Eurasian Journal of Soil Science 2022, 11(1), 61 - 65

Eurasian Journal of Soil Science

Journal homepage : http://ejss.fesss.org

Productivity of indigenous alfalfa (Medicago sativa) cultivar depending on agricultural practices on sierozem soils in South Kazakhstan

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Article Info

Received : 25.03.2021
Accepted : 01.09.2021
Available online : 10.09.2021

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Abstract

In Turkestan region of South Kazakhstan has large areas of fertile sierozem soils that are important for crop production and its accompanying economic development. And also, alfalfa (Medicago sativa) is an important forage crop grown for seed production. The soils are fertile loams, but because of the regions dry environment, they need to be irrigated. Field experiments were conducted from 2017 to 2020 on one-year or older alfalfa stands grown for seed production at various plots on sierozem soils in rainfed areas of Turkestan region to determine the influence of agricultural practices such as fertilizer use, pesticide use and conventional tillage on seed yield and dry hay of alfalfa stands. The findings of field research experiments indicated that agricultural practices of fertilizer use, pesticide use and conventional tillage was essential to obtain maximum seed yield and dry hay of alfalfa. But, it was determined that the best outputs tended to be obtained with Fertilizer use + Pesticide use + Conventional tillage.

Keywords: Sierozem, Alfalfa, fertilizer use, pesticide use, conventional tillage, agricultural practices.

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Introduction

Agriculture is an important part of the economy in Kazakhstan and contributes significantly to the food security of the majority of population. Sustainable development of agriculture, increase of production and improvement of population welfare largely depend on soil condition and its fertility. Over the past decade, the agricultural lands, however, have suffered from progressive degradation leading steadily to the loss of their fertility and eventually to a low yield and inefficiency of production as a whole (Nurbekov et al., 2016).

In South Kazakhstan, alfalfa (*Medicago sativa*) is one of the important forage crops, providing high-protein fodder as herbage, haylage, hay and vitamin-enriched flour. Alfalfa stimulates recovery of soil fertility and structure, protects sloping land from water erosion and prevents soil salinization on irrigated areas (Massaliyev et al., 2015) Yield of alfalfa under rainfed production depends mainly on the soil moisture available from rainfall. Alfalfa is one of the best preceding cover crop in a crop sequence for all crops and is included in all types of crop rotations recommended for rainfed areas in South Kazakhstan Province (Toktarbekova et al., 2020). Alfalfa gives rich harvest of hay and seeds for four years of its life-cycle, followed by a decrease in yields caused by strong thinning of herbage and infestation from ephemeral weeds.

: https://doi.org/10.18393/ejss.993599
: http://ejss.fesss.org/10.18393/ejss.993599
Publisher : Federation of Eurasian Soil Science Societies
e-ISSN : 2147-4249

Therefore, standing of alfalfa in cereal-fodder crop rotations should be for 3-4 years but sometimes it can be up to 5-6 years. Expansion of seeding areas under alfalfa on rainfed lands through outscaling Conservation Agriculture technologies is instrumental for building solid fodder reserves for livestock production.

South Kazakhstan is mostly an arid and semi-arid, strongly continental climate, with hot summers and cold winters. Sierozems are brown desert soils that are located in Turkestan region of South Kazakhstan and are extent of the alfalfa growing region (Shokparova and Issanova, 2013; Beketova et al., 2017; Yertayeva et al., 2018). Sierozem soils are a valuable resource because of their extent and because they are fertile. Sierozems must be properly managed and protected for efficient and sustainable productivity. They have been researched in the past but mainly as a soil-geographic resource. Further study is needed to quantify and expand their value in production and assure environmental sustainability (Jalankuzov et al., 2013; Saparov, 2014). Many factors are involved in producing a high-quality alfalfa crop. Although some factors (like rainfall and temperature) cannot be controlled, many other critical components of the production system can be carefully managed. High yields require maintenance of agricultural practices to meet the needs of the rapidly growing crop. As the demand for high-quality and high-yielding hay increases, closer examinations of the role of proper agricultural practices are needed.

Our objective was to study agricultural practices such as fertilizer use, pesticide use and conventional tillage, that would enhance alfalfa (*Medicago sativa*) on the sierozem soils of South Kazakhstan.

Material and Methods

Study Area

The experiment was performed at Kazygurt district of the Turkestan region, South Kazakhstan (Figure 1). The experimental fields had been in alfalfa growing regions of South Kazakhstan for at least 10 years. Alfalfa (*Medicago sativa*) is the major crop in this region, which are generally planted in March and harvested in October. This region is characterized by a semi-arid climate. Most of the precipitation occurred in June to September. The annual mean precipitation and mean temperature from the establishment of the experiment is shown in Figure 2.

Figure 1. Study area

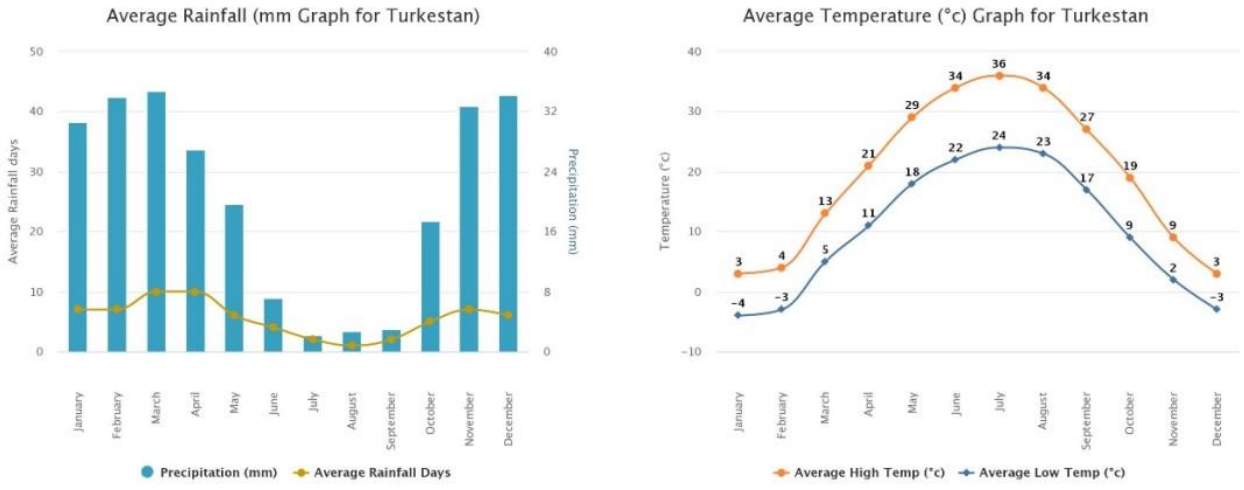

Figure 2. Monthly average temperature (0C) and distribution of precipitation (mm) of the experimental area.

Soil

The main soil type, which is typical for the region, is sierozem soils. The sierozem soils are found in arid regions which characterized by a brownish-gray surface on a lighter layer based on a carbonate or hard-pan

layer (USDA, 1999). Ordinary sierozems develop on loess-like loams and have fully developed profile with a rather noticeable division into genetic horizons. Sierozems are marked by good water-physiological properties, high biological activity, and adequate fertility; they produce high yields when irrigated. There are various subtypes: light, conventional (standard), dark, and northern (Saparov, 2014). The soil belongs to the general soil type of dark sierozem. The soil had a mean soil bulk density of 1.30-1.50 g/cm^3, pH was 7,6-7,7 and calcium carbonate ($CaCO_3$) concentration was 6,6-7,4%, soil organic matter was 1.02-1.38%, total N was 0.058-0.126%, available phosphorus was 8,5-19,5 mg/kg and exchangeable potassium was 360-388 mg/kg.

Alfalfa

The objects of the research were indigenous alfalfa (Medicago sativa) cultivar, Krasnovodopadskaya 8, allowed for use. Krasnovodopadskaya 8 is a early ripening indigenous from Kazakhstan alfalfa (Medicago sativa) cultivar. Proper variety selection can have a dramatic impact on yield, quality, and stand longevity. Select adapted, high yielding, and pest-resistant varieties. Consider using more than one variety if the planting involves a large acreage. Most states in the South Kazakhstan publish recommended indigenous alfalfa (Medicago sativa) cultivar, Krasnovodopadskaya 8.

Treatments and Experimental design

The field experiment was performed using a completely randomized block design with four replications during the 2017-2020. In this experiment four different years old indigenous alfalfa used. These alfalfas are i) 1st years old, ii) 2nd years of life, iii) 3rd years of life, and iv) 4th years of life. The experimental unit was 200 m^2 (20 m x 10m). The experiment was performed with the following five treatments of agricultural practices given in Table 1. During the field experiment (2017-2020), every year same agricultural practices used in same plot of field experiment.

Table 1. Treatment description and practice of conservation agriculture used in the field experiment during the 2017 – 2020.

Treatments	Fertilizer Use	Pesticide Use	Conventional Tillage
T1 (Absolute Control)	-	-	-
T2	-	+	-
T3	-	-	+
T4	+	-	+
T5	+	+	+

The sources of fertilizers used were urea 46% N and triple superphosphate 44% P_2O_5. The dose of N was 12 kg/ha, P was 40 kg/da at the beginning of March. The source of pesticide used was Karate 5 EC (active ingredient is: Lambda-Cyhalothrin) and its dose was 0.2 lt/ha. A tillage method is 12-14 cm soil depth using with chisel cultivator at second decade of March. Data on seed yield and dry hay of alfalfa were measured from all plots during the 2018-2020. The economic efficiency of the factors under study is determined by calculating the actual costs of labor and funds for all types of work, the prevailing norms and market prices in the region of the Turkestan region, Kazakhstan.

Results and Discussion

Effect of different agricultural practices on seed yield and dry hay of alfalfa was evaluated (Figure 3). There were no significant differences among treatments for seed yield and dry hay of alfalfa between 2018 and 2020. According to the Figure 3, there was a significant difference between control treatments (T1) on seed yield and dry hay of alfalfa and agricultural practices (T2, T3, T4 and T5). All agricultural practices significantly influenced seed yield and dry hay of alfalfa compared to control treatment. Chemical inputs (Fertilizer and pesticide use) and conventional tillage increased the seed yield and dry hay of alfalfa. However, Fertilizer use + Pesticide use + Conventional tillage (T5) has shown a great influence on the seed yield and dry hay of alfalfa followed by Fertilizer use + Conventional tillage (T4). The lowest seed yield and dry hay recorded by the control experiment (T1) might be the reason why the yield parameters were very low compared with other treatments. Pesticide use (T2) and Conventional tillage (T3) were similar in their effect on seed yield and dry hay of alfalfa.

In South Kazakhstan, alfalafa is an important forage crop in sierozem soils. Alfalfa is a high-yielding, high-quality perennial forage that removes plant nutrients from soil in large quantities. For optimal production, the nutrients must be available at the appropriate level and time. It is common practice to not to apply fertilizer in the first year of alfalfa, which results in relatively low yields but newly planted alfalfa needs a readily available supply of phosphorus, potassium and other plant nutrients immediately after emergence. A well-planned fertilizer program is necessary for alfalfa forage production. Berg et al. (2003) reported that to

meet the total seasonal nutritional requirements, an adequate nutrient supply must be available for uptake by the crop to meet periods of peak demand. In South Kazakhstan, this peak demand time for nutrients will be the late-bud stage when the crop is fully covering the ground and when intensive plant growth is going on. Applying 12 kg N/ha and 40 kg P/ha^{-1} (T4 and T5) during seeding has been shown to increase seedling size by four times compared to no fertilizer (control) treatment (T1). Between 2017 and 2020, the difference in seed yield and dry hay of alfalfa between unfertilized plots (T1) and fertilized plots (T4, T5) further increased, and a significant difference was observed between the T1 and T4 treatments (Figure 3). These findings corroborated the results of other studies that reported a positive influence of P and N on alfalfa yield even in soils (Markus and Battle, 1965; Kafkafi et al., 1977; Barbarick, 1985; Macolino et al., 2013; Yertayeva et al., 2019).

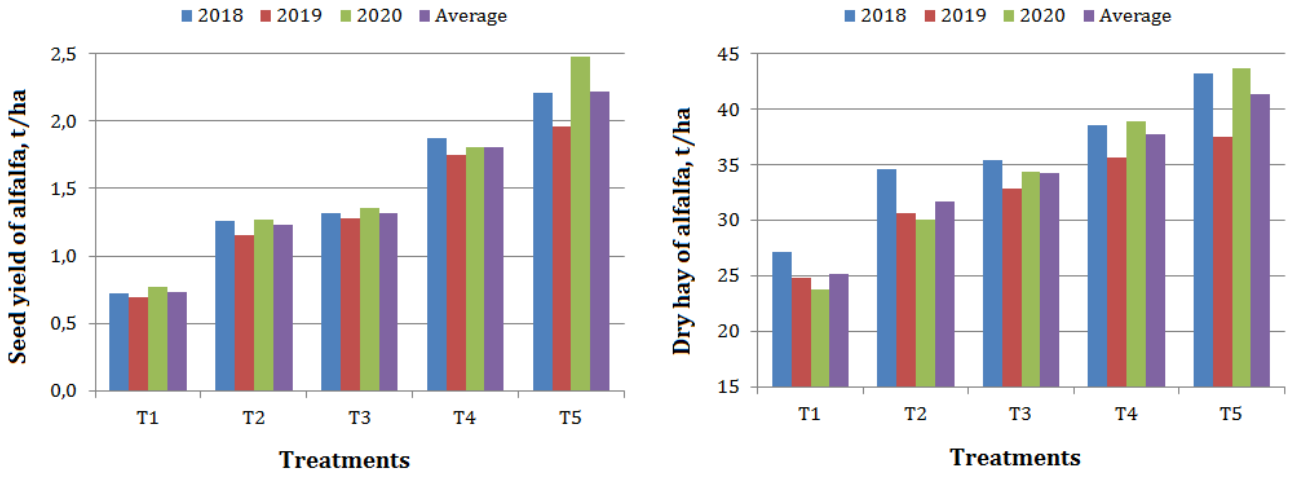

Figure 3. Effect of agricultural practices on seed yield and dry hay of alfalfa

Alfalfa weevil control is often necessary for high yields, high quality, and long-lived stands. Other insects may, at times, attack alfalfa. These include meadow spittlebugs, aphids, clover-root curculios, three-cornered alfalfa hoppers, and grasshoppers. In the South Kazakhstan, blister beetles will occasionally infest alfalfa, but are rarely problematic. Use of resistant varieties, proper harvest and fertility management, routine scouting, biological control, and selective use of insecticides are important factors in insect control. In this experiment, pesticide use (T2 and T5) increased the seed yield and dry hay of alfalfa compared to control treatment (T1). Similar results were obtained by Pellissier et al. (2017) and Harrington et al (2021) on alfalfa and the other crops. Numerous studies have reported that if plants have an insect pest problem, pesticide usage increased plant yield and yield parameters (Sun et al., 2014; Moyer et al., 2014).

In the South Kazakhstan, in rainfed areas under conventional tillage, the biggest problem is with open fallow when multiple tillage operations are conducted to control weeds, causing substantial soil erosion and degradation. It is established that through application of No-Till practices soil moisture can be increased and conserved compared with conventional tillage. However, it was determined that, seed yield and dry hay of alfalfa affected by conventional tillage practices (T3, T4 and T5) compared to absolute control plot (T1). Conventional tillage practices increased (T3, T4, T5) increased the seed yield and dry hay of alfalfa compared to control treatment (T1). In this research, we used Chisel cultivator to conventional tillage. Chisel plow has some adventages and disadvantages. Major advantages are : less erosion than from cleanly tilled systems and less wind erosion than fall plow or fall disk because of rough surface; Well adapted to poorly drained soils; Good to excellent incorporation. Major disadvantages are: Little erosion control; High soil moisture loss; Medium to high labor and fuel requirements (Amini and Asoodar, 2015). Similar results were obtained by Małecka et al. (2012) and Suleimenova et al. (2019) on alfalfa and the other crops.

Conclusion

Agriculture is an important part of the economy in Kazakhstan and contributes significantly to the food security of the majority of population. Sustainable development of agriculture, increase of production and improvement of population welfare largely depend on soil condition and its fertility. Traditionally, agriculture in South Kazakhstan province is dominated by medium-size and small farms. Water deficiency has remained one of the most important issues in the irrigated crop sector of South Kazakhstan province. In order to increase plant production in sierozems, which are widely distributed in Southern Kazakhstan, the effect of various agricultural practices other than irrigation has been one of the important research topics. In this study, the effects of fertilizer use, pesticide use and conventional tillage on alfalfa yields grown on

sierozems were investigated. According to the results, it was determined that each of the agricultural practices had a significant effect on increasing alfalfa yield. However, the best outputs tended to be obtained with Fertilizer use + Pesticide use + Conventional tillage. However, it is necessary to detail the results obtained from this study with future studies.

References

Amini, S., Asoodar, M.A., 2015. The effect of conservation tillage on crop yield production (The Review). *New York Science Journal* 8(3): 25-29.

Barbarick, K.A. 1985. Potassium fertilization of alfalfa on a soil high in potassium. *Agronomy Journal* 77: 442–445.

Beketova, A.K., Kaldybaev, S., Yertayeva, Z., 2017. Changes in the composition and properties of meadow solonchaks of the ili alatau foothill plain in the republic of Kazakhstan during a long postmeliorative period. *OnLine Journal of Biological Sciences* 17(4): 290–298.

Berg, W.K., Brouder, S.M., Joern, B.C., Johnson, K.D., Volenec, J.J., 2003. Improved phosphorus management enhances alfalfa production. *Better Crops* 87 (3): 20-24.

Harrington, K., Carrière, Y., Mostafa, A.M., 2021. Re-evaluating the economic ınjury level for alfalfa weevil (Coleoptera: Curculionidae) control in low desert irrigated alfalfa. *Journal of Economic Entomology* 114(3): 1173–1179.

Jalankuzov, T., Suleimenov, B., Busscher, W.J., Stone, K.C., Bauer, P.J., 2013. Irrigated cotton grown on sierozem soils in South Kazakhstan. *Communications in Soil Science and Plant Analysis* 44(22): 3391-3399.

Kafkafi, U., Yoles, D., Noy, Y., 1997. Studies on fertilization of field-grown irrigated alfalfa I. Effect of potassium source and time of application. *Plant and Soil* 46: 165–173.

Macolino, S., Lauriault, L.M., Rimi,F., Ziliotto, U., 2013. Phosphorus and Potassium Fertilizer Effects on Alfalfa and Soil in a Non-Limited Soil. *Agronomy Journal* 105: 1613–1618.

Małecka, I., Blecharczyk, A., Sawinska, Z., Dobrzeniecki, T., 2012. The effect of various long-term tillage systems on soil properties and spring barley yield. *Turkish Journal of Agriculture and Forestry* 36: 217-226.

Markus, D.K., Battle, W.R., 1965. Soil and plant responses to long-term fertil-ization of alfalfa (*Medicago sativa* L.). *Agronomy Journal* 57: 613–616.

Massaliyev, N.M., Ramazanova, S.B., Rakhymzhanov, B.S., 2015. Influence of alfalfa varieties on changes in the composition of mobile forms of phosphorus in the soil in the South-Eastern Kazakhstan. *Biosciences Biotechnology Research Asia* 12(2): 691-698.

Moyer, J.L., Whitworth, R.J., Davis, H., 2014. Flaming dormant alfalfa for pest control. *American Journal of Plant Sciences* 5(7): 44124.

Nurbekov, A., Kassam, A., Sydyk, D., Ziyadullaev, Z., Jumshudov, I., Muminjanov, H., Feindel, D., Turok, J., 2016. Practice of conservation agriculture in Azerbaijan, Kazakhstan and Uzbekistan. Food and Agriculture Organization of The United Nations. Ankara, Turkey. 69p. Available at [access date: 25.03.2021]: http://www.fao.org/3/i5694e/i5694e.pdf

Pellissier, M.E., Nelson, Z., Jabbour, R., 2017. Ecology and management of the alfalfa weevil (Coleoptera: Curculionidae) in Western United States Alfalfa. *Journal of Integrated Pest Management* 8(1): 5;1-7.

Saparov, A., 2014. Soil resources of the Republic of Kazakhstan: Current status, problems and solutions. In: Novel measurement and assessment tools for monitoring and management of land and water resources in agricultural landscapes of Central Asia. Mueller, L., Saparov, A., Lischeid, G. (Eds.). Environmental Science and Engineering. Springer, Cham. pp. 61-73.

Shokparova, D.K., Issanova, G.T., 2013. Degradation of sierozem soils in the Ile Alatau Foothils. *World Applied Sciences Journal* 26 (7): 979-986

Suleimenova, N., Makhamedova, B., Orynbasarova, G., Kalykov, D., Yertayeva, Z., 2019. Impact of resource conserving technologies (RCT) on soil physical properties and rapeseed (Brassica napus L.) yield in irrigated agriculture areas of the south-eastern Kazakhstan. *Eurasian Journal of Soil Science* 8(1): 83–93.

Sun, B., Peng,Y., Yang,H., Li, Z., Gao, Y., Wang, C., Yan,Y., Liu, Y., 2014. Alfalfa (Medicago sativa L.)/Maize (Zea mays L.) intercropping provides a feasible way to improve yield and economic incomes in farming and pastoral areas of Northeast China. *PlosOne* 9(10): e110556.

Toktarbekova, S.T.K., Meiirman, G.T., Yerzhanova, S.T., Abayev, S.S., Umbetov, A.K., 2020. Productivity of the green mass of new alfalfa cultivars depending on the effect of macro- and microfertilizers on various phosphorous backgrounds. *Journal of Ecological Engineering* 21(2):57–62.

USDA, 1999. Soil Taxonomy. A Basic System of Soil Classification for Making and Interpreting Soil Surveys. United States Department of Agriculture, Natural Resources Conservation Service, Agriculture Handbook Number 436. 886p. Available at [access date:25.03.2021]: https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_051232.pdf

Yertayeva, Z., Kaldybaev, S., Beketova, A., 2018. The scientific basis of changes in the composition and properties of meadow saline soil of the foothill plains of the ili alatau during a long postmeliorative period. *Ecology, Environment and Conservation* 24(2): 715–720.

Yertayeva, Z., Kızılkaya, R., Kaldybayev, S., Seitkali N., Abdraimova, N., Zhamangarayeva, A., 2019. Changes in biological soil quality indicators under saline soil condition after amelioration with alfalfa (Medicago sativa L.) cultivation in meadow Solonchak. *Eurasian Journal of Soil Science* 8(3): 189–195.