalfa cultivation. Mathematical processing was carried out using analysis of variance<sup>5</sup>.

We studied the effect of primary and secondary tillage techniques on alfalfa forage mass productivity, consisting of moldboard plowing (control), beardless plowing, minimal tillage (primary tillage), and zero tillage at the background

of double superphosphate application at a rate of 48 kg/ha in the daytime. Tillage was combined with seedbed preparation, which consisted in scuffing, cultivating and bursting (at a depth of 12-14 cm) at the background of double harrowing, leveling, and rolling down before and after sowing. Mentioned techniques are essential elements of soil fertility that is crucial for successful growth of alfalfa not only during the first year, but in the later years as well. The determination of optimal parameters of these agronomic factors for alfalfa cultivation create real conditions for the formation of full-fledged forage mass with high protein content of this cultivar, which is very sensitive to soil fertility.

The following observations and surveys were conducted during the experiments:

- a) Phenological observations (beginning and ending of plant development phases);
- b) Count plant density per 1 m<sup>2</sup> in each experimental option;
- c) Measurement of plants height and determination of the foliage before assessing the harvest;
- d) Assessing the yield of forage mass in the early flowering phase by the method of plants mowing on each experimental plot;
- e) Analysis of the chemical composition and nutritional value of forage mass.

Observations and counts were conducted in accordance with practices generally accepted in agriculture, crop production and field fodder production. Mathematical data processing was carried out using analysis of variance<sup>6</sup>.

## RESULTS AND DISCUSSION

Application of mineral fertilizers is an important technique to provide a significant increase in the yield of alfalfa hay. There is an opinion, often perceived as a set rule, that alfalfa needs only phosphorus nutrition. However, the experiments conducted in the South-Eastern Kazakhstan and Eastern Siberia show that the application of complete mineral fertilizers results in significant increase in the seed yield of alfalfa. At that, the amount of the fodder mass was not subjected to significant changes<sup>2, 3, 4, 10</sup>.

The first mowing of alfalfa was conducted in wet and cool weather conditions. Therefore, the spring regrowth of plants proceeded inharmoniously and took pretty long time, as well as the duration of the flowering phase. Yields of alfalfa during the first and third years of life were low due to adverse weather conditions, consisting in the lack of rainfall, low atmospheric moisture and high air temperature during the three summer

**Table 1.** Effect of mineral fertilizers on yield of alfalfa hay over the years of life, hwt/ha, (2013-2015)

Option	1 <sup>st</sup> year	2 <sup>nd</sup> year	3 <sup>rd</sup> year	Average		
				Yield, hwt/ha	yield gain, hwt/ha	% to control
Without fertilizers, (control)	20.4	122.9	91.5	78.3	-	-
P <sub>48</sub>	28.6	137.6	117.9	94.7	16.4	120.9
HCP <sub>0.95</sub> , hwt	1.3	6.2	5.8			

**Table 2.** Effect of nitragin application on yield of alfalfa hay, hwt/ha

Option	Year of plant life						Average	
	1st		2nd		3rd		x	Yield gain
	x	Yield gain	x	Yield gain	x	Yield gain		
Control	20.4	-	122.9	-	91.5	-	78.3	-
Nitragin, 25 g/kg	21.9	1.5	127.8	4.9	112.8	21.3	87.5	9.2
Nitragin, 50 g/kg	28.6	8.2	137.6	14.7	117.9	26.4	94.7	16.4
Nitragin, 75 g/kg	24.3	3.9	124.4	1.5	108.2	16.7	85.6	7.3
HCP <sub>0.95</sub> , hwt	1.3		6.2		5.8			

months. Against this background, soil texture features in the soil treatment options such as minimum plowing + cultivation, beardless plowing + cultivation, and minimum plowing + bursting had a beneficial effect on the alfalfa vegetation. In the first year of the life of the alfalfa we obtained 20.4-28.6 hwt/ha of hay, taking into account additional yield of 8.2 hwt/ha that was caused by high application rates of  $P_{48}$ . Next year the yield of alfalfa hay has increased significantly over three mowings and accounted for 122.9-137.6 hwt/ha. Here we also obtained heavy yield in the option where additional yield amounted for 14.7 hwt/ha (Table 1).

Further, due to poor weather conditions in the period from June to August 2015 (lack of precipitation and high daily average air temperature) that had negative effects on the cultivar's vegetative mass formation, its productivity decreased to 91.5-117.9 hwt/ha. Nevertheless, despite the mentioned background, in this option we received the greatest yield gain (26.4 hwt/ha).

The use of nitragin had a significant effect on the enhancement of the alfalfa forage production indicators, resulting in essential increase in yield of hay as compared to the control, where the nitragin was not applied (Table 2).

The application of this preparation in any rates had sufficiently beneficial impact on the level of alfalfa forage production, which in physical terms amounted for 21.4-127.8 hwt/ha depending on harvest record year, and over three years was on average 85.6-94.8 hwt/ha, exceeding the best control option more than twice. The greatest extra yield was obtained in the first year of alfalfa life. Further we observed a subtle decrease in the yield of alfalfa hay. The third year of alfalfa life coincided with adverse weather conditions. Together with the damped effect of the previously used preparation this has led to a significant reduction in the productivity of the cultivar.

Studied techniques differently affected the productivity of alfalfa. The highest yield of hay was provided in an option with the minimal basic tillage + presowing cultivation, which amounted to 20.4-28.6 hwt/ha in a first year of plant life, 122.0-137.6 hwt/ha – in a second year, and 91.5-117.9 hwt/ha – in a third-year. Good results have been obtained in options such as beardless plowing + cultivation and minimum tillage +

bursting, which also were significantly superior to control. In terms of yield of hay, the options with the cultivation and bursting at beardless plowing and minimum tillage significantly exceeded the control. Higher extra yields were provided by techniques based on minimum primary soil tillage in combination with presowing cultivation.

Plant formation in old-growth crops is significantly thinned out due to large amount of accumulated specific pests and pathogens. Various recorded fungal diseases were evident in the studied seed-plot with various activities. The disease excitants invaded control within the range of 1.5-4.0 points, while in the option with application of  $P_{48}$  – 0.1-1.9 points. Thus, brown leaf spot (*Pseudopeziza medicaginis* Sacc) reaches maximum development during blossoming of alfalfa and causes premature and strong defoliation that leads to a decrease in yield of hay. Since the causative agents of spackled yellows and rust were almost lacking, just a single plants in a few plots were diseased by 0.1 points. The highest activity was shown mainly in third hay crops by agents of downy mildew. Apparently, they have adapted to Kapchagai 80 variety of alfalfa inasmuch that struck crops at 1.9-3.6 points.

As for spackled yellows (*Sporonema phacidioides* Desm (Syn. *Glocosporium morianum* Sacc), in our experiments the first mowing of alfalfa formed before mass development of the fungus. Therefore, we observed just a few specimens of affected plants. Maximum disease intensity (1.0-1.7 points) occurred in the second mowing. However, the infestation of alfalfa with spackled yellows was lower than with brown patch.

Virus diseases in alfalfa are also common in our agricultural zone. The external manifestation of plants infection with disease is tessellation, deformation, etiolation, necrosis, leaf and stem curl, leading to the transformation of the whole plant into “witches’ broom.” The virus is spread through the specialized pest – alfalfa psylla. The symptoms of plants infection by this virus were most evident in the third mowing. The assessment of disease accounted for 0.6-1.5 points.

Bacterial wilt diseased the control plants at 1.5 points, while in option with application of  $P_{48}$  – at 0.5 points. The presence of this pathogen is not always clearly detected, when using alfalfa in form of hay, rather than using it in seed form. The

infection of plants by bacterial wilt was more reliably detected on the seed bearers. Diseased plants lag behind in growth and development. Their depression affects the intensity of passing through phenological stages of flowering and fruit formation that ultimately leads to a significant reduction in the yield of hay and, especially, of the cultivar seed.

A significant reduction in hay yields in the third year of alfalfa life had a negative impact on the average results of conducted experiments. In the calculation of the average indicators over the three year period the yield of alfalfa hay was equal to 78.3-94.7 hwt/ha, where the additional yield in the studied option amounted to 16.4 hwt/ha, whereas the excess yield over the control was of 20.9%. The conducted calculations show that the average yield of hay in the option with application of  $P_{48}$  reliably exceeded that in the control option.

In the plots, treated by  $P_{48}$ , plants were 14-18 cm higher than those in control. At that, the alfalfa growth rates increased slightly (3 cm/day). The highest plant growth rates were observed in the plots with the application of  $P_{48}$  during the alfalfa branching and budding period. Application of mineral fertilizers contributed to a significant increase in indicators of the main elements of the plants habit. The greatest number of stalks and tassels were formed in the plots, treated with  $P_{48}$ , and nitragin applied in the rate of 50 g/kg of seeds. This led to a significant increase in yields of hay.

Discussing the obtained results, we can make preliminary conclusions that the most favorable conditions for forming the harvest of hay of the target cultivar is combination of different soil treatment techniques: minimum tillage and beardless plowing (main), as well as the cultivation and bursting (presowing) with the application of  $P_{48}$  and nitragin in the rate of 50 g/kg of seeds.

At unreasonably prolonged use of grass stand, arable layer of soil is heavily compacted. In addition, biotic factors, necessary for the successful functioning of the plant, essentially deteriorate. Consequently, the impact of these undesirable growing conditions hamper penetration of moisture and air to plant roots, microbial processes slow down, while adverse environmental factors are accumulated. Due to the significant negative impact of these conditions, the intensity of the alfalfa growth and development

is reduced and, ultimately, all this leads to losses in yield of forage mass.

Studied techniques of soil treatment and fertilizer application significantly reduced the activity of alfalfa pathogens, among which varieties of fungi, causing brown patch, spackled yellows, black stem, etc. are the most harmful and widespread in the South-East of Kazakhstan. Viral and bacterial diseases are sometimes dangerous as well.

## CONCLUSION

Analysis of the obtained data shows that use of the most optimal soil treatment methods, application of  $P_{48}$ , and treatment of seeds with nitragin at the rate of 50 g/kg significantly increase the yield of alfalfa hay. At all studied options, the yield of forage mass in alfalfa plots significantly decreased with the increase of plants age. A sharp decrease in the productivity of alfalfa in the third year of life seems to take place not only under the effect of adverse biotic and abiotic factors, but also because of noticeable weakening of aftereffect of mineral fertilizers.

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